PROGRAMMATIC BIOLOGICAL ASSESSMENT
FOR
ONGOING AND PROGRAMMED FUTURE MILITARY OPERATIONS AND ACTIVITIES
AT
FORT HUACHUCA, ARIZONA

JULY 2002

ENVIRONMENTAL AND NATURAL RESOURCES DIVISION
DIRECTORATE OF INSTALLATION SUPPORT
US ARMY GARRISON
FORT HUACHUCA, ARIZONA

LIST OF ACRONYMS AND ABBREVIATIONS

AAFES	Army and Air Force Exchange Service
ac-ft	Acre feet
ADES	Arizona Department of Economic Security
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AEIS	Annual Economic Impact Statement
AEROSTAT	AEROSTAT Radar System
AGFD	Arizona Game and Fish Department
AMA	Active Management Area
AR	Army Regulation
ASA	Army Security Agency
ASC/NETCOM	Army Signal Command/Network Enterprises Technology Command
ASIP	Army Stationing and Installation Plan
ASP	Ammunition Supply Point
ATC	Air Traffic Control
AWRMP	Army Water Resources Management Plan
AZ ANG	Arizona Air National Guard
AZ ARNG	Arizona Army National Guard
BA	Biological Assessment
BLM	US Bureau of Land Management
Bn	Battalion
BO	Biological Opinion
BRWRA	Blue Range Wolf Recovery Area
CER	Center for Economic Research
cfs	Cubic feet per second
CLIMAS	Climatic Assessment
CPOC	Civilian Personnel Operations Center
DA	Department of the Army
DIS	Directorate of Installation Support
DoD	US Department of Defense
DZ	Drop Zones
EA	Environmental Assessment
ECAP	Environmental Compliance Achievement Program
EEC	Engineering and Environmental Consultants, Inc.
EIFS	Economic Impact Forecast System
EIS	Environmental Impact Statement
EPG	US Army Electronic Proving Ground
EPR	Environmental Program Requirements
ENRD	Environmental and Natural Resources Division
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FLPMA	Federal Land Protection and Management Act
FR	Federal Register
FTJE	Full-Time Job Equivalents
FTX	Field Training Exercise
gpd	Gallons per day
gppd	Gallons per person per day
gpm	Gallons per minute
IA	Inventory Areas
INA	Irrigation Non-expansion Area
INRMP	Integrated Natural Resource Management Plan
ITAM	Integrated Training Area Management
LAAF	Libby Army Airfield
LLNB	Lesser Long-Nosed Bat
LRAM	Land Rehabilitation and Maintenance
LSPB	Lower San Pedro Basin
MCA	Military Construction Army
MG	Millions of gallons
MI	Military Intelligence
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MO ANG	Missouri Air National Guard
mph	Miles per hour
msl	Mean sea level
MSO	Mexican Spotted Owl
NATO	North Atlantic Treaty Organization
NEPA	National Environmental Policy Act
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
OMA	Operation and Maintenance Army
PAC	Protected Activity Center
Pers. com.	Personal communication
RATO	Rocket Assisted Take-offs
RCRA	Resource Conservation and Recovery Act
RU	Recovery Units
RV	Recreational Vehicle
SAIC	Science Applications International Corporation
SPRNCA	San Pedro Riparian National Conservation Area
TM	Technical Manual
TNC	The Nature Conservancy
TR	Transitional Residence
TRADOC	Army Training and Doctrine Command
UAV	Unmanned Aerial Vehicle
USPP	Upper San Pedro Partnership
USASC	US Army Signal Command
USAF	US Air Force
USAG	US Army Garrison
USAIC	US Army Intelligence Center
USAIC&FH	US Army Intelligence Center & Fort Huachuca
USDA	US Department of Agriculture
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
USP	Upper San Pedro
USPB	Upper San Pedro Basin
UXO	Unexploded Ordnance
W&EST	Water and Environmental Systems Technology
WIG	Water Issues Group
YBCU	Yellow-Billed Cuckoo

THIS DOCUMENT CONTAINS SENSITIVE INFORMATION ABOUT BIOLOGICAL RESOURCES. ITS USE AND DISTRIBUTION SHOULD BE RESTRICTED TO AGENCY RESOURCE MANAGERS AND SPECIALISTS. GENERAL DISTRIBUTION OF THIS INFORMATION COULD LEAD TO DISTURBANCE OF PROTECTED BIOLOGICAL RESOURCES.

EXECUTIVE SUMMARY

This Biological Assessment (BA) is a comprehensive document that analyzes the potential effects to threatened and endangered species and their critical habitat, related to Fort Huachuca's presence within the Sierra Vista subwatershed. Fort Huachuca has included many significant conservation measures, which are also a part of the proposed action.

By incorporating the conservation measures committed to in the BA, the Army expects the resulting Biological Opinion (BO) will provide a quantifiable, measurable, and time-sensitive plan to address all direct, indirect, interrelated, and interdependent effects associated with its water usage in the Sierra Vista subwatershed. The Army is committed to achieving zero balance between its pumpage and recharge so that by the year 2011 it will have "no effect" with regard to its water usage in the Sierra Vista subwatershed. Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects (3,599 ac-ft) associated with groundwater usage by 2011 as well. Together the Army expects that the groundwater deficit in the Sierra Vista subwatershed will be reduced to zero by 2011.

This BA analyzes the potential effects of ongoing and programmed future military operations and activities at and near Fort Huachuca on federally listed threatened and endangered species, proposed and candidate species and designated critical habitat. The scope of the BA includes lands controlled or leased by Fort Huachuca, the restricted airspace used by the installation, and adjacent lands to include the San Pedro Riparian National Conservation Area (SPRNCA).
The operational baseline at Fort Huachuca is comprised almost entirely of intelligence and communications systems testing and training. Because of the nature of this vital national defense mission, these activities account for nearly 95% of training range use (USAIC&FH 1997). Other activities on the Fort include field training exercises, aviation activities, live-fire qualification and training, vehicle maneuver training, and administrative and support activities.

The species addressed in this BA were identified from a USFWS listing of all federally listed, proposed and candidate species that may occur in the project area (Cochise County). A total of 28 species or subspecies of plants and animals are addressed in this BA, 21 of which are federally listed, one is proposed, five are federal candidate species, and one is a species for which there is a conservation agreement in place. Critical habitat designations for four species are also addressed.

Species considered in this BA include Cochise pincushion cactus, Canelo Hills ladies' tresses, Huachuca water umbel, Lemmon fleabane, Huachuca springsnail, bald eagle, Mexican spotted owl, southwestern willow flycatcher, cactus ferruginous pygmy-owl, northern aplomado falcon, yellow-billed cuckoo, whooping crane, mountain plover, black-tailed prairie dog, lesser long-nosed bat, jaguar, ocelot, Mexican gray wolf, Sonora tiger salamander, Ramsey Canyon leopard frog, Chiricahua leopard frog, New Mexican ridge-nosed rattlesnake, Gila topminnow, Gila chub, desert pupfish, loach minnow, spikedace, and razorback sucker. Potential effects to the designated critical habitat for the Huachuca water umbel, Mexican spotted owl, spikedace, and loach minnow are also addressed.

Determination of the potential effects of ongoing and programmed future military operations and activities at and near Fort Huachuca to federally listed, proposed, and candidate species was based on existing information about the distribution, abundance, habitat requirements, and sensitivity to disturbance of the individual species. These determinations considered the implementation of conservation measures as described in Section 5 because they are part of the proposed action.

Fort Huachuca's ongoing and programmed future military operations and activities will have no effect on the following 15 species: razorback sucker, desert pupfish, Cochise pincushion cactus, cactus ferruginous pygmy-owl, whooping crane, Chiricahua leopard frog, black-tailed prairie dog, New Mexican ridge-nosed rattlesnake, Gila topminnow, Gila chub, mountain plover, ocelot, Mexican gray wolf, Lemmon fleabane, and the northern aplomado falcon.

Ongoing and proposed activities by Fort Huachuca may affect, but are not likely to adversely affect, the following five species: Canelo Hills ladies' tresses, bald eagle, jaguar, and the loach minnow and spikedace to include their designated critical habitat.

Under current conditions, activities at Fort Huachuca have the potential to adversely affect the following eight species: Huachuca water umbel, Mexican spotted owl, lesser long-nosed bat, Sonora tiger salamander, the southwestern willow flycatcher, Ramsey Canyon leopard frog, Huachuca springsnail, and the yellow-billed cuckoo. This includes critical habitat designated for the Huachuca water umbel and Mexican spotted owl.

To offset the potential effects by Fort Huachuca on the above species with regard to water usage, the Army has committed to a series of aggressive water conservation measures and projects. Specifically, Fort Huachuca commits to achieving zero water balance for its on-post water use. In other words, by the year 2007, any water consumed by Fort Huachuca operations on-post will be balanced by the Fort's water recharge, conservation, and replenishment actions. Even more significantly, by the year 2011, Fort Huachuca commits to balancing both on-post and off-post water use that is attributable to it. This BA describes the measures, projects, and actions that Fort Huachuca will employ to save 2,784 acre-feet (ac-ft) of water per year in the Sierra Vista subwatershed by 2011. Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects (3,599 ac-ft) associated with groundwater usage by 2011 as well.

In light of its extensive mitigation and conservation commitments, the Army's proposed activities at and near Fort Huachuca are not likely to jeopardize the continued existence of any federally listed, proposed, or candidate species.

TABLE OF CONTENTS

SECTION 1 INTRODUCTION 1
1.1 OBJECTIVE 1
1.2 SCOPE 1
1.3 CONSULTATION HISTORY 4

SECTION 2 PROPOSED ACTION - FORT HUACHUCA'S ONGOING AND PROGRAMMED OPERATIONS AND ACTIVITIES 5
2.1 BASELINE OPERATIONS, ACTIVITIES, AND MISSIONS 5
2.2 MILITARY OPERATIONS AND ACTIVITIES 5
2.2.1 MILITARY INTELLIGENCE TRAINING 6
2.2.2 INTELLIGENCE AND COMMUNICATIONS SYSTEMS 6
2.2.3 MANAGEMENT, OPERATION, AND MAINTENANCE OF ARMY INFORMATION SYSTEMS 6
2.2.4 INTELLIGENCE AND ELECTRONIC WARFARE EQUIPMENT TRAINING AND TESTING 7
2.2.5 COMMUNICATIONS SYSTEMS TRAINING AND TESTING 8
2.2.6 FIELD TRAINING EXERCISES 11
2.2.7 LAND NAVIGATION 11
2.2.8 PATROLLING AND TACTICS TRAINING 13
2.2.9 INDIVIDUAL DEVELOPMENT TRAINING 13
2.2.10 VEHICLE MANEUVER TRAINING 14
2.2.11 LIVE FIRE QUALIFICATION AND TRAINING 14
2.2.12 SMALL ARMS 16
2.2.13 ARTILLERY AND MORTAR 18
2.2.14 ADMINISTRATIVE AND SUPPORT ACTIVITIES 18
2.3 AVIATION ACTIVITIES 18
2.3.1 FIXED-WING PILOTED AIRCRAFT TRAINING 22
2.3.2 ROTARY-WING AIRCRAFT OPERATION AND TRAINING 23
2.3.3 UNMANNED AERIAL VEHICLE TESTING AND TRAINING 23
2.3.4 UNMANNED DRUG SURVEILLANCE BALLOON OPERATION 25
2.4 RECREATIONAL ACTIVITIES 25
2.4.1 RECREATIONAL ACTIVITIES AT FORT HUACHUCA 26
2.4.2 HUNTING AND FISHING 26
2.4.3 HIKING, CAMPING, AND SPORTS 26
2.4.4 HORSEBACK RIDING AND GRAZING 30
2.5 INTEGRATED NATURAL RESOURCES MANAGEMENT AND FIRE MANAGEMENT PLANNING 30
2.6 REALTY ACTIONS AND ENERGY INITIATIVES 34
2.7 PROGRAMMED FACILITIES DEVELOPMENT 35
2.8 CANTONMENT AREA 35
2.9 TRAINING AREA ACTIVITIES 37
2.9.1 TRAINING AREA ALPHA 37
2.9.2 TRAINING AREA BRAVO 39
2.9.3 TRAINING AREA CHARLIE 39

2.9.4 TRAINING AREA DELTA 40
2.9.5 TRAINING AREA ECHO 41
2.9.6 TRAINING AREA FOXTROT 41
2.9.7 TRAINING AREA GOLF 42
2.9.8 TRAINING AREA HOTEL 42
2.9.9 TRAINING AREA INDIA 43
2.9.10 TRAINING AREA JULIET 43
2.9.11 TRAINING AREA KILO 44
2.9.12 TRAINING AREA LIMA 44
2.9.13 TRAINING AREA MIKE 45
2.9.14 TRAINING AREA NOVEMBER 45
2.9.15 TRAINING AREA OSCAR 46
2.9.16 TRAINING AREA PAPA 46
2.9.17 TRAINING AREA QUEBEC 46
2.9.18 TRAINING AREA ROMEO 47
2.9.19 TRAINING AREA SIERRA 47
2.9.20 TRAINING AREA TANGO 48
2.9.21 TRAINING AREA UNIFORM 48
2.9.22 TRAINING AREA VICTOR 49
2.9.23 TRAINING AREA WHISKEY 49
2.9.24 TRAINING AREA X-RAY 50
2.9.25 TRAINING AREA YANKEE 50
2.9.26 IMPACT AREA ZULU 51
2.10 OFF-POST ACTIVITIES AUTHORIZED OR CARRIED OUT BY FORT HUACHUCA 52

SECTION 3 ENVIRONMENTAL SETTING 53
3.1 LAND USE 53
3.1.1 INSTALLATION LAND USE 55
3.1.2 OPEN/OPERATIONAL AREAS 55
3.1.3 BUILT-UP AREAS 57
3.2 CLIMATE 57
3.3 SOILS 58
3.4 PHYSIOGRAPHY 60
3.5 WATER RESOURCES 64
3.5.1 REGIONAL SURFACE WATER RESOURCES 64
3.5.2 SURFACE WATER AT FORT HUACHUCA 67
3.5.3 WATER QUALITY 67
3.6 HYDROLOGY OF THE UPPER SAN PEDRO RIVER BASIN 67
3.6.1 BACKGROUND 67
3.6.2 RIVER FLOW AND TRENDS 68
3.6.3 SUMMARY OF GROUNDWATER DATA 74
3.6.4 SUMMARY OF PREDICTIVE MODELING 77
3.7 WATER USE AND MANAGEMENT 86
3.7.1 REGIONAL WATER SUPPLY 86
3.7.2 FORT HUACHUCA WATER SUPPLY 87

3.7.3 GROUNDWATER DEFICIT IN THE SIERRA VISTA SUBWATERSHED 87
3.7.4 TOTAL POPULATION IN THE SIERRA VISTA SUBWATERSHED 88
3.7.5 DIRECT, INDIRECT, INTERRELATED, AND INTERDEPENDENT POPULATION ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED 89
3.7.6 INDUCED POPULATION ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED 91
3.7.7 INDIRECT POPULATION ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED 92
3.7.8 TOTAL WATER USE ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED 93
3.7.9 CUMULATIVE EFFECTS – POPULATION AND WATER USE PROJECTIONS 94
3.8 BIOLOGICAL RESOURCES 95
3.8.1 VEGETATION 95
3.8.2 SOUTH RANGE 97
3.8.3 WEST RANGE 99
3.8.4 EAST RANGE 99
3.8.5 FAUNA 100
3.9 FEDERALLY LISTED, PROPOSED, AND CANDIDATE SPECIES 100
3.9.1 COCHISE PINCUSHION CACTUS 101
3.9.2 CANELO HILLS LADIES' TRESSES 105
3.9.3 HUACHUCA WATER UMBEL 106
3.9.4 LEMMON FLEABANE 114
3.9.5 HUACHUCA SPRINGSNAIL 115
3.9.6 BALD EAGLE 115
3.9.7 MEXICAN SPOTTED OWL 117
3.9.8 SOUTHWESTERN WILLOW FLYCATCHER 122
3.9.9 CACTUS FERRUGINOUS PYGMY-OWL 126
3.9.10 NORTHERN APLOMADO FALCON 128
3.9.11 YELLOW-BILLED CUCKOO 131
3.9.12 MOUNTAIN PLOVER 133
3.9.13 WHOOPING CRANE 134
3.9.14 LESSER LONG-NOSED BAT 135
3.9.15 JAGUAR 139
3.9.16 OCELOT 141
3.9.17 MEXICAN GRAY WOLF 142
3.9.18 BLACK-TAILED PRAIRIE DOG 144
3.9.19 SONORA TIGER SALAMANDER 146
3.9.20 RAMSEY CANYON LEOPARD FROG 149
3.9.21 CHIRICAHUA LEOPARD FROG 151
3.9.22 NEW MEXICAN RIDGE-NOSED RATTLESNAKE 152
3.9.23 GILA TOPMINNOW 153
3.9.24 DESERT PUPFISH 154
3.9.25 LOACH MINNOW 155
3.9.26 SPIKEDACE 157

3.9.27 RAZORBACK SUCKER 159
3.9.28 GILA CHUB 160

SECTION 4 POTENTIAL EFFECTS OF PROPOSED ACTION ON FEDERALLY LISTED, PROPOSED, AND CANDIDATE SPECIES 163
4.1 GENERAL EFFECTS ANALYSIS 164
4.2 HABITAT LOSS 164
4.3 FIRE 165
4.3.1 FORT HUACHUCA 165
4.3.2 US FOREST SERVICE LAND 168
4.3.3 SAN PEDRO RIVER 168
4.3.4 BABOCOMARI RIVER 169
4.4 NOISE 169
4.5 DIRECT MORTALITY 171
4.6 HUMAN DISTURBANCE 171
4.7 EROSION 172
4.8 GROUNDWATER USE 173
4.9 CUMULATIVE EFFECTS 175
4.10 EFFECTS DETERMINATIONS FOR THREATENED, ENDANGERED, PROPOSED AND CANDIDATE SPECIES AND DESIGNATED CRITICAL HABITAT 177
4.10.1 HUACHUCA WATER UMBEL 180
4.10.2 SOUTHWESTERN WILLOW FLYCATCHER 194
4.10.3 MEXICAN SPOTTED OWL 202
4.10.4 LESSER LONG-NOSED BAT 215
4.10.5 SONORA TIGER SALAMANDER 224
4.10.6 YELLOW-BILLED CUCKOO 228
4.10.7 HUACHUCA SPRINGSNAIL 232
4.10.8 RAMSEY CANYON LEOPARD FROG 234
4.10.9 SPIKEDACE 236
4.10.10 LOACH MINNOW 239
4.10.11 CANELO HILLS LADIES' TRESSES 242
4.10.12 BALD EAGLE 243
4.10.13 JAGUAR 243
4.10.14 CHIRICAHUA LEOPARD FROG 244
4.10.15 MOUNTAIN PLOVER 244
4.10.16 OCELOT 245
4.10.17 BLACK-TAILED PRAIRIE DOG 245
4.10.18 DESERT PUPFISH 246
4.10.19 GILA TOPMINNOW 246
4.10.20 GILA CHUB 247
4.10.21 WHOOPING CRANE 247
4.10.22 NORTHERN APLOMADO FALCON 247
4.10.23 LEMMON FLEABANE 248

SECTION 5 CONSERVATION MEASURES 249
5.1 INTRODUCTION 249
5.2 WATER RELATED CONSERVATION MEASURES 250
5.2.1 WATER CONSERVATION 251
5.2.2 EFFLUENT REUSE 251
5.2.3 EFFLUENT RECHARGE 254
5.2.4 CONSERVATION EASEMENTS 255
5.2.5 STORMWATER RECHARGE 256
5.2.6 WATER MITIGATION POLICY 257
5.2.7 SUMMARY OF WATER CONSERVATION MEASURES 260
5.3 REGIONAL INITIATIVES THAT ADDRESS CUMULATIVE GROUNDWATER USAGE 260
5.3.1 UPPER SAN PEDRO PARTNERSHIP 261
5.3.2 CITY OF SIERRA VISTA EFFLUENT RECHARGE PROJECT 263
5.3.3 BUREAU OF LAND MANAGEMENT LAND 264
5.3.4 US FOREST SERVICE 264
5.3.5 STATE OF ARIZONA LAND EXCHANGES 264
5.3.6 COCHISE COUNTY – SIERRA VISTA 265
5.3.7 ARIZONA DEPARTMENT OF WATER RESOURCES 266
5.3.8 SAN PEDRO ALLIANCE 266
5.3.9 STREAMFLOW GAUGING AND EDUCATION 266
5.3.10 SAN PEDRO FOUNDATION 267
5.3.11 NATURE CONSERVANCY AND UDALL CENTER 267
5.3.12 INTERNATIONAL AGREEMENT BETWEEN MEXICO AND THE UNITED STATES ON PROTECTING THE SAN PEDRO RIVER 267
5.3.13 ALTERNATIVE FUTURES STUDY 267
5.4 OTHER CONSERVATION MEASURES 268
5.4.1 INTERAGENCY AGREEMENT 268
5.4.2 EROSION CONTROL 268
5.4.3 ENVIRONMENTAL FUNDING SOURCES AND PROCESS 269
5.4.4 MONITORING AND SURVEYING OF LISTED AND CANDIDATE SPECIES 271
5.4.5 PROTECTION OF LISTED AND CANDIDATE SPECIES 271
5.4.6 INTEGRATED TRAINING AREA MANAGEMENT (ITAM) 272
5.4.7 FIRE MANAGEMENT 272
5.4.8 RECREATION MANAGEMENT 273
5.4.9 ENVIRONMENTAL AWARENESS EDUCATION 274
5.4.10 INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP) 274
5.4.11 AGAVE MANAGEMENT PLAN 274
5.5 SPECIES SPECIFIC CONSERVATION MEASURES 275
5.5.1 HUACHUCA WATER UMBEL (ENDANGERED) WITH CRITICAL HABITAT 275
5.5.2 LESSER LONG-NOSED BAT (ENDANGERED) 276
5.5.3 SONORA TIGER SALAMANDER (ENDANGERED) 278
5.5.4 SOUTHWESTERN WILLOW FLYCATCHER (ENDANGERED) 279
5.5.5 CANELO HILLS LADIES' TRESSES (ENDANGERED) 280
5.5.6 JAGUAR (ENDANGERED) 281
5.5.7 SPIKEDACE (THREATENED) WITH CRITICAL HABITAT 281

5.5.8 MEXICAN SPOTTED OWL (THREATENED) WITH CRITICAL HABITAT 281
5.5.9 BALD EAGLE (THREATENED) 284
5.5.10 LOACH MINNOW (THREATENED) WITH CRITICAL HABITAT 284
5.5.11 RAMSEY CANYON LEOPARD FROG (CONSERVATION AGREEMENT) 285
5.5.12 HUACHUCA SPRINGSNAIL (CANDIDATE) 285
5.5.13 YELLOW-BILLED CUCKOO (CANDIDATE) 285
5.6 REPORTING REQUIREMENTS 285
5.7 MANAGEMENT RESPONSIBILITIES 286
5.8 TIMELINE TO IMPLEMENT CONSERVATION MEASURES 287

SECTION 6 REFERENCES 295

LIST OF APPENDICES

APPENDIX A PREVIOUS CONSULTATION HISTORY ON FORT HUACHUCA ACTIVITIES AT OR ON FORT HUACHUCA 327
APPENDIX B MAJOR UNIT DESCRIPTIONS 333
APPENDIX C FORT HUACHUCA FISHING FACTS 337
APPENDIX D TERMINATION LETTER FOR 203 ACRE LAND CONVEYANCE 339
APPENDIX E CURRENT LEASES AT FORT HUACHUCA 341
APPENDIX F SUMMARY OF HYDROGEOLOGY 347
APPENDIX G FORT HUACHUCA RELATED POPULATION ADJUSTED FOR DOUBLE COUNTING 377
APPENDIX H OFF-POST CONTRACT PERSONNEL 379
APPENDIX I ECONOMIC IMPACT FORECAST REPORT – 2002 381
APPENDIX J SIERRA VISTA SUBWATERSHED DATA 417
APPENDIX K ESTIMATED WATER BUDGET FOR THE SIERRA VISTA SUBWATERSHED 419
APPENDIX L UPPER SAN PEDRO PARTNERSHIP PLANNING OPTIONS 423
APPENDIX M FORT HUACHUCA PROJECTED PUMPING 2001 THROUGH 2011 425
APPENDIX N FORT HUACHUCA EFFLUENT ANALYSIS 2001 THROUGH 2011 427
APPENDIX O USING CONSERVATION EASEMENTS TO SAVE THE UPPER SAN PEDRO RIVER 429
APPENDIX P FORT HUACHUCA WATER USE MITIGATION POLICY 441
APPENDIX Q UPPER SAN PEDRO PARTNERSHIP PROPOSED WORKING PLAN OUTLINE 443
APPENDIX R FORT HUACHUCA ENVIRONMENTAL PROGRAM REQUIREMENT PROJECTS 447

LIST OF FIGURES

FIGURE 1 FORT HUACHUCA AND SURROUNDING AREAS 2
FIGURE 2 FORT HUACHUCA TRAINING AREAS AND ON-POST ASA SITES 9
FIGURE 3 FORT HUACHUCA OFF POST ASA SITES 10
FIGURE 4 FORT HUACHUCA TRAINING AREAS AND FACILITIES 12
FIGURE 5 FORT HUACHUCA EAST RANGE OFF ROAD MANEUVER AREAS AND MORTAR FIRING POINTS 15
FIGURE 6 FORT HUACHUCA LIVE FIRE RANGES 17
FIGURE 7 FORT HUACHUCA REGIONAL AIR ACTIVITIES 20

FIGURE 8 FORT HUACHUCA AIR SAFETY FANS AND LOCAL ACTIVITIES 21
FIGURE 9 GAME MANAGEMENT AREAS - MAIN POST 27
FIGURE 10 GAME MANAGEMENT AREAS - EAST RANGE 28
FIGURE 11 FORT HUACHUCA MAIN FIRE BREAKS ON THE SOUTH RANGE 32
FIGURE 12 LAND OWNERSHIP 54
FIGURE 13 FORT HUACHUCA LAND USE 56
FIGURE 14 FORT HUACHUCA SOILS 59
FIGURE 15 FORT HUACHUCA CONTOURS 62
FIGURE 16 UPPER SAN PEDRO RIVER BASIN 63
FIGURE 17 FORT HUACHUCA WATER RESOURCES 65
FIGURE 18 SAN PEDRO RIVER STREAMFLOW PATTERNS FOR 1991 – 1992 70
FIGURE 19 SAN PEDRO AT CHARLESTON DAILY FLOW RECORD 1935 – 1999 71
FIGURE 20 FORT HUACHUCA WATER USE (PUMPING) HISTORY 88
FIGURE 21 FORT HUACHUCA VEGETATION 96
FIGURE 22 HUACHUCA WATER UMBEL AND CRITICAL HABITAT LOCATIONS IN THE SPRNCA 103
FIGURE 23 LOCATION OF LISTED AND SENSITIVE SPECIES ON FORT HUACHUCA AND THE BABOCOMARI RIVER 104
FIGURE 24 FORT HUACHUCA FIRE FREQUENCY 1973 - 2002 167
FIGURE 25 FORT HUACHUCA NOISE CONTOURS 170

LIST OF TABLES

TABLE 1 FIRING RANGES ON FORT HUACHUCA 16
TABLE 2 PONDS OF FORT HUACHUCA 29
TABLE 3 LONG-RANGE MCA AND OPERATION AND MAINTENANCE ARMY (OMA) PROJECTS LISTING (FY 02 – 14) 36
TABLE 4 TERRAIN TYPE AND TRAFFIC PERMITTED BY TRAINING AREA 38
TABLE 5 SUMMARY OF GROUNDWATER MODELING EFFORTS 80
TABLE 6 FORT HUACHUCA POPULATION ADJUSTED FOR DOUBLE COUNTING 90
TABLE 7 FORT HUACHUCA POPULATION AND WATER USE 1997 – 2001 90
TABLE 8 FORT HUACHUCA SPENDING IN COCHISE COUNTY (IN MILLIONS) 91
TABLE 9 VEGETATION TYPES PRESENT ON FORT HUACHUCA RANGES 97
TABLE 10 FEDERALLY LISTED, PROPOSED, AND CANDIDATE SPECIES AND THEIR OCCURRENCE AT FORT HUACHUCA AND THE SPRNCA 102
TABLE 11 MSO OCCUPANCY AND REPRODUCTION IN PACS ON FORT HUACHUCA 1990 – 2001 121
TABLE 12 MSO OCCUPANCY AND REPRODUCTION IN INVENTORY AREAS ON FORT HUACHUCA, 2000 – 2001 122
TABLE 13 SUMMARY OF POTENTIAL EFFECTS OF FORT HUACHUCA ACTIVITIES ON 23 FEDERALLY- LISTED, THREATENED, ENDANGERED, PROPOSED, AND CANDIDATE SPECIES 179
TABLE 14 WATER CONSERVATION PROJECTS AND ESTIMATED SAVINGS 252
TABLE 15 PROPOSED OR COMPLETED STORMWATER PROJECTS AND AMOUNT OF ESTIMATED ANNUAL RECHARGE 258
TABLE 16 APPROVED PROJECTS FOR FORT HUACHUCA 270

TABLE 17 CONSERVATION MEASURES ACCOMPLISHED ON AN ANNUAL BASIS 288
TABLE 18 PROJECTS SCHEDULED FOR FISCAL YEAR 2002 289
TABLE 19 PROJECTS SCHEDULED FOR FY 2003 290
TABLE 20 PROJECTS SCHEDULED FOR FY 2004 291
TABLE 21 PROJECTS SCHEDULED FOR FY 2005 291
TABLE 22 PROJECTS SCHEDULED FOR FY 2006 292
TABLE 23 PROJECTS SCHEDULED FOR FY 2007 292
TABLE 24 PROJECTS SCHEDULED FOR FY 2008 293
TABLE 25 PROJECTS SCHEDULED FOR FY 2009 293
TABLE 26 PROJECTS SCHEDULED FOR FY 2010 294
TABLE 27 PROJECTS SCHEDULED FOR FY 2011 294

SECTION 1
INTRODUCTION

1.1 OBJECTIVE

The objective of this BA is to analyze the potential effects to federally listed threatened and endangered species, critical habitat, and candidate species related to the ongoing and programmed future military operations and activities at and near Fort Huachuca. The analysis of potential effects includes the implementation of significant conservation measures which Fort Huachuca has committed to as part of the proposed action. This includes lands controlled or leased by Fort Huachuca and the restricted airspace used by the installation.

This BA is prepared to support consultation under Section 7(A)(2) of the Endangered Species Act (ESA) of 1973, as amended.

Determination of effects for each species were developed according to:

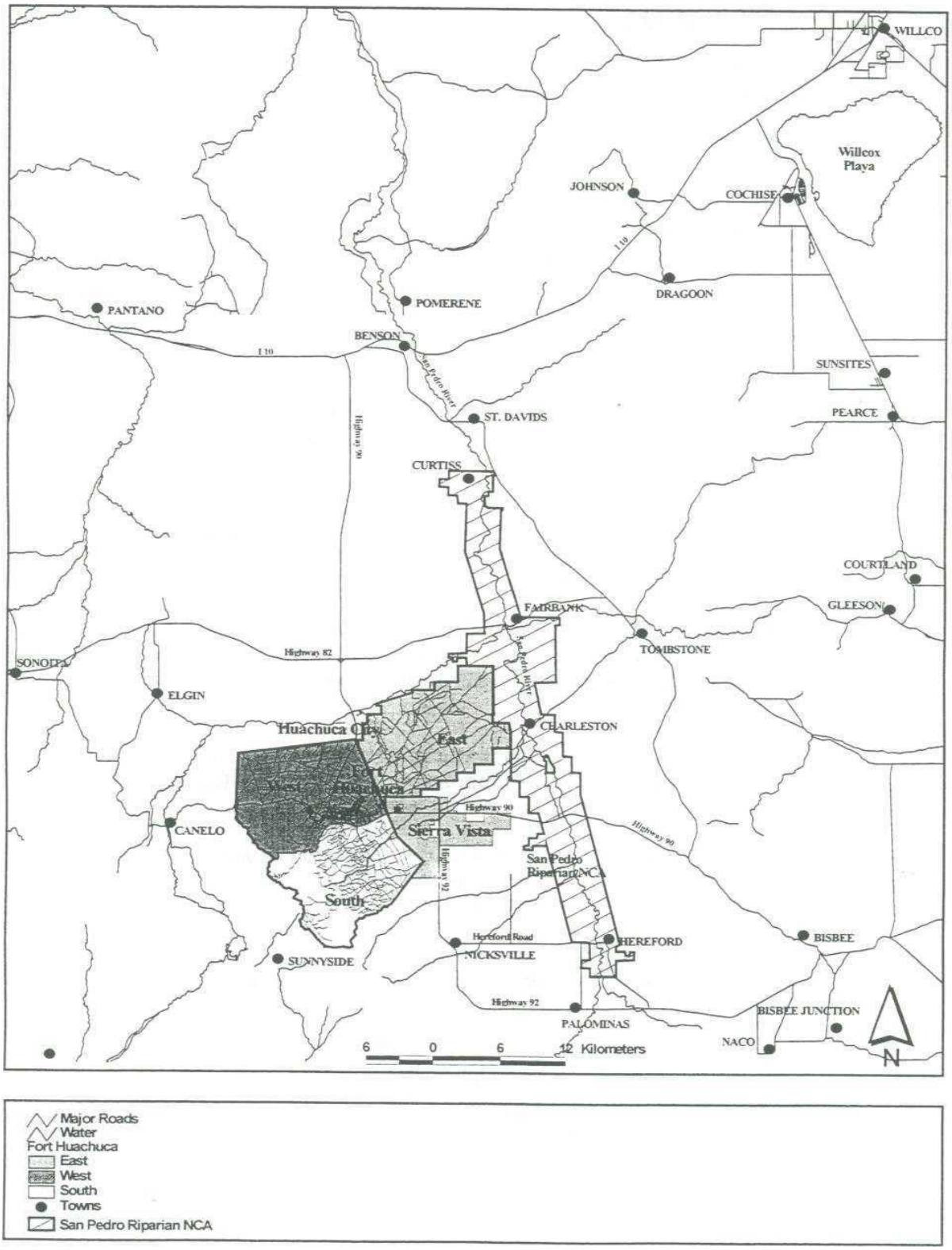
- Abundance and distribution of the species in the region, and the likelihood of the species to occur in the vicinity of ongoing military operations and activities;
- Habitat requirements of the species;
- Availability of suitable habitat in the vicinity of ongoing and programmed military operations and activities, including critical habitat designated by the USFWS;
- Documented or potential sensitivities of the species to disturbances likely to result from ongoing and programmed military operations and activities;
- Ongoing and planned conservation and measures associated with ongoing and programmed military operations and activities; and
- Analysis of potential direct, indirect, interrelated, interdependent, and cumulative effects of military and non-military activities at and near Fort Huachuca.

1.2 SCOPE

The scope of this BA is to determine the potential effects to federally listed, proposed, and candidate species and designated critical habitat (with an emphasis on the SPRNCA) of ongoing and programmed future military operations and activities at and near Fort Huachuca (Figure 1). This analysis includes lands controlled or leased by Fort Huachuca (lands potentially affected by the Fort's activities but not under Army ownership) and the restricted airspace used by the installation.

Section 2 of this BA provides a description of the proposed action or more specifically, all ongoing and programmed future military operations and activities at Fort Huachuca. This

FIGURE 1 FORT HUACHUCA AND SURROUNDING AREAS



includes all installation tenant activities and even non-tenants who conduct activities at Fort Huachuca on an infrequent basis for short time periods. The proposed action also includes those actions taking place on and off the installation for which USAIC&FH is responsible for funding, permitting, or carrying out to accomplish the military mission. Finally, the programmed future military operations and activities addressed in this BA include all actions currently planned by the installation for the foreseeable future.

In general, ongoing and programmed future military operations and activities at Fort Huachuca include:

- Electronic and communications testing and training activities on Fort Huachuca or within the restricted airspace;
- Field training exercises and training involving on-road/trail vehicle travel, live fire weapons qualifications in portions of the South Range, dismounted land navigation and patrol training, and use of an impact area on the East Range for live mortar fire training;
- Recreation activities on Fort Huachuca; and
- Programmed renovation and construction of facilities development projects on Fort Huachuca to support military-related activities. These include projects within the current Military Construction Army (MCA) planning cycle.

The proposed action described in Section 2 includes significant water conservation measures which are designed to completely offset all direct, indirect, interrelated and interdependent effects associated with Fort Huachuca in the Sierra Vista subwatershed. The Fort Huachuca Integrated Natural Resource Management Plan (INRMP) is also a conservation measure and is considered part of the ongoing and programmed future military activities evaluated in this BA.

Section 3 provides a detailed description and analysis of the environmental setting in the Sierra Vista subwatershed. This includes land use, climate, hydrology, population, economics, water use and management, biological resources, and threatened and endangered species. An extensive discussion of cumulative effects is also provided.

Important issues which are addressed in Section 3, and other sections of the BA include:

- The potential effects, if any, of Fort Huachuca's groundwater withdrawal on surface flows of the San Pedro River and habitat in the SPRNCA; in addition, cumulative effects associated with groundwater usage are discussed in detail.
- Analysis of demographic and economic data related to Fort Huachuca; and
- The potential effects, if any, of military activities, fire management activities, and recreational activities on federally listed species and their habitats on and near Fort Huachuca.

Section 4 provides a detailed discussion and analysis of the potential effects on federally listed, proposed, and candidate species and designated critical habitats.

Section 5 provides a detailed description of all the conservation measures that Fort Huachuca will implement as part of the proposed action. To eliminate all potential effects associated with the water usage of Fort Huachuca on listed species and their critical habitat, the Army has committed to a series of aggressive water conservation measures and projects. Specifically, Fort Huachuca commits to achieving zero water balance for its on-post water use. In other words, by the year 2007, any water consumed by Fort Huachuca operations on-post will be balanced by the Fort's water recharge, conservation, and replenishment actions. In addition, by the year 2011, Fort Huachuca commits to balancing its attributable water use in the Sierra Vista subwatershed which equates to a water savings of over 2,784 ac-ft. Fort Huachuca will also request that the communities and agencies within the Sierra Vista subwatershed, through the USPP, make a commitment to offset the cumulative effects (3,599 ac-ft) associated with groundwater usage by 2011 as well.

1.3 CONSULTATION HISTORY

The lesser long-nosed bat, listed in 1988, was the first listed species known to commonly occur at Fort Huachuca. Listing of the bat generated a need for Section 7 consultation. Since that listing, the Service and the Army have conducted Section 7 consultation on numerous projects at Fort Huachuca (Appendix A). Consultations are listed chronologically, from most recent to oldest and only documents issued by the Service are described.

From 1988 - 1993, consultation on listed/proposed species was often combined with review of National Environmental Policy Act (NEPA) compliance documents. Since 1993, consultations have often taken the form of concurrence by the Service on determinations by the Army that their activities would not effect, or would not adversely affect listed species.

As more species were listed in the area (Mexican spotted owl - 1993; southwestern willow flycatcher - 1995; Huachuca water umbel, Sonora tiger salamander, and Canelo Hills ladies' tresses - 1997), the need for consultation grew. Work began on development of a programmatic BA in 1995 and culminated in a final programmatic BA in March 1998 (SAIC 1998a). After extensive coordination between the Army and the Service, a final BO was issued on October 29, 1999. Since that time, the Army has consulted, both formally and informally, on a number of projects.

On April 8, 2002, a US District Court ruled that the October 1999 BO did not comply with Section 7(A)(2) of the ESA and that the Army was violating its duty to not cause jeopardy or adverse modification to endangered species and/or their critical habitat. As a result of this court ruling, the Army has developed this programmatic BA to address the potential effects of its ongoing and future military activities on federally listed species and critical habitat.

Consultation correspondence contained in this list is available from the Army and USFWS files.

SECTION 2
PROPOSED ACTION – FORT HUACHUCA'S ONGOING AND PROGRAMMED OPERATIONS AND ACTIVITIES

This section describes ongoing and programmed future military operations and activities that occur at or near Fort Huachuca and are being evaluated as part of the proposed action. This includes programmed facilities development projects on the installation, resource management, recreation, and other land uses. This section concludes with summary descriptions of operations and activities that occur in, or are programmed for, training areas across the installation. This section incorporates the conservation measures in Section 5, which will be implemented by Fort Huachuca as part of the proposed action.

2.1 BASELINE OPERATIONS, ACTIVITIES, AND MISSIONS

The ongoing missions and activities at Fort Huachuca constitute the baseline at the installation. The operations, missions, and activities previously discussed in Fort Huachuca's 1998 BA (SAIC 1998a) and in the BO issued by the USFWS in October 1999 (USFWS 1999a) are incorporated by reference. Additional activities and missions have occurred since the preparation of these documents and are included in the operational baseline for purposes of this BA. These include the establishment of a regional Civilian Personnel Operations Center (CPOC) at Fort Huachuca and its recent expansion (EAs in 1997 and in 2001); Expansion of Unmanned Aerial Vehicle (UAV) testing and training (Environmental Assessment (EA) in June 2000); Artificial Aquifer Recharge Projects (EA, 2000); Purchase of Conservation Easements (EA, 2001); and installation of a Bergey wind turbine.

This section also includes several proposed actions for which NEPA analysis is either completed or in progress, but for which decisions to implement have not been made. These projects include: a proposed increase in student population at the Military Intelligence (MI) Center (EA in December 2001); the expansion of Humor Drop Zone (DZ) for Missouri Air National Guard (MO ANG) training; the installation of improved air surveillance radar; establishment of a Department of Defense (DoD) training center; construction and operation of an Army and Air Force Exchange Service (AAFES) mini-mall (EA in draft); stand-up of 9th Army Signal Command/Network Enterprise Technology Command (ASC/NETCOM) (EA being staffed); and the Real Property Master Plan for the Electronic Proving Ground (EPG) (EA draft March 2002).

Intelligence and communications systems testing and training activities account for nearly 95% of training range use (USAIC&FH, 1997). Other supported activities on the installation include field training exercises, aviation activities, live-fire qualification and training, vehicle maneuver training, and administrative and support activities e.g., CPOC. For purposes of this BA, each operational activity is discussed in further detail.

2.2 MILITARY OPERATIONS AND ACTIVITIES

Fort Huachuca is one of 16 US Army installations under the command and control of the US Army Training and Doctrine Command (TRADOC). In October 2002, Fort Huachuca's higher headquarters for garrison operations will be the Installation Management Agency, with the southwestern regional

headquarters located at Fort Sam Houston, Texas. Fort Huachuca remains the Headquarters for the US Army Intelligence Center (USAIC). It is also the headquarters for the US Army Signal Command (USASC). In October 2002, the USASC will transition to become the 9th ASC/NETCOM. This action will be discussed in further detail below. The Garrison Commander and principal training staff are currently integrated into the USAIC Headquarters Command, designated USAIC&FH. Major missions assigned to the installation exist to:

- research, develop, test, and evaluate concepts, doctrine, materials, and equipment in the areas of intelligence, electronic warfare, and information systems;
- develop, conduct, and evaluate training in intelligence, electronic warfare, and information systems;
- provide trained operational forces in the areas of intelligence and communications;
- operate, manage, and defend the Army's information operations and infrastructure;
- perform aviation operations; and
- provide training opportunities for Active Duty, Reserve, and National Guard Forces.

2.2.1 MILITARY INTELLIGENCE TRAINING

Fort Huachuca currently provides MI training to over 2,500 students annually. To better enable the United States to fight the war against terrorism, an EA was prepared in December 2001 to support expanding the Army's training base to produce greater numbers of highly skilled soldiers capable of executing critical National Defense MI missions. To date, this action has not occurred but it is incorporated as part of the operational baseline for this BA.

2.2.2 INTELLIGENCE AND COMMUNICATION SYSTEMS

The majority of operational testing and training at Fort Huachuca is related to intelligence and communications systems. Units are engaged in the development and testing of various types of electronic equipment (see Appendix B for detailed descriptions of these units). These units are also involved in training soldiers in the use of this equipment in classrooms and during field training exercises. An EA (USAIC&FH 1992, USAIC&FH 1993b) was prepared to address, in one comprehensive document, all of the field testing and training of electronic equipment and the field exercises conducted in connection with this testing and training.

2.2.3 MANAGEMENT, OPERATION, AND DEFENSE OF ARMY INFORMATION SYSTEMS

In order to fight the war against terrorism, the USASC will be taking on additional responsibilities for the management, operation, and defense of all Army Information Systems. In October 2002 it will transition to 9th ASC/NETCOM which will involve hiring up to 130

personnel over the next several years to take on this mission. This activity is also incorporated into the operational baseline of this BA.

2.2.4 INTELLIGENCE AND ELECTRONIC WARFARE EQUIPMENT TRAINING AND TESTING

A major mission at Fort Huachuca is the testing of intelligence and electronic warfare equipment and training of soldiers on intelligence tactics and procedures requiring realistic placement of intelligence systems globally. Equipment is stationed at various Army Security Agency (ASA) sites across the installation and off-post to test the capability of electronic systems to operate under a variety of geographic and atmospheric conditions (USAIC&FH 1992, USAIC&FH 1993b). These sites constitute a network of approximately 2,400 on-post and 675 off-post markers (Figures 2 and 3). Training and testing is conducted by dispatching intelligence and electronic warfare equipment to a selection of ASA sites that meet the requirements for training to be conducted. On-post sites are located across the installation along existing roads and trails and previously disturbed areas. Off-post sites are usually located within the road right-of-way shoulders along several highways in Cochise and Santa Cruz Counties. The remaining off-post sites are located in previously disturbed areas.

At the time of training, vehicles and personnel can be deployed to any combination of ASA sites but most remain on Fort Huachuca. Training sites generally consist of 1-2 vehicles with 4-6 support personnel and up to approximately 20 students. On rare occasions, training activities can be as large as 20 vehicles, 50 support personnel, and 60-70 students (USAIC&FH 1992, USAIC&FH 1993b). Types of equipment include electronic, computer, or radar imaging systems. The vehicular components of the intelligence training systems can consist of military 5-ton trucks, heavy duty 4-wheel drive vehicles, and on very infrequent occasions, tracked vehicles. These vehicles are either equipped with an electronic equipment shelter or are used to transport soldier-transported systems and operators. These vehicles are either driven to previously established parking areas at the site or other designated sites are authorized. Vehicles must either remain on established roads or trails or can park adjacent to the road or trail in a previously disturbed, designated area at each ASA site. Tracked vehicle movement is not authorized outside of the installation and is confined to existing roads and trails in Training Areas Bravo, Charlie, Delta, and Foxtrot on the East Range (refer to Section 2.8 for detailed information on individual training area activities). Tracked vehicles are sometimes used outside the installation but on these occasions they are transported to the training or test site on trailers. If necessary for the test, they are off-loaded but remain stationary.

Several types of transmitting antennae are used, from small vehicle or system mounted whip antennae, to ground mounted antennae that can be raised to a height of 20-25 meters. Testing activities in some cases last for periods of up to 90 days. At each site, antennae(s) may be erected consisting of driving metal or wooden stakes into the ground 12-18 inches for the attachment of guywires. Exercises generally last for no more than 10-11 days with 18 daily hours of operation (USAIC&FH 1992, USAIC&FH 1993b). This training can require 30-50 students to walk cross-country to other predetermined locations/ASA sites. Training sites located in or near protected agave management areas found in Training Areas Lima, Mike, and portions of Hotel, India,

Romeo, Tango, Victor, Whiskey, X-Ray, and Yankee adhere to special use regulations. These regulations stipulate that:

- no firing of blanks or pyrotechnics will occur with 0.25 miles of protected agave management areas;
- training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment; and
- night operations are prohibited from July 1 to October 31 in protected agave management areas.

Military trainers and civilian testers who fail to comply with these measures of protection may, at the discretion of the Range Control Officer, lose their privilege to train or test in these areas.

2.2.5 COMMUNICATIONS SYSTEMS TRAINING AND TESTING

Another major mission at Fort Huachuca involves radio systems training and testing. The physical components of the systems during training consist of a variety of satellite, troposcatter, high-frequency, and microwave equipment to provide communications support. Portable equipment is moved on military 5-ton and 2-ton vehicles pulling a wide variety of generators, antennae, and trailers. During training, vehicles and personnel are deployed to a variety of preexisting sites across the installation. Typical exercises last from 7-14 days with 24-hour operations. Each field unit may utilize up to 40-80 vehicles, 50 generators, 12 communications shelters, and 80-100 soldiers per site, generally there are as little as 3 vehicles and 9 soldiers at each relay site (USAIC&FH 1992, USAIC&FH 1993b). The maximum area covered by a unit during training can be up to 40 acres with 13 remote site locations per exercise. Large bivouac exercises occur in predefined areas used repeatedly for such activities with relay sites located across the installation. Predefined bivouac areas often include permanent structures and concrete pads for repeated bivouac establishment. Remote relay sites are located all across the installation. Sites selected for use across the installation must be approved by Range Control prior to use. Range Control may restrict the use of certain areas during high fire potential seasons and enforce special regulations for areas within protected agave areas (see section 2.2.6).

Two types of larger exercises are also conducted: Battalion (Bn) and Brigade (Bde). Battalion level exercises are conducted 8-12 times per year and involve 160-200 personnel in which approximately 20 vehicles are used. Brigade level exercises are conducted 1-2 times per year and involve 400-500 personnel with approximately 150-200 vehicles used in such operations. There are no set timelines for testing activities. Tests are conducted year-round and may run 24 hours per day, 7 days per week, for as long as a month. Lately, portions of the brigade have been deployed extensively and training exercises have been reduced. These activities occur at similar sites to those mentioned previously for communications training. Range Control may restrict the use of certain areas during high fire potential seasons and enforce special regulations for areas within protected agave areas.

FIGURE 2 FORT HUACHUCA TRAINING AREAS AND ON-POST ASA SITES

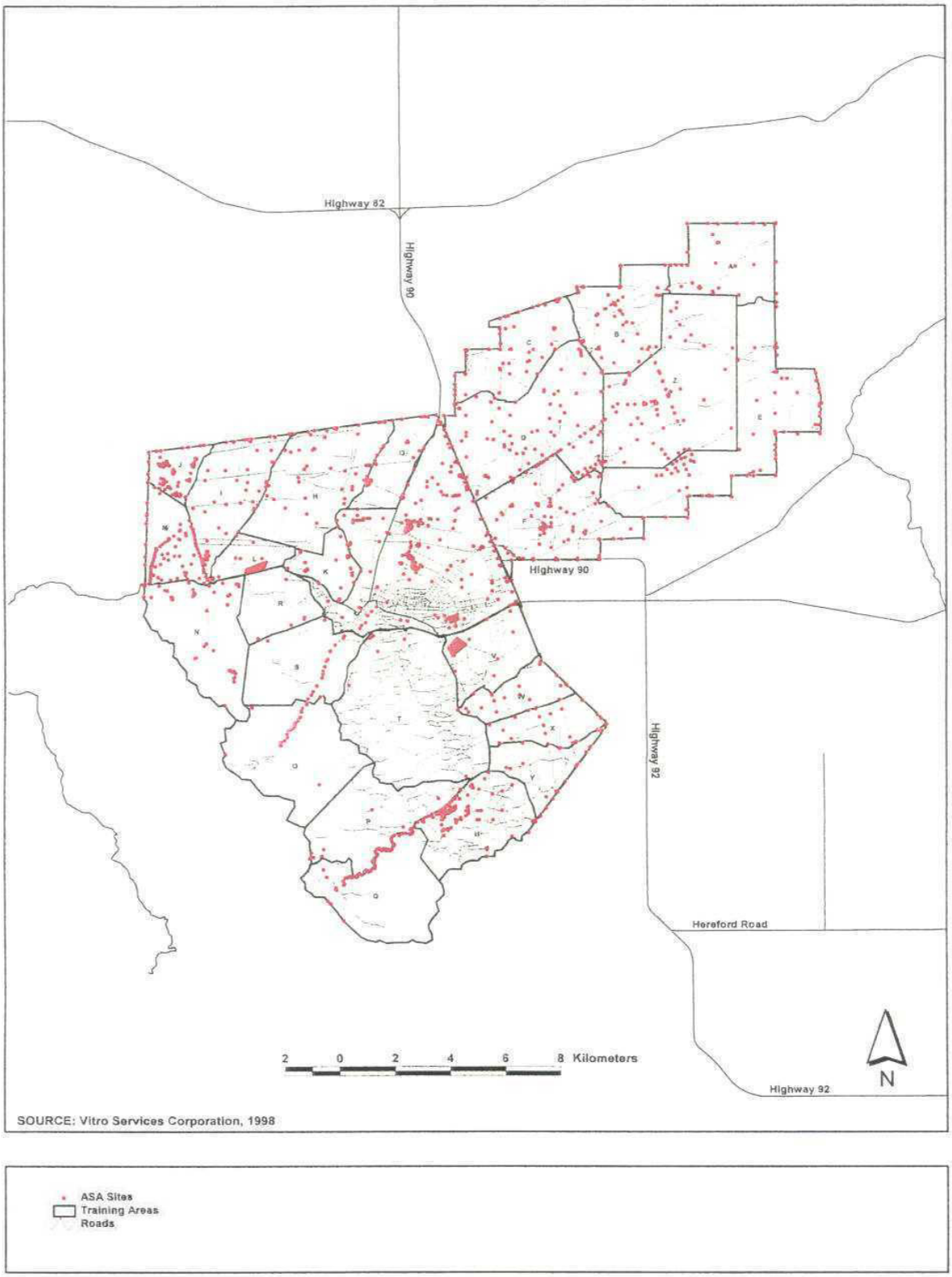
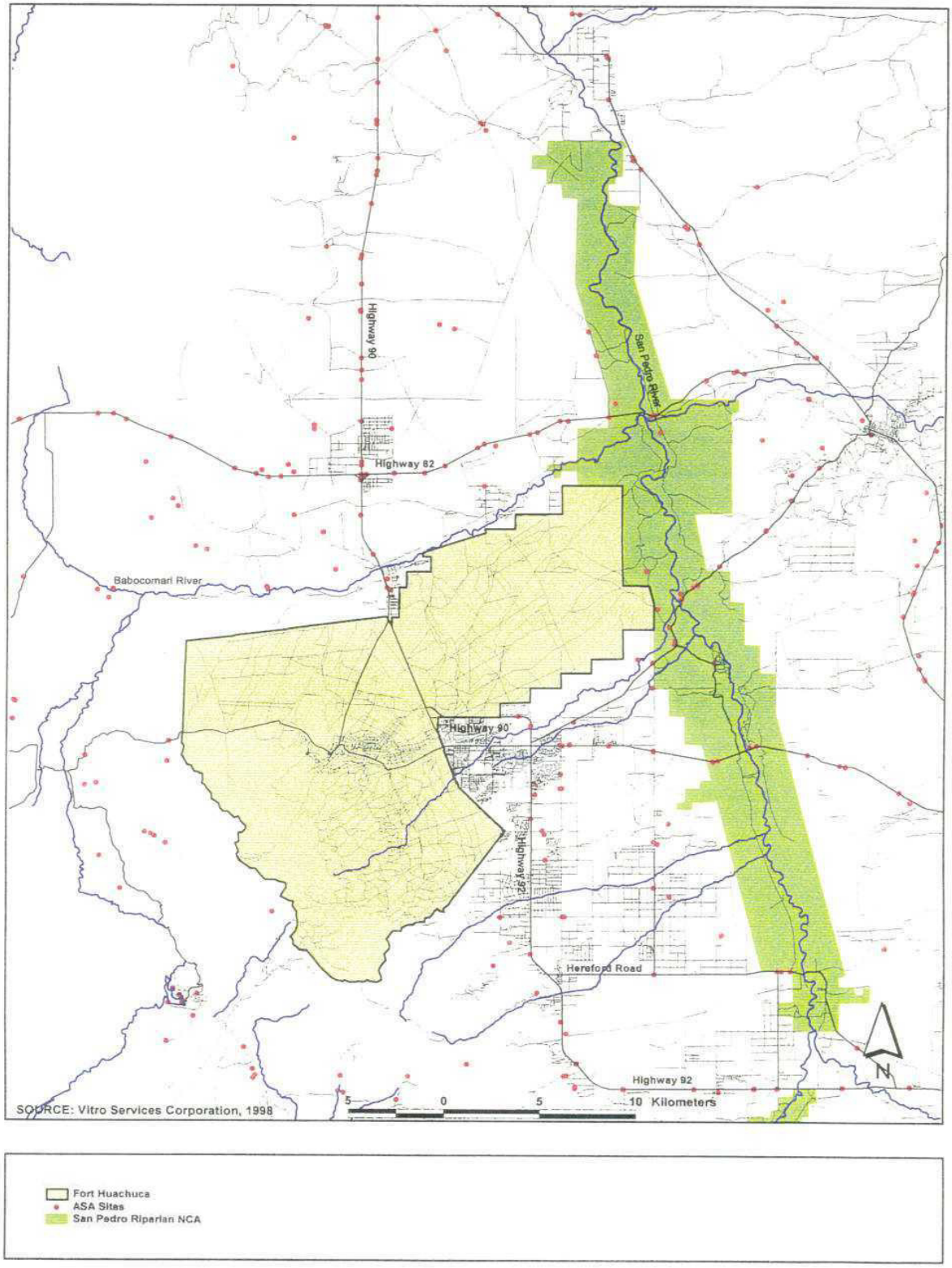


FIGURE 3 FORT HUACHUCA OFF POST ASA SITES



2.2.6 FIELD TRAINING EXERCISES

Fort Huachuca is used for training by various Fort Huachuca operational units, Army Reserve and Arizona National Guard units, and Fort Huachuca partner organizations. All training activities requiring use of range facilities are scheduled, coordinated, and controlled through the Installation Range and Training Office. Field training exercises consist of land navigation, patrolling and tactics training, individual development training, and vehicle maneuver training.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises. Specific bivouac areas vary from exercise to exercise and do not always coincide with existing ASA sites. Use of any site must be requested a minimum of 21 days in advance from Range Control with an eight-digit grid coordinate location.

No vegetation clearing is authorized during the establishment of a bivouac. Holes can only be dug into the ground with prior permission from Range Control. Concrete pads in some permanent bivouac areas are used for cooking purposes to prevent waste water from seeping into the ground in case of spills.

There are approximately 18 established bivouac areas on the installation (Figure 4). These sites are used on a more frequent basis for the larger scale communications testing and training activities. These larger bivouac areas (40 acres) are maintained as permanent areas of repeated use so as to minimize the need for additional large set up areas.

2.2.7 LAND NAVIGATION

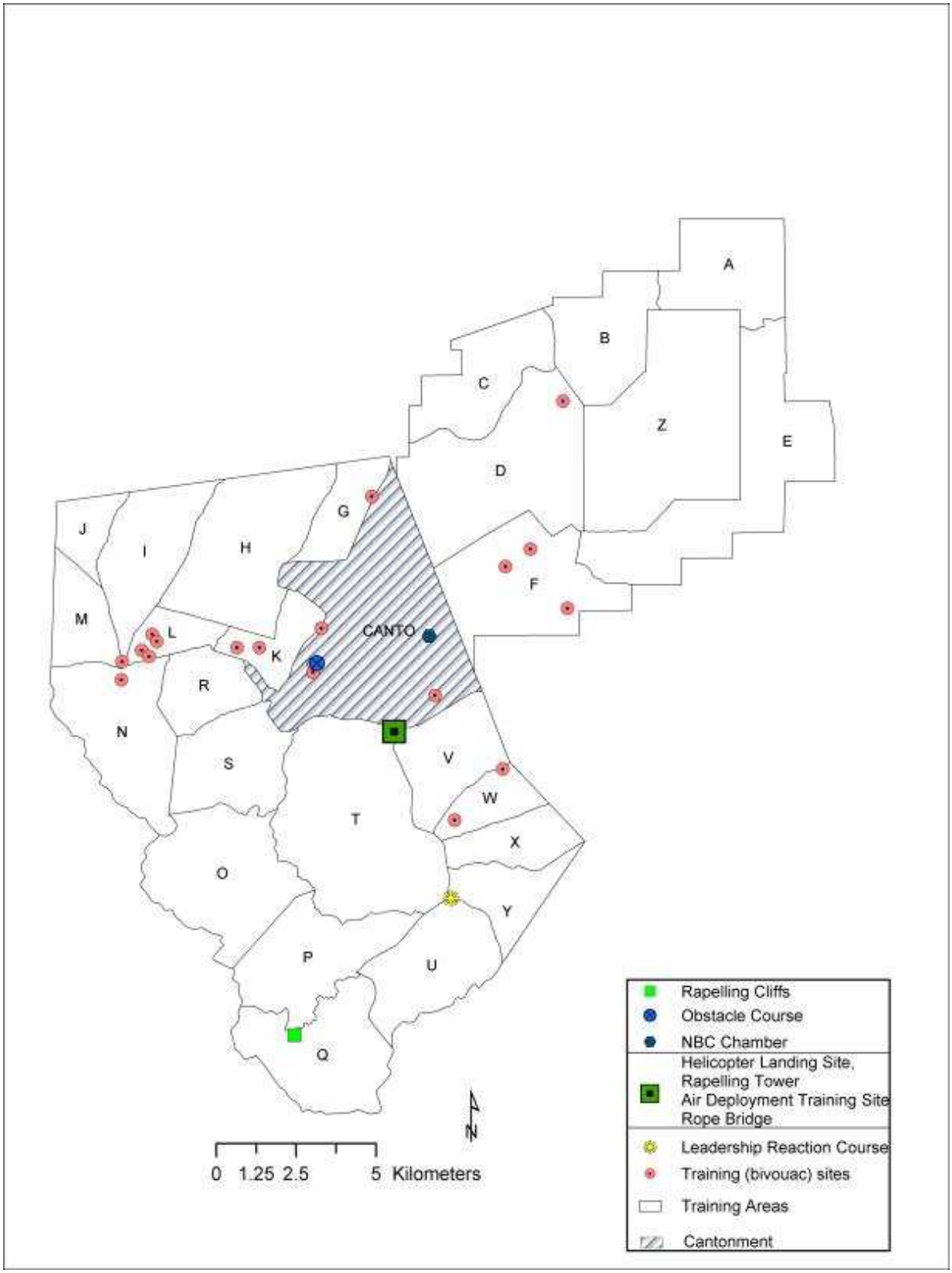
Land navigation involves the training of personnel to accurately navigate the terrain on foot and locate pre-established sites and locations. Land navigation exercises typically involve 15-20 personnel and 4-5 vehicles for transportation of personnel to and from the field site. Operations generally last for one day from morning until evening and are conducted year around except in protected agave management areas as stated below. All vehicles are kept on existing roads and trails. There is no live fire, firing of blanks, or pyrotechnics permitted. There are two existing land navigation courses on the installation:

1. Land navigation course in Training Area Uniform consisting of 44 surveyed concrete points with ASA markers.

2. Land navigation course in Training Area Mike consisting of 58 surveyed concrete points with ASA markers.

Additional land navigation training is conducted across the installation on the West and South Ranges. This training is similar to that which occurs on Land Navigation Courses. Vehicles are used to transport personnel to and from the field and are kept on existing roads, trails or parking areas at all times. There is no live fire, firing of blanks, or pyrotechnics permitted. Activities are conducted during day and night times, except within protected agave management areas where night operations are prohibited from July 1 through October 31.

FIGURE 4 FORT HUACHUCA TRAINING AREAS AND FACILITIES



2.2.8 PATROLLING AND TACTICS TRAINING

Patrolling and tactics training occurs across the South and West Ranges. The exercises, which generally last three days, are conducted every month of the year. Approximately 43 personnel are involved in the operations each month. Ammunition used during these operations includes pyrotechnics, smoke, and M16A2 blanks.

In these training exercises, soldiers maneuver on trails and cross-country. They occasionally dig holes about 5 inches deep to bury sensors near the trails and major roads. All vehicles used during this training are kept on existing roads and trails.

Training may take place during the day or at night. No firing of blanks or pyrotechnics can occur within 0.25 mile of protected agave management areas. Firing of blanks is also prohibited if it is determined by Range Control or the Fort Huachuca Fire Chief that a fire hazard exists. Activities are conducted during day and night times, except within protected agave management areas where night operations are prohibited from July 1 through October 31.

Occasionally, a Special Forces unit will request to conduct patrolling training in the Huachuca Mountains on Fort Huachuca. These exercises usually involve teams of less than 12 personnel. Personnel are provided training on environmental awareness, and are prohibited from making campfires or killing animals during their patrolling training. This type of training may occur once a year at Fort Huachuca.

2.2.9 INDIVIDUAL DEVELOPMENT TRAINING

Several individual development training facilities are located on the South and West Ranges and within the cantonment area including:

- a rappelling tower (Training Area Tango) - A two-level tower platform used for rappelling practice;
- a rappelling cliff (Training Area Quebec) - Cliffs located in Garden Canyon which vary in height from approximately 70-100 feet;
- a rope bridge Training Site (Training Area Victor) - An open area with four upright telephone pole tops, approximately four feet high;
- a Leadership Reaction Course (Training Area Uniform) - Eight stations, each depicting a situation which requires the negotiation of obstacles by an expedient means; and
- a Demonstration Hill (Training Area Kilo) - May be used to conduct various types of demonstrations.

These permanent facilities are used to train personnel from a variety of host and partner organizations (Figure 4, page 12).

2.2.10 VEHICLE MANEUVER TRAINING

Vehicle maneuver and driver training activities occur across the installation on various existing roads and trails. The majority of all vehicle maneuver training consists of wheeled-vehicles with occasional tracked-vehicle training. Wheeled-vehicle training maneuvers can include attaching and detaching trailers, loading and unloading equipment, and driver training across the installation. All maneuvering activities are confined to the existing roads and trails.

Oversized vehicles are restricted to roads; whereas light vehicles can use roads and trails. No cross country maneuvering or other use of existing off-road maneuvering lanes occurs or is planned except as described for the MO ANG below or emergency situations (safety, fire, etc.) All existing and planned operations will adhere to the following regulations:

1. Follow Fort Huachuca Regulation 385-8, Safety - Range and Training Area Operations (1 May 2001);

2. Follow guidelines set forth in the Installation Spill Contingency Plan - Fort Huachuca, Arizona (20 December 1996); and

3. Submit Fort Huachuca Form 1155 (Revised), 1 Aug 93 through appropriate channels for approval prior to commencement of maneuvers which require access to the East Range.

Off-road vehicle travel is not currently authorized at any location on Fort Huachuca. Approximately 5,172 acres within the East Range (Training Areas Charlie and Delta) have been designated for off-road maneuvering lanes, but no off-road activity has occurred since 1994 (Figure 5). With the expansion of Humor DZ, and its use for dropping palletized loads from aircraft, approximately four short off-road recovery trips will be required for each of the 25 classes offered by the MO ANG. These would occur in Training Area Bravo, between the existing Humor DZ and Hubbard landing strip. No other off-road vehicle maneuver is presently occurring or is planned on the installation. If the off-road maneuvering lanes were to be used in the future, separate Section 7 consultation would be initiated.

2.2.11 LIVE FIRE QUALIFICATION AND TRAINING

Most live fire activities take place on weapons qualifications ranges in Training Area Tango. Maximum ammunition and associated noise levels used on these ranges are listed in Table 1. Locations of these firing ranges and their associated safety fans are provided in Figure 6. When conditions permit, tracer rounds are permitted on all live firing ranges with the exception of Ranges 2, 3, and 4.

FIGURE 5 FORT HUACHUCA EAST RANGE OFF ROAD MANEUVER AREAS AND MORTAR FIRING POINTS

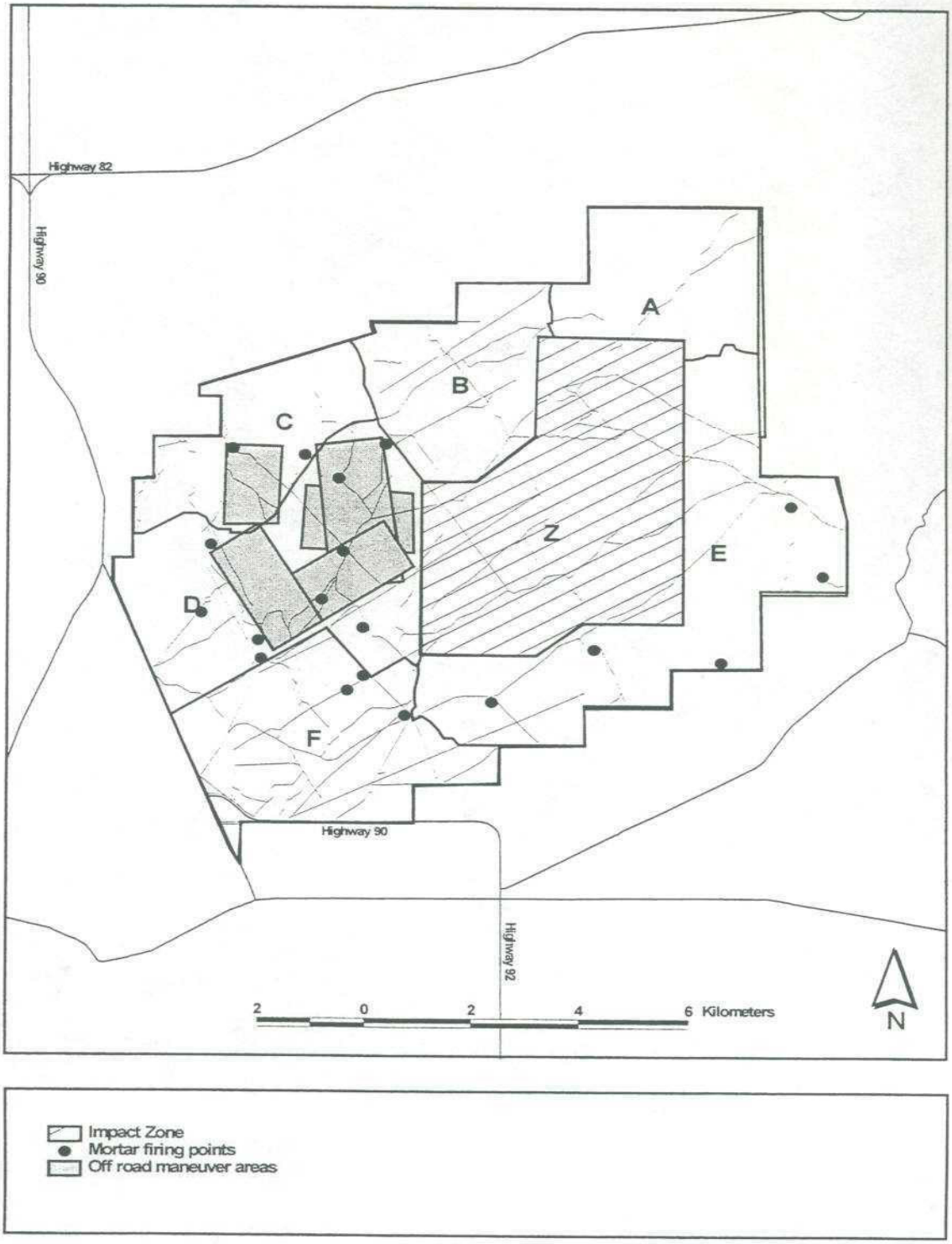


TABLE 1 FIRING RANGES ON FORT HUACHUCA

Range	Range Utilization	Maximum Ammo Permitted	Maximum Noise Level At Firing Point[1]
Range 1	Currently inactive	NONE	N/A
Range 2	M-16 Rifle Zero Range with 40 firing points and a target width of 100 meters.	5.56mm	156 dbP
Range 3	Small bore multi-purpose range with 15 firing points, and 75 meters maximum range.	7.62mm	156 dbP
Range 4	Pistol range complex consisting of a competition firing range with 25 firing points and target distances at 25 and 50 meters (Range 4A), and an US Army Standard Pistol Qualification course consisting of four firing points with target distances from 7 to 31 meters (Range 4B).	.45 cal	162 dbP
Range 5	High explosive hand grenade range with 12 firing points. Currently inactive, due to safety considerations.	M67 FRAG (ONLY)	171 dbP
Range 6	Fifty firing points and six firing lines from 100 to 1,000 yards.	.50 cal	159 dbP
Range 7	Currently inactive	NONE	N/A
Range 8	Automated record fire range with 10 firing points and target distances from 50 to 300 meters.	5.56mm	156 dbP
Range 9	Range 9A serves as a multi-purpose machine gun range with four firing points, Range 9B is used for recoilless rifles.	.50 cal, 106mm	160 dbP
Range 10	M-79 and M-203 grenade launcher range. High Explosive (HE) cannot be fired on this range.	40mm	154 dbP
Range 11	Currently inactive	NONE	N/A
Range 12A	.50 caliber, 7.62mm and 40mm live fire weapons range. HE ammunition cannot be fired on this range.	120mm, .50 cal	160 dbP
Range 12B	Tank gunnery range. HE ammunition cannot be fired on this range.	NONE[2]	N/A
Range 12C	Tank gunnery range. HE ammunition cannot be fired on this range.	NONE[2]	N/A
Range 13	M-16 marksmanship record fire range with 16 firing positions and targets from 50 to 300 meters.	5.56mm	156 dbP
Range 14	Currently inactive Squad attack course	NONE	N/A
Range 15	Currently inactive Platoon attack course	NONE	N/A

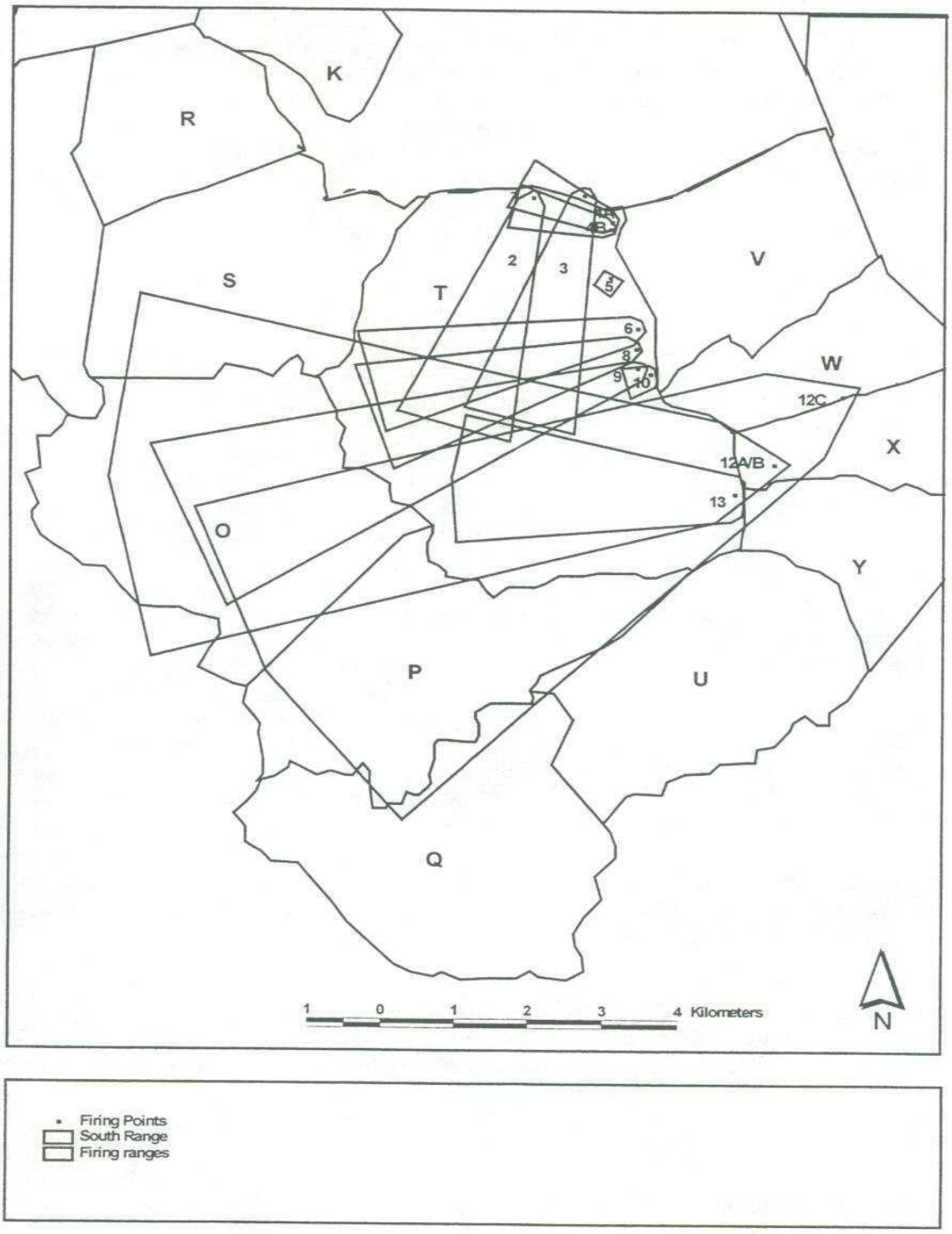
Source: Zillgens 1991; pers com. Miller 2002

1. Based on impulse noise levels and do not represent steady noise or time-weighted average.
2. There is no tank gunnery firing currently authorized at Fort Huachuca.

2.2.12 SMALL ARMS

Small arms qualification and live fire at Fort Huachuca occur on only nine of the 17 existing live fire ranges in Training Area Tango (Table 1). Firing positions and safety fans for these ranges are provided in Figure 6. Firing ranges are used for personnel qualification and training throughout the year. Live fire does not take place at night on Ranges 2, 3, and 4 during the period July 1 through October 31. Range 9 is scheduled to be renovated in the next two years however, the overall use and footprint of the range are not anticipated to change.

FIGURE 6 FORT HUACHUCA LIVE FIRE RANGES



2.2.13 ARTILLERY AND MORTAR

The East Range contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (Figure 5, page 15). These points support 60 and 80 mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.

Training activities which include use of the East Range for mortar firing are subject to Army Regulation (AR) 385-5 and must carry sufficient fire suppression equipment at all times in the event of a fire. Range Control regulations also require observation personnel to maintain constant watch during training activities for accidental fires resulting from mortar use on the East Range.

2.2.14 ADMINISTRATIVE AND SUPPORT ACTIVITIES

The administrative and support activities performed at Fort Huachuca are those activities associated with the day-to-day operation of the installation and the ranges, inclusive of those activities performed by USAIC&FH, the directorates, and partner organizations. Several administrative and support organizations exist at Fort Huachuca to support the installation's ongoing role as a major Army testing and training installation. Personnel from these organizations are located in the cantonment area. They include those personnel associated with the CPOC and its recent expansion.

The US Army Garrison (USAG) at Fort Huachuca includes the Command Group; Protocol Office, Public Affairs Office; Chaplain Activities Office; Inspector General; Office of the Staff Judge Advocate; Joint Planning Group; Office of the Chief of MI; the Directorate of Installation Support (DIS); Resource Management; Public Safety; Programs for Community Activities; Human Resources; Information Management; Contracting; Operations, Training and Doctrine; Evaluation and Standardization; and Combat Developments. The Garrison also includes a Department of Tactics, Intelligence and Military Science. These offices support more than 40 commands, agencies, and activities which reside across the installation. Each organizational element may contain additional divisions, branches, and sections. The offices and directorates are primarily located within the cantonment area.

AAFES provides support for many of the commercial needs of soldiers and their families. Currently, AAFES provides the following on-post locations for services: Main Post Exchange, Shoppette/Mini Mall with gasoline dispensing, several food service operations, laundry and dry cleaning services, Laundromat (self-serve), and Military Clothing Sales. AAFES is proposing to build an additional mini-mall with gasoline dispensing capability near the main gate of Fort Huachuca. An Environmental Assessment evaluating this proposed action is in progress.

2.3 AVIATION ACTIVITIES

Aviation activities at Fort Huachuca include fixed-wing piloted aircraft training, rotary-wing piloted aircraft training, UAV testing and training, and unmanned drug surveillance balloon operation. Aviation activities generally occur at LAAF, a military-civilian joint-use facility located along the northern boundary of the cantonment area. The LAAF supports military aircraft involved in test and

training programs, troop movements, and standard military, commercial and private travel operations. Three runways, several taxiways, aprons, and parking areas for fixed and rotary-wing aircraft cover the largest portion of the airfield area. Air operations are sustained by numerous support facilities which include a flight control tower, a navigational aids building, an airfield operations building, an airfield fire and rescue station, utilities support structures, and storage buildings. Air space used by UAVs at Fort Huachuca and restricted airspace over the installation is shown in Figure 7. Flight corridors and other aviation-related training areas at Fort Huachuca are shown in Figure 8 and include:

- a C-5A aircraft training mock-up (Training Area Victor) - a concrete platform depicting a C-5A aircraft cargo bay used to simulate cargo loading;
- an emergency helicopter landing area (Training Area Victor);
- helicopter landing areas for proficiency and emergency operations (Training Areas November, Romeo, India, and Kilo);
- the Hubbard Assault Airstrip (Training Areas Bravo and Delta) - a dirt assault strip/landing zone, surveyed and approved by the USAF, which can accommodate C-130 aircraft (675 x 1600 meters);
- the Hubbard DZ (Training Areas Charlie and Delta) 850 x 1700 meters;
- the Humor DZ (Training Area Bravo) 825 x 1660 meters (proposed expansion would increase dimensions to 1800 x 3000 meters);
- the Havoc DZ (Training Areas Charlie and Delta) 850 x 1700 meters; and
- the Hyena DZ (Training Area Echo) 300 x 300 meters.

Approximately 70,155 aviation evolutions occurred at LAAF between September 1996 and August 1997 (each landing or departure counts as one evolution each) (Scheibe 1997). Military operations include approximately 50,651 evolutions or 72% of all activity (of these, 50% were jet and 50% were propeller). General aviation accounted for approximately 11,015 evolutions or 16% of all activity. Commercial Air Traffic accounted for approximately 8,489 evolutions or 12% of all activity (Scheibe 1997).

Approaches to LAAF are considered Class D Airspace since the facility contains a manned operating control tower. The airport's airspace includes a horizontal radius of 4.3 statute miles of the airport, extending from the surface up to 7,200 feet mean sea level (msl). Aircraft are not permitted to enter the airspace until the Air Traffic Control (ATC) tower is contacted for clearance to do so. During the time the ATC tower is closed, the airspace reverts to Class G, or uncontrolled airspace.

FIGURE 7 FORT HUACHUCA REGIONAL AIR ACTIVITIES

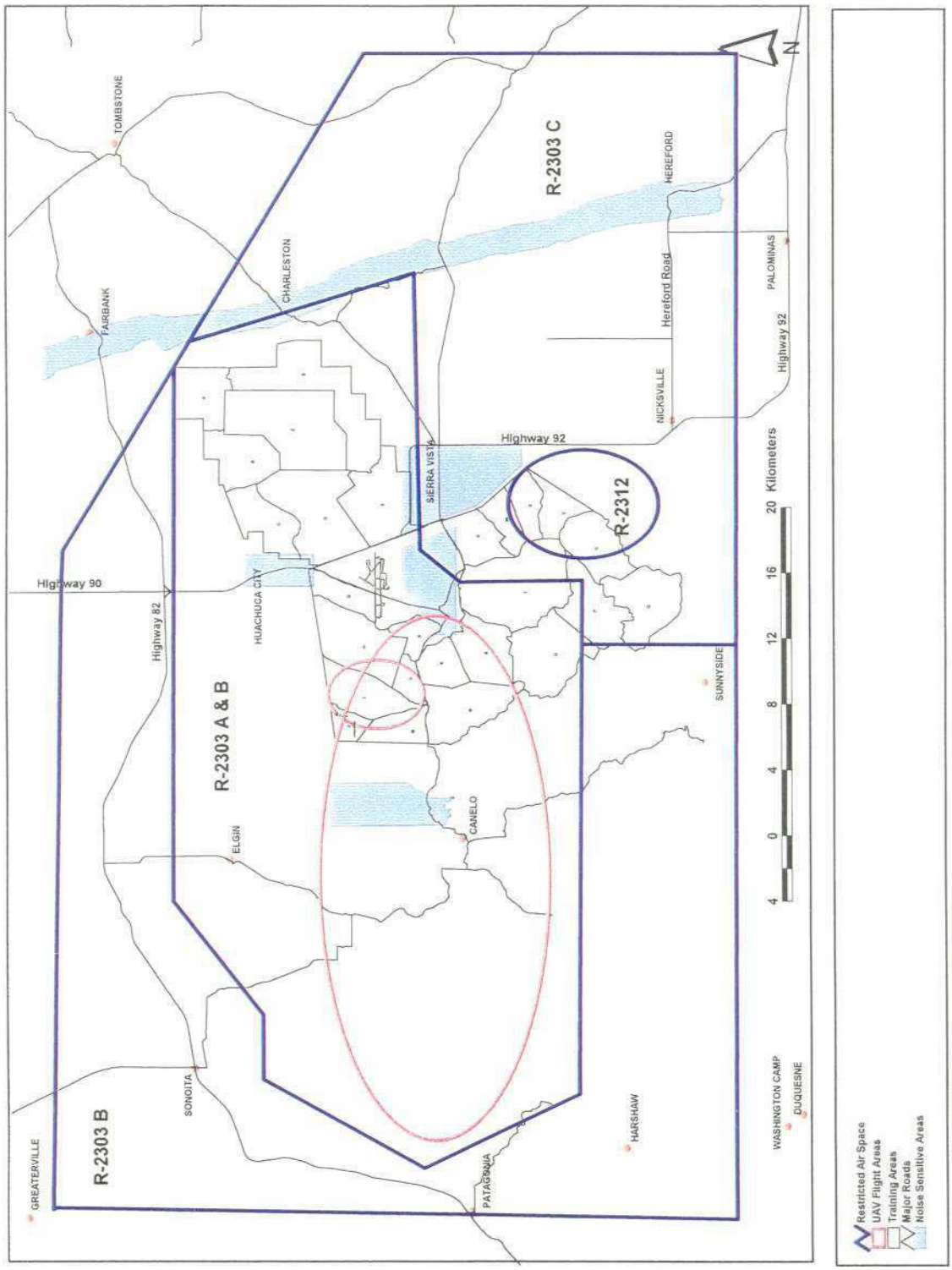
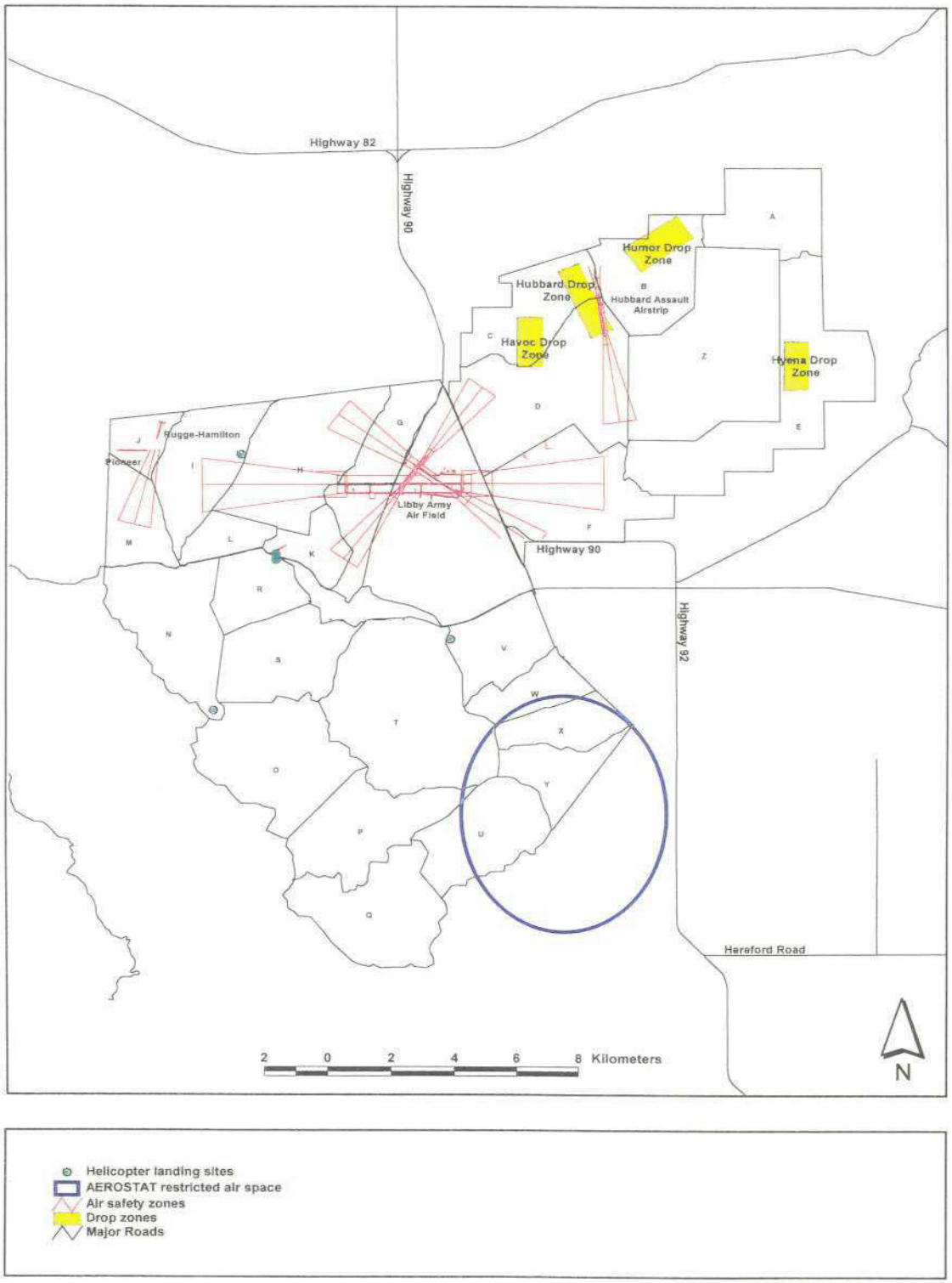


FIGURE 8 FORT HUACHUCA AIR SAFETY FANS AND LOCAL ACTIVITIES



Restricted areas contain airspace identified by an area on the surface of the earth within which the flight of aircraft is subject to restrictions. If the restricted area is active, the ATC facility having jurisdiction over the airspace needs to authorize clearances to aircraft that cannot avoid the restricted area, unless the aircraft is on a previously approved altitude reservation mission or is part of an activity within the restricted area (Coffman and Associates 1995). If the restricted area is not active and has been released to the controlling agency (Federal Aviation Administration (FAA)), the ATC facility will allow aircraft to transition through the airspace without issuing special clearances. Four restricted areas, R-2303A, R-2303B, R-2303C, and R-2312, are located in the vicinity of LAAF. Flight operations originating at LAAF (i.e. helicopter and UAV operations) utilize only small portions of this airspace.

Other fixed wing activities at LAAF include tenants at Fort Huachuca, such as the US Forest Service (USFS) Air Tanker base and the US Border Patrol border surveillance activities. Occasionally, other agencies use LAAF on a temporary basis, including North Atlantic Treaty Organization (NATO) partner aircraft, transient USAF operational aircraft, and civilian air shows.

2.3.1 FIXED-WING PILOTED AIRCRAFT TRAINING

Fort Huachuca airspace and facilities are used by other DoD agencies for proficiency testing and training during exercises originating at other installations. USAIC&FH is not the proponent for any military fixed-wing piloted aircraft training activity based at Fort Huachuca or any other installation. The following summary discussions represent aviation activities that utilize Fort Huachuca airspace or facilities during training or testing operations. The potential effects from these fixed-wing piloted aircraft training activities at LAAF and within Fort Huachuca airspace are evaluated in this BA.

Individual pilot proficiency training for the USAF and USAF Reserve is conducted in Fort Huachuca airspace and at LAAF facilities. The most common aircraft is the ground attack A-10 aircraft flown out of Davis-Monthan Air Force Base in Tucson. These A-10s averaged 18,885 flight evolutions at LAAF for calendar years 1988-1993, for an average of 37% of the annual military activity at the airfield (Scheibe 1997). This training consists of low altitude touch-and-goes (simulated aircraft landings and take-offs where aircraft are flown to LAAF and make approaches to the airfield, simulate a landing, and depart without actually grounding the aircraft). The LAAF air zone used during this activity is shown in Figure 8 (page 21). The Arizona Air National Guard (AZ ANG) and MO ANG use Fort Huachuca airspace and LAAF facilities on a continuous basis for individual proficiency training for pilots. The AZ ANG maintains a training center on post for the MO ANG's training course: Advanced Airlift Tactics and Training Center. They have five C130s and/or C17s at a time, 25-26 training classes per year. All personnel are qualified on their aircraft (i.e. the pilots are qualified to fly their aircraft already), and they are learning to evade surface to air fire, drop pallet loads from the aircraft, avoid detection, etc. The AZ ANG 162nd Fighter Group headquartered in Tucson, uses LAAF for instrument approach procedures, missed approach procedures, instrument departure procedures, and touch-and-go takeoffs and landings. Most training is conducted using the Lockheed C-130 aircraft, a four-engine turboprop powered tactical transport. Other similar turboprop transports, such as the two-engine Transall C-160, are used by some training units. The AZ ANG and MO ANG aircraft

have used LAAF for an annual average of 21,400 flight evolutions, or approximately 42% of the annual military activity at the airfield (Scheibe 1997).

Drop zones (DZ) on the East Range and the Hubbard Landing Zone are used by the AZ ANG and MO ANG as training flight destinations/objectives where actual airdrops or landings can be practiced. The Hubbard Landing Zone provides tactical airlift crews a rare peacetime opportunity to land and takeoff from a dirt runway. The Hubbard Landing Zone is presently used by each training aircrew for four landings and takeoffs during the class period. Annual operations for the landing zone are approximately 720 evolutions (AZ ANG 1992). The Missouri Air Guard has recently requested an expansion of the Humor DZ to accommodate air drops of palletized loads. The expansion would increase the size of the DZ to 1800 x 3000 meters. The Hubbard Landing Zone air zone used during this activity is shown in Figure 8 (page 21).

The DoD in cooperation with the FAA is proposing to replace the current air surveillance radar at Fort Huachuca within the next five years. Several alternatives for the location of the new system are being analyzed by the contractor, but no decision has been made. Once the locations are narrowed to two or three alternatives. Fort Huachuca will determine the potential effects to federally-listed species and consult with USFWS if appropriate.

2.3.2 ROTARY-WING AIRCRAFT OPERATION AND TRAINING

Most rotary-wing aircraft operations occur at LAAF. On occasion, rotary-wing operation may occur at the various helicopter landing pads across the installation and at the Black Tower UAV complex on the West Range (Figure 8, page 21). Typical rotary-wing aircraft operations include departure from LAAF upwards to approximately 8,500 feet above msl and subsequent cross-country travel throughout Arizona to other military installations and destinations. Rotary-wing traffic adheres to existing restricted airspace regulations (Figure 7, page 20). Helicopters are required under FAA regulation to be operated in a safe manner. Three helicopters are currently in operation at Fort Huachuca. They are primarily operated at 3,500 feet above ground level (agl), but may be operated at any elevation that is safe. Joint Task Force 6 helicopters take off and land at Fort Huachuca; JTF6 flights occur approximately 20-25 days annually and include low-level flights along the Mexican border, but not on Fort Huachuca. There are no low-level rotary-wing aircraft training exercises conducted at Fort Huachuca.

2.3.3 UNMANNED AERIAL VEHICLE TESTING AND TRAINING

In general, UAVs are large radio-controlled aircraft that have a 20-30 foot wingspan and are approximately 20-30 feet long (USAIC&FH 1993a, AUAVPO 1991). The following activities incorporated into the proposed action are:

a. Transfer in 2001 of the Navy's Pioneer UAV to Pensacola, Florida

b. Deployment of the Medium UAV (Shadow) in 2001. Training on the Hunter UAV will continue until late 2003 or early 2004. Shadow will be phased in as production continues. Aircraft are similar in size and range.

c. Upgrade of existing UAV facilities. A new runway with supporting facilities is proposed for the Rugge-Hamilton facility. The Applied Instruction Building would be expanded by 56,000 square feet. Additional facilities would be constructed at Shadow (previously Pioneer). An existing dirt airstrip at Demonstration Hill would be paved and used. LAAF would continue to serve as a UAV test site.

d. Construction of new UAV training facilities. There are proposed new facilities at LAAF, East Range, and near existing facilities.

e. Increased frequency of testing and flights The proposed action includes an anticipated increase of 30% in airspace R-2303A. Rugge-Hamilton and Shadow are expected to be used 300 flying days per year, 8 hours per day.

The Comprehensive UAV Testing and Training EA, (June 2000) provides additional information on these activities.

Fort Huachuca currently supports the operation and training of the Shadow UAV. This UAV has standard flight elevations of 3,500-4,000 and 6,500-7,000 feet agl respectively during testing and training activities. The minimum altitude at which UAVs travel (excluding take off and landing approaches) is 1,000 feet agl. Generally, UAVs operate above the West Range and to the west of Fort Huachuca. Typical flight paths for these UAVs are shown in Figure 7 (page 20). The UAV Training Center on the West Range provides support to the Shadow UAV Training Site. This training is conducted at the Advanced Instruction Building, Shadow training complex, and Rugge-Hamilton flight line, approximately 9.7 km (6 miles) west of the cantonment area on the West Range. The mission is to train UAV operators for the US Army and US Marines. Operational proficiency training involves field exercise activity by the active duty operational Army units located at Fort Huachuca (USAIC&FH 1993a, AUAVPO 1991) and the combined services UAV training. The training center operates on the West Range from approximately 0500 hours to 1600 hours with infrequent night operations. They use equipment such as UAVs, ground control stations, 5-ton trucks, mobile power units, and antennas.

Flight tests involve take-offs from the Fort Huachuca UAV complex on the West Range and travel westward to the Canelo Hills and Altar Valley target areas. Within the two target areas, accurately surveyed ground points are marked with steel reinforcing bar rods as potential target vehicle parking spots. These temporary markers are placed at each target site so vehicle drivers can locate the area. During the flight tests, 5-6 trucks may be positioned at fixed stations within each target area for up to four hours at a time. The target vehicles used are generally 2-ton trucks (two each), and 4-wheel drive pickup trucks (eight each). No off-road travel by vehicles is authorized. Target vehicles are provided with shovels and fire extinguishers. Vehicle parking points were identified and evaluated under NEPA (USAIC&FH 1993a, AUAVPO 1991). A Biological Evaluation was conducted as part of the NEPA process and found no effect to federally listed threatened and endangered species as a result of Short Range UAV activities.

Other activities conducted by UAV facilities involve flight tests of UAV systems requiring moving and fixed imagery targets. Such tests are normally conducted both within and outside the Fort boundaries. Typically, the activity is broken into two parts:

1. Launch and recovery of the vehicles from Training Areas India and Juliet (Hubbard and Rugge-Hamilton sites) which does not involve a large number of vehicles or personnel; and

2. Imagery targeting which involves the creation of imagery targets for the UAVs such as command posts, tank personnel, etc.

The on-post activities are located across the East and West Ranges at previously determined sites. The number of personnel per target positioning can range from five to a maximum of 90. Each unit would spend 1-2 days in each area and may then be replaced by another detachment. The movement of vehicles is confined to existing roads and trails, with some occasional off-road foot traffic activity. The number of vehicles in an area at a given time is approximately 18 per exercise. Off-post sites are usually pre-surveyed points along state highways, and vehicles are usually positioned within the highway right-of-way to reduce environmental impacts. Rocket-assisted takeoffs (RATOs) occur at Shadow and Rugge-Hamilton Airstrips. The noise generated by the takeoff rockets range from 76 to 93 dB. Frequency of RATOs is less than ten times a year at the installation.

Other UAV activities on Fort Huachuca may include activities similar to those described above using either smaller UAVs or larger UAVs. At this time, only testing activities using these sizes of UAV occur at Fort Huachuca. The Comprehensive UAV Testing and Training EA, June 2000, describes these activities and is incorporated by reference.

2.3.4 UNMANNED DRUG SURVEILLANCE BALLOON OPERATION

In 1987, an AEROSTAT Drug Surveillance Balloon became operational in the southern portion of the South Range. The blimp-type balloon is ground tethered and is an aerial platform for radar equipment used to detect aircraft illegally entering the US (Zillgens 1991). They provide radar data for US Customs, the DoD, and the FAA. They operate year round, 24 hours per day within approximately nine hectares (23 acres) of the South Range. Airspace used for the AEROSTAT balloon is shown in Figure 7 (page 20) and Figure 8 (page 21). This airspace is restricted only for AEROSTAT activities.

2.4 RECREATIONAL ACTIVITIES

Southeastern Arizona is a popular destination for local visitors, as well as national and international travelers. The addition of the SPNRCA, the Scenic Railroad, CNF, Coronado National Memorial, Ramsey Canyon Preserve, Kartchner Caverns State Park, and other unique tourist and recreational attractions further enhance visitor interest in Cochise County. Although current recreational use in the Sierra Vista area is mostly concentrated in areas just outside the Fort (Ramsey and Carr Canyons and the SPNRCA), Garden, Huachuca, and Scheelite Canyons on Fort Huachuca are additional popular recreational sites. With the development of Kartchner Caverns State Park, recreational interest throughout the area is expected to grow with an emphasis on scenic, natural, and cultural resources.

2.4.1 RECREATIONAL ACTIVITIES AT FORT HUACHUCA

Recreational use of Fort Huachuca lands has increased in recent years along with the general increase in tourism throughout the Cochise County area. Fort Huachuca is open to the public and areas outside the firing ranges and impact areas are available for recreational activities. The variety of natural and recreational resources in the Fort Huachuca area, especially for bird watching and hiking, suggest that interest in these resources will continue to grow. Popular activities at the Fort include bird watching, hiking, horseback riding, golfing, fishing, and hunting. Generally, recreational activities are unrestricted but portions of the Fort may be closed to the public during military training activities. Civilians participating in recreational activities can gain access to the installation by showing a photo identification card and registering their vehicle at the main or east gate to obtain a vehicle permit.

Public access to recreational areas may be prohibited by the Range Control Officer due to ongoing training and testing activities. As a result, some or all of Fort Huachuca may be closed to recreational activities on any given day.

2.4.2 HUNTING AND FISHING

Mule deer, white-tailed deer, pronghorn, javelina, bear and mountain lion are historically the big game species hunted at Fort Huachuca. Hunters also have the opportunity to hunt three species of quail, two species of dove, and several other small game species. There are 30 hunting management areas on Fort Huachuca (Figures 9 and 10). Fort Huachuca hunting seasons and bag limits are set in coordination with the Arizona Game and Fish Department (AGFD).

There are 16 ponds (approximately 32 acres) located on the Fort (Table 2). Seven of these ponds are stocked with trout when water conditions are favorable. Ponds are open for fishing during daylight hours only. Garden Canyon Creek is closed to fishing. The use of live bait (i.e. salamanders, fish, frogs, and crayfish) for fishing on Fort Huachuca is prohibited (Appendix C)

Hunting and fishing programs are covered by the 2001 Fort Huachuca INRMP (ENRD 2001).

2.4.3 HIKING, CAMPING, AND SPORTS

- Lower Garden Canyon picnic area has ten sites with tables and grills and is open to self-contained recreation vehicle and tent camping. The area includes a comfort station, playgrounds, and a ramada for protection from the sun and rain

- Middle Garden Canyon picnic area has picnic tables, grills, a playground, and a ramada

- Upper Garden Canyon picnic area has picnic tables, grills, a playground and a ramada

- Golf Course Pond has 12 picnicking sites with tables, grills, and ramadas. RV camping is permitted and a comfort station and softball field are located on site

FIGURE 9 GAME MANAGEMENT AREAS – MAIN POST

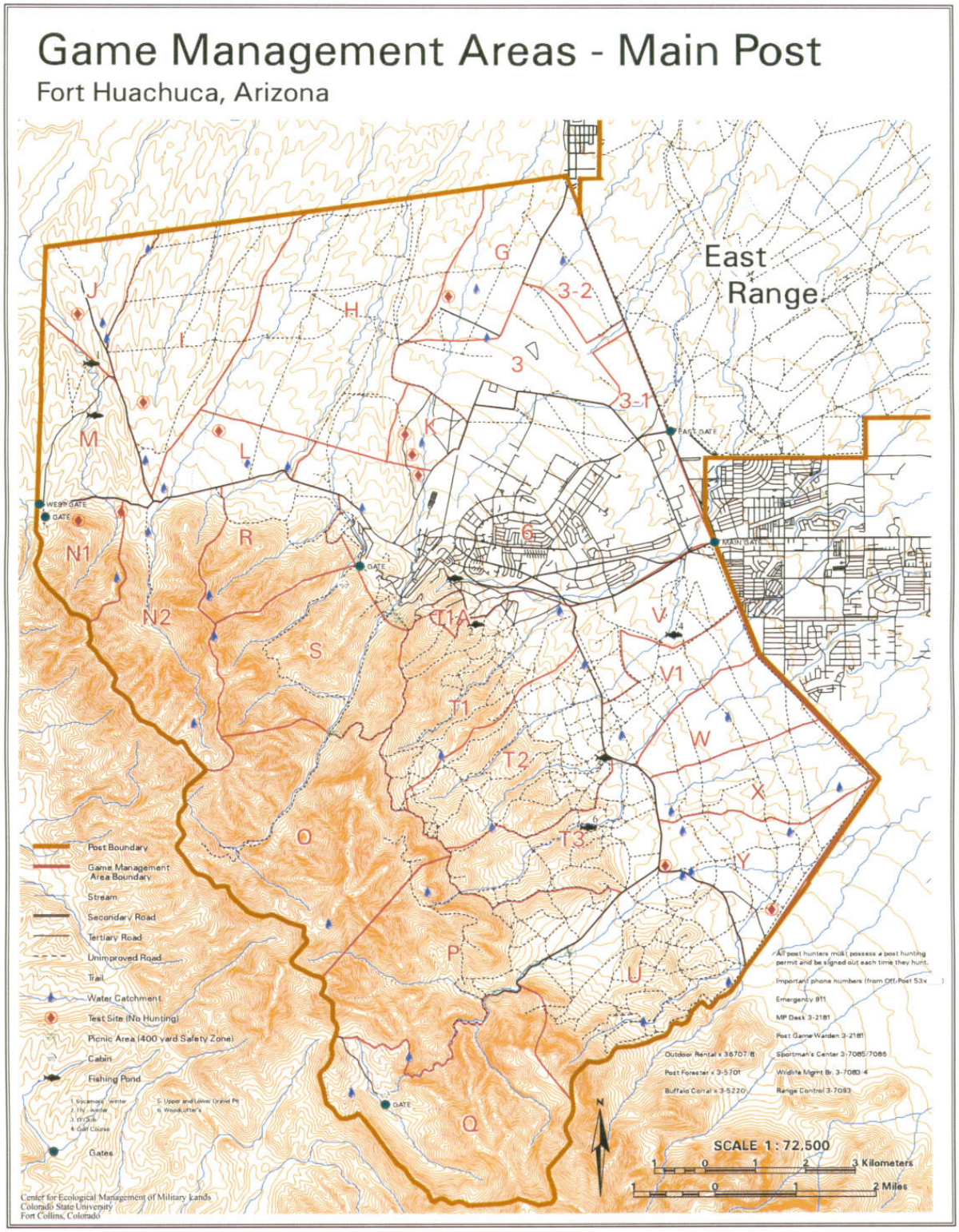


FIGURE 10 GAME MANAGEMENT AREAS – EAST RANGE

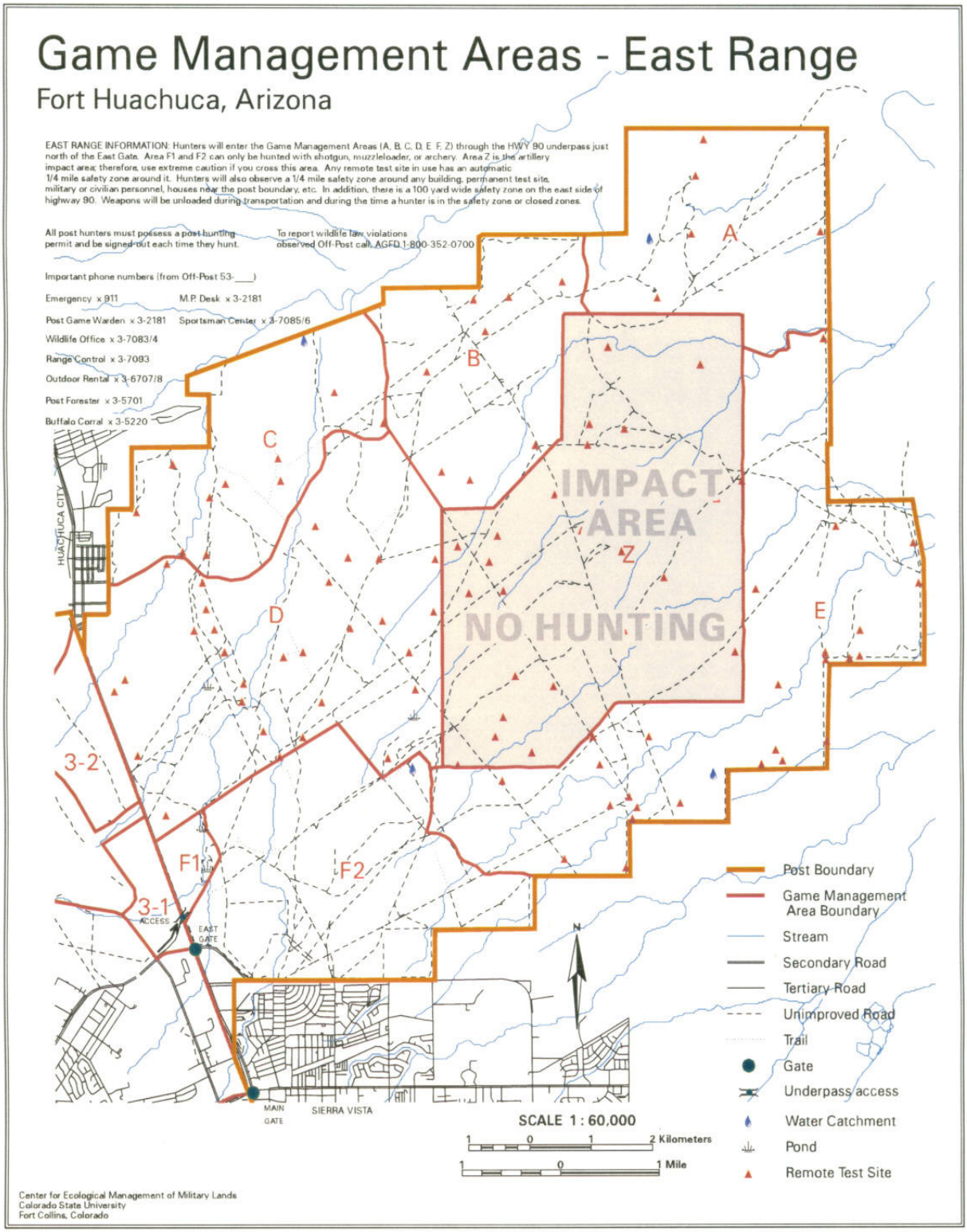


TABLE 2 PONDS OF FORT HUACHUCA

Pond	Game Management Area	Size (Sq. Acres)	Depth	Stocked1
Golf Course	V	5	>14'	Yes
Officers Club	Cantonment	3	>15'	Yes
Gravel Pit	T-2	5	>13'	Yes
Woodcutters	T-3	2.5	>15'	Yes
Fly	T-1	3.25	5'	Yes
Lower Garden	Y	2.5	8'	No
Middle Garden	U	2	8'	No
Sycamore I	H	2.5	15'	Yes
Sycamore II	J	1.75	7'	Yes
Tinker Canyon	U	1	8'	No
Blacktail	N-2	1.5	- -	No
Hidden	I	0.75	2.5'	No
Antelope	I	1.5	2'	No
Laundry Ridge	K	- -	- -	No
Upper Garden	Q	- -	- -	No
Kino	M	- -	- -	No

1 Ponds are stocked with trout if conditions are favorable but not always annually.

- Apache Flats Recreational Vehicle (RV) Park has 50 spaces for RVs with electricity, picnic tables, grills, and a dump station. Water is available at all 50 spaces
- Split Rock cabin is available for rental if fire conditions permit
- Garden Canyon Cabin near Sawmill Canyon is available for rental if fire conditions permit
- Sportsman Center campground has 24 hookups for RVs, ramadas, picnic tables, and grills

Garden and Huachuca Canyon areas offer a wooded site for picnicking away from the main post. Reservoir Hill offers a spectacular view of much of the San Pedro Valley. Camping on post is permitted only in designated campgrounds. Canyon areas are accessible only during daylight hours.

Approximately 72 km (45 miles) of hiking trails are available on the Fort. Some of these connect with USFS trails and provide hiking access to other portions of the Huachuca Mountains, including the Miller Peak Wilderness Area.

Recreational rock climbing and rappelling is prohibited. An existing 18-hole golf course serves both military and civilian personnel and is located on the eastern end of the cantonment area just south of the Main Gate. Recreational caving is permitted in specified caves when the lesser long-nosed bat is not present on the installation.

2.4.4 HORSEBACK RIDING AND GRAZING

Horses can be rented by the hour or by the day at the Buffalo Corral Riding Stables located on West Gate Road. Boarding of privately owned horses is also available. Three areas are used for grazing horses at Fort Huachuca. These three areas support approximately 50-60 horses. Use of these areas is rotated on a 12-18 month rotation schedule.

Pasture A is approximately 946 acres and is used on an infrequent basis from May to October. Pasture B is approximately 175 acres and is used between the months of March and May. Pasture C is approximately 312 acres and divided into two sections with rotation between the two. Horses are grazed in Area C from May to October. At other times, horses are kept in the corral and are not grazed.

Horseback riding is authorized across the installation with the exception of firing ranges (when in use), impact areas, and areas of the installation with sensitive species.

2.5 INTEGRATED NATURAL RESOURCES MANAGEMENT AND FIRE MANAGEMENT PLANNING

Fort Huachuca completed an INRMP in November 2001 (ENRD 2001). The plan will help guide natural resources management on Fort Huachuca from 2001-2005 while supporting Fort Huachuca's military mission. The INRMP ensures that natural resource conservation and military activities are integrated and consistent with federal stewardship requirements. The INRMP includes planning for inventory and monitoring, vegetation, wildland fire management, erosion and nonnative species control, and recreational management. The INRMP and all of its components are included in this BA as part of the proposed action.

A fire management plan for Fort Huachuca was drafted by Robinett *et. al*. (1997). As of this writing, the plan has not been adopted in full by Fort Huachuca, but the programmatic guidance for fire planning in that plan is considered part of the proposed action by Fort Huachuca. That guidance, as well as other fire management activities that Fort Huachuca plans to implement, is summarized below:

1. Policies to be followed in fire management include:

    a. Protection of life (firefighter and public) is the first priority. Property, military training, and natural/cultural resources (including endangered species protection) are second priority.

    b. Each prescribed fire shall be compatible with approved military training, public safety, or resource management objectives.

    c. The use of prescribed fire shall be considered in establishing the management strategy for all ecosystems, particularly those determined to be partially or totally fire dependent.

d. Interagency (National Wildfire Coordinating Group 1979) prescribed fire qualification and certification standards will be implemented. A qualified and adequate work force will be trained and maintained to plan and implement managed fire projects safely and effectively. Each prescribed fire shall be conducted by qualified personnel in accordance with the Western Region Prescribed Fire Qualification System.

e. Public health and environmental quality considerations will be incorporated into the use of managed wildland fire.

f. Once adopted, the Fort Huachuca Fire Management Plan will be reviewed on an annual basis and formally evaluated and reaffirmed every three years. Monitoring results from burns will be used in assessing the plan and making necessary revisions.

g. All areas with burnable vegetation will be allowed fire occurring at a reasonable return interval, except where occupied by human settlement. All areas below Charlie Break will be managed primarily by Fort Huachuca, while areas above Charlie Break will be managed primarily by the CNF under existing MOA (Figure 11).

h. Fires occurring in areas of human settlement (i.e. administrative sites, historic structures) will be suppressed immediately.

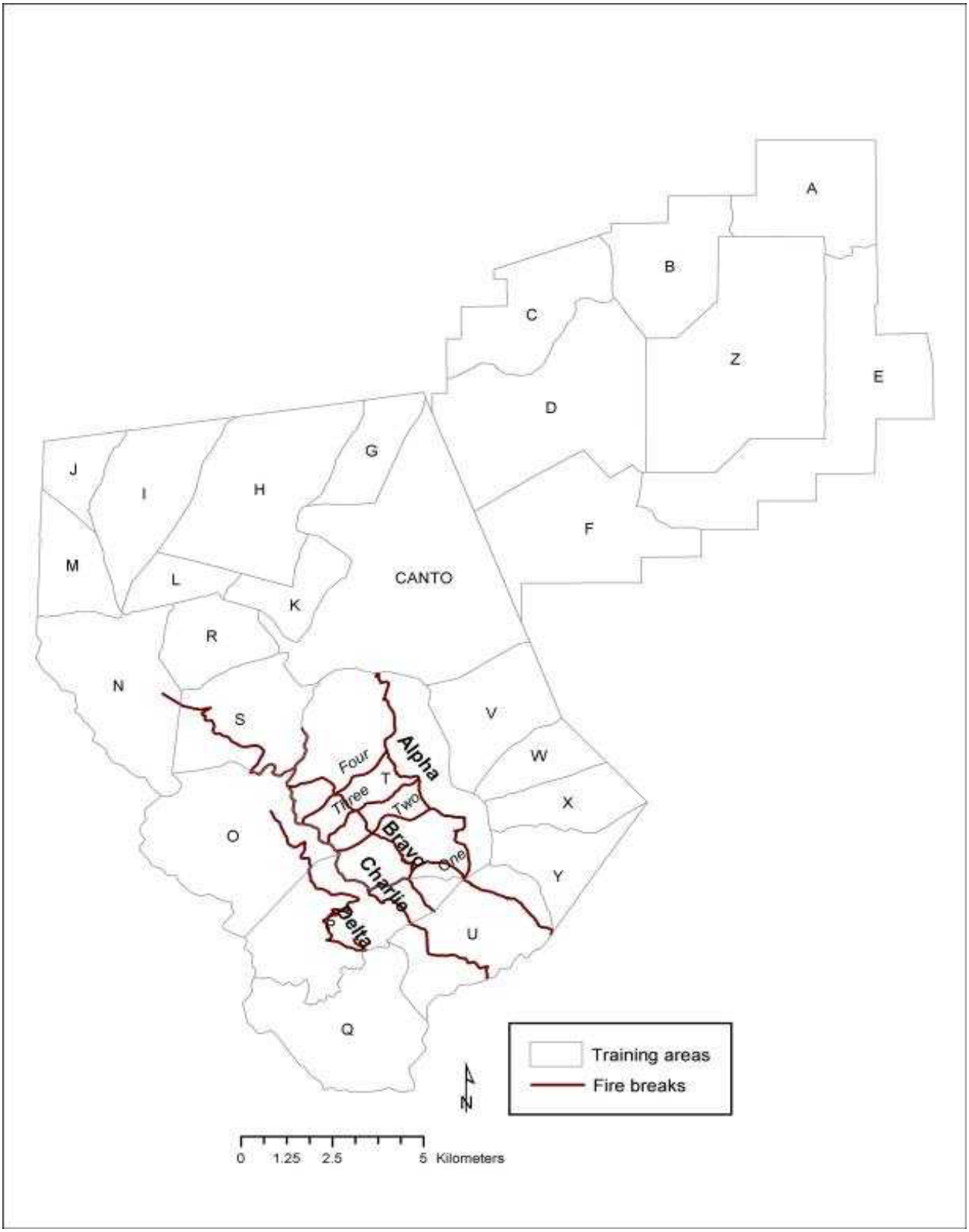
i. Fort Huachuca's fire management policy in military training areas below Charlie Break is one of prescribed burning coupled with control of fires that occur in or near structures and/or occur in the grasslands and savannas outside of prescribed parameters. Ignitions started by tracer fire will be managed to consume fuels throughout the entire Small Arms Impact Range Area in a safe, prescribed manner.

j. USFS and Fort Huachuca policy for woodlands and forests above Charlie Break allows for unplanned ignitions and management-ignited prescribed burning, as well as suppression (confine, contain, control) when appropriate. Charlie Break runs roughly from the junction of Training Areas November, Romeo, and Sierra southeast to a point on the south boundary of Training Area Uniform.

2. Prescribed (natural or ignited) fire shall be managed in accordance with the following guidelines. Implementation of prescribed fire will be contingent upon compatibility with military training, availability of funding and resources, and occurrence of correct burning conditions.

a. For each prescribed fire, Fort Huachuca will develop a prescribed burn plan that will include a description of the burn area, burn objectives, public safety issues, protection of sensitive features, range of expected results, weather and fuel conditions needed to achieve the desired fire behavior, containment procedures, pre-burn coordination (e.g. with the Service and the CNF), monitoring plan, smoke management plan, and contingency plan.

FIGURE 11 FORT HUACHUCA MAIN FIRE BREAKS ON THE SOUTH RANGE



b. The goals of prescribed burns on Fort Huachuca will include: 1) reducing fuel loads in military training areas to reduce the possibility of catastrophic fires; 2) maintaining or improving wildlife habitat, including improving pronghorn antelope range away from firing ranges to reduce antelope foraging in burns near firing ranges; 3) reducing the risk of catastrophic fires in habitats used by federally-listed threatened, endangered, and candidate species; 4) decreasing the likelihood of major fires in upper elevations that can cause an increase in erosion and decrease in water infiltration/recharge of aquifers; 5) reestablishing the natural frequency/intensity of fires that would sustain the flora and fauna biodiversity of Fort Huachuca; 6) reducing the potential for fire to spread into the Fort's urban interface areas; and 7) minimizing the threat of fire to the Fort's historical buildings and archeological sites.

c. Average fire return intervals should reflect the intervals of the natural fire cycle. Burn intervals in grassland, oak savanna, and pine-fir woodlands should average 5-10 years. Burn intervals will vary, but intervals shorter or longer than the average will be appropriate in some areas to meet management or military training objectives. Fire intervals in agave management areas shall be once every 10-15 years.

3. Subject to available funding and resources, the Fort will take action to reduce woody fuels above Charlie Break. Fuel reduction could be accomplished by mechanical means, such as pruning and thinning; as well as prescribed fire.

4. Once adopted and incorporated into the INRMP, Fort Huachuca will implement the Fire Management Plan to address suppression needs and prescribed fire. The plan will include guidelines related to: resource personnel responsibilities; adjacent landowner responsibilities; fuels management; climatic monitoring; prescribed burning; smoke management; firebreaks; pre-suppression; and training, research, and equipment needs.

5. Post-wide wildfire suppression activities will include the following five fire management measures to prevent fires and aggressively control wildfires if they occur:

a. Provision of fire suppression trucks on-site during live fire exercises when deemed necessary by the Range Control Officer and the Fort Huachuca Fire Department.

b. Maintenance of required firebreaks.

c. Avoidance of firing activities during high hazard conditions, such as strong winds.

d. Avoidance of the use of tracers during high to extreme fire danger periods.

e. To reduce the potential for adverse effects of fire suppression measures on listed and candidate species and their habitat. A biologist or other qualified environmental specialist will be available to serve as a resource advisor to provide guidance to individuals in charge of fire suppression activities.

2.6 REALTY ACTIONS AND ENERGY INITIATIVES

Fort Huachuca has the authority to exchange, acquire, or dispose of lands to benefit their mission. Currently, the Fort proposes to exchange a 26-acre parcel near Kayetan Drive and Buffalo Soldier Trail to the Arizona State Land Department for state in-holdings on the East Range. This exchange was authorized by special state legislation in 1987. A related land exchange is also being planned to gain full title to several parcels of land on the East Range of the Fort. In cooperation with the Bureau of Land Management (BLM) and the State of Arizona, state trust lands may be exchanged to ensure that full title to those parcels is conveyed to the federal government. This administrative action will not change land use or activities on those inholdings.

The City of Sierra Vista seeks to acquire 203 acres from Fort Huachuca adjacent to Libby Airfield pursuant to the Airport Improvement Act to be used for aviation-related uses. In June 2002, as an immediate and drastic measure to mitigate its impact within the Sierra Vista subwatershed, the Army set aside further consideration of this transfer to the City of Sierra Vista (Appendix D). If this realty action is proposed in the future it will undergo a separate Section 7 consultation.

Fort Huachuca has been a recognized leader in energy reduction initiatives over the past decade.[1] The recent energy crisis in California highlighted the need to develop other sources of energy. One promising energy alternative is wind power. Fort Huachuca has installed one Bergey wind turbine on the West Range and wind data collection equipment on the South Range. There is one data tower now; an additional 11 towers may be installed as discussed in the August 2001 consultation. Under current economic conditions, no further installation of wind turbines is proposed.

Electrical privatization is required by a Secretary of the Army initiative. Currently, Fort Huachuca purchases electricity from Tucson Electric Power as delivered to the main substation near Greely Hall. Operation and maintenance of the Fort's distribution system is performed by the government under contract with All Star. Under this initiative, the Fort's distribution system would be turned over to a private contractor. Electrical rate to the contractor would include purchased power and operation and maintenance of the distribution system. Fort Huachuca is in

[1] Fort Huachuca and its personnel have been honored to receive numerous awards recognizing the Fort's energy conservation and savings work, to include:

- Program Recognition:
  - 1994 Federal Energy Efficiency Award
  - 1994 Army Most Improved Program Award
  - 1995 First Place Secretary of the Army Energy Conservation Award
  - 1996 Federal Energy Saver Showcase designation
  - 1996 Federal Energy Efficiency Award
  - 1996 Federal Renewable Energy Award
  - 1997 Secretary of the Army Energy Conservation Award
  - 1999 Federal Energy Efficiency Award
- Individual Recognition:
  - 1992 Federal Energy Efficiency Award (Mr. Bill Stein)
  - 1996 Federal Energy Management Award (Mr. Vince Moreau)

Other environmental awards are noted in Section 5, footnote 1, of this BA.

the process of soliciting this service and expects completion by 2004. This initiative is expected to have no effects on listed species.

Privatization of the natural gas distribution system, water production and distribution system, and wastewater collection and treatment system are also Secretary of the Army initiatives. These projects are still in the planning stages.

Fort Huachuca currently has other alternative and renewable energy projects in place (photovoltaic, fuel cell, Dish/Stirling (solar)). These are small scale and there may be similar projects installed.

Medium and large scale power sources (photovoltaic, Dish/Stirling, Solar Chimney/Biomass, and cogeneration have been mentioned). Economic feasibility and funding availability are uncertain; these projects are not included in the proposed action.

2.7 PROGRAMMED FACILITIES DEVELOPMENT

Programmed renovation and construction of facilities development projects support mission-related activities. Army projects programmed for construction within the current cycle are listed in Table 3. These new military construction projects will occur within the cantonment area and within compatible land use areas. Facilities development projects include MCA projects targeted for construction and several physical upgrades or improvements to existing buildings.

2.8 CANTONMENT AREA

The cantonment area and other developed lands on the Fort cover approximately 5,720 acres, or approximately 8% of the installation. The majority of the buildings and structures on the installation are located within the main cantonment area. More than 1,889 buildings are located within the cantonment area. The cantonment area provides the location for a variety of operational and testing facilities, maintenance and production facilities, research, development, test and evaluation, supply facilities, hospital and medical facilities, administrative facilities, housing and community facilities, utility and ground improvements, housing and community support services, as well as administrative and operational directorates and training facilities. Major command headquarters are located throughout the cantonment area as well as maintenance and storage facilities, facilities for research, development and testing, medical care, and training. Within the cantonment and other built-up areas, land management activities and maintenance fall under the direction of the DIS.

TABLE 3 LONG-RANGE MCA AND OPERATION AND MAINTENANCE ARMY (OMA) PROJECTS LISTING (FY 02-14)

FY	Project Description	Project No.	Scope	Unit of Measure	Funding
02	Effluent Reuse & Recharge/P2	46756	- -	- -	MCA
02	WNR Pershing Plaza West - P1	31434	75	Units	MCA/AFH
03	WNR Pershing Plaza West - P2 (P/S only)	54403	75	Units	MCA/AFH
04	WNR Pershing Plaza West - P3 (P/S only)	54404	77	Units	MCA/AFH
06	Bowling Center Upgrade (P/S) (A/C - Elec. Upgrade)	43410	- -	- -	NAF
06	RV Park Expansion (P/S only)	53018	100	Spaces	NAF
06	Barracks with Battalion (P/S only)	38675	224795	SF	MCA
06	UAV Training Facility (P/S only)	55205	24540	SF	MCA
06	Chapel	50198	19940	SF	MCA
06	Global Information (P/S only)	55241	83250	SF	MCA
06	Vehicle Maintenance Facility	01388	21600	SF	MCA
07	Electronic Maintenance Facility (P/S only)	47283	50507	SF	MCA
07	Test & Evaluation Facility (P/S only)	53342	41220	SF	MCA
07	Youth Center Addition	33321	5332	SF	MCA
07	Community Club (P/S only)	45970	10000	SF	NAF
07	Sportsman Center (P/S only)	45969	10000	SF	NAF
07	Water Tank Potable (P/S only)	54561	.6m	GAL	MCA
07	Running Track (P/S only)	52128	5280	LF	MCA
07	Buffalo Corral Upgrade	45972	- -	- -	NAF
07	Pershing Plaza E/1 (P/S only)	31430A	75	Units	MCA/AFH
08	Aircraft Fuel Storage (P/S only)	46513	458000	GAL	MCA
08	Airfield Fence (P/S only)	44768	36800	LF	MCA
08	Pershing Plaza E/2 (P/S only)	31430B	77	Units	MCA/AFH
09	Chapel (Ed) (P/S only)	46484	16455	SF	MCA
10	Pershing Plaza E/3 (P/S only)	31430C	75	Units	MCA/AFH
10	Roads Paved (P/S only)	28561	- -	LF	MCA
10	Cavalry Park / #6 & Signal Village #1	42752	56	Units	MCA/AFH
11	Ammunition Supply Point (P/S only)	11708	25163	SF	MCA
11	Miles Manor 1 & 2 (P/S only)	31432	46	Units	MCA/AFH
12	Christy Sewer (P/S only – awaiting funds	48149	- -	- -	OMA
12	Combined Sewers areas 5 & 6 (P/S only – awaiting funds	48327	- -	- -	OMA
13	Army Continuing Ed Services Bldg (P/S Only)	56208	- -	- -	MCA
13	Combined Sewers areas 3 & 4 (P/S awaiting funds)	53291	- -	- -	OMA
14	Main Gate Access Bldg (Being Programmed)	58605	8600	SF	MCA
14	East Gate Access Bldg (Being Programmed)	58603	5600	SF	MCA

Fort Huachuca maintains and operates a number of facilities and conducts activities associated with operating a military installation. These include: 1) operation and maintenance of a 3.1 million gallon (mg) per day capacity wastewater treatment plant; 2) collection of solid waste, and disposal primarily at the Huachuca City landfill, but some material goes to the Elfrida landfill; 3) a recycling program for paper, aluminum cans, and newspaper that produced 527.8 tons in 2001; 4) a network of roads, most of which are primary or collector streets in the cantonment area, and

many unpaved routes on the training ranges; 5) operation of three gates to the installation: the Main, East, and West Gates; 6) distribution and use of electricity supplied by Tucson Electric Power Company (Fort Huachuca used 101,115,000 kilowatt hours in Fiscal Year 2001; 7) distribution and use of stationary fuels, such as natural gas furnished by Southwest Gas Company and propane; 8) distribution, storage and use of vehicle and aircraft fuels; and 9) operation of a Hazardous Material Center (hazardous material storage complies with Occupational Safety and Health Administration hazardous communications standards and National Fire Prevention Association standard codes, the Installation Spill Contingency Plan, and the Installation Hazardous Waste Management Plan.

The following outdoor training facilities are located within the cantonment area:

- Obstacle Course - Clover shaped with 17 obstacles. This course is a test of a soldier's basic motor skills and physical conditioning.

- Confidence Course - Clover shaped with four groups of higher and more difficult obstacles than the obstacle course. Designed to give soldiers confidence in their mental and physical abilities and cultivate their spirit of daring; and

- LAAF is located in the northernmost corner of the cantonment area. This airfield consists of a 12,000 foot Class "B" main runway on an east-west axis, a 5,365 foot secondary runway on a southeast-northwest axis, and a 4,300 foot tertiary runway running parallel to the main runway. Support facilities including a flight control tower, a navigational aids building, an airfield operations building, an airfield fire and rescue station, and storage buildings are located along the southern side of the main runway and within the operational land use zone. Maintenance facilities and the City of Sierra Vista air terminal are on the north side of the airfield (Zillgens 1991).

2.9 TRAINING AREA ACTIVITIES

This section describes each of the training areas on the installation and the activities conducted in these areas. Information sources for this section include interviews with the Range Control Officer, ATC and Air Operations Personnel, annual range utilization surveys, and a supplemental study on training area utilization (SAIC 1997b). This section discusses the infrastructure and facilities in the training areas, the military operations, and the recreational use of each training area. Table 4 provides a listing of individual training areas and the type of traffic (both on-road and off-road) permitted in each area.

2.9.1 TRAINING AREA ALPHA

Training Area Alpha is located in the East Range and covers an area of 2,471 acres (10 km^2). The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by Range Control to stay on existing roads and trails. Only wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is permitted.

TABLE 4 TERRAIN TYPE AND TRAFFIC PERMITTED BY TRAINING AREA

Training Area	Location by Range	Total Acres	Terrain Type	Traffic Permitted On Existing Road and Trails	Traffic Permitted Off Existing Roads and Trails
Alpha	East	2471	High Desert	Foot/Wheel	Foot
Bravo	East	2471	High Desert	Foot/Wheel/Tracked	Foot/Wheel
Charlie	East	2100	High Desert	Foot/Wheel/Tracked	Foot/Wheel/Tracked [1]
Delta	East	4694	High Desert	Foot/Wheel/Tracked	Foot/Wheel/Tracked [1]
Echo	East	4942	High Desert	Foot/Wheel	Foot
Foxtrot	East	3583	High Desert	Foot/Wheel/Tracked	Foot
Golf	West	1087	High Desert	Foot/Wheel	Foot
Hotel	West	4200	High Desert	Foot/Wheel	Foot
India	West	2223	High Desert	Foot/Wheel	Foot
Juliet	West	1111	High Desert	Foot/Wheel	Foot
Kilo	West	1136	High Desert	Foot/Wheel	Foot
Lima	West	840	High Desert	Foot/Wheel	Foot
Mike	West	1087	High Desert	Foot/Wheel	Foot
November	West	3410	Mountain	Foot/Wheel	Foot
Oscar	South	2619	Mountain	Foot/Wheel	Foot
Papa	South	3459	Mountain	Foot/Wheel	Foot
Quebec	South	2347	Mountain	Foot/Wheel	Foot
Romeo	West	1359	Mountain	Foot/Wheel	Foot
Sierra	South	2322	Mountain	Foot/Wheel	Foot
Tango	South	5312	Mountain	Foot/Wheel	Foot
Uniform	South	2347	Mountain	Foot/Wheel	Foot
Victor	South	1599	High Desert	Foot/Wheel	Foot
Whiskey	South	1482	High Desert	Foot/Wheel	Foot
X-Ray	South	1235	High Desert	Foot/Wheel	Foot
Yankee	South	1482	High Desert	Foot/Wheel	Foot
Zulu	East	6954	High Desert	Foot/Wheel	Foot

[1] Off-road wheeled and tracked-vehicle traffic is restricted to existing off-road maneuvering lanes. These lanes are currently inactive and have no programmed use. Any such future use of these lanes is subject to NEPA documentation and USFWS consultation prior to any scheduled use. As of this time, there is no authorized off-road activity in these lanes.

This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (Figure 5, page 15). These points support 60 and 80mm mortar, and 4.2-in mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.

Training Area Alpha is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.2 TRAINING AREA BRAVO

Training Area Bravo covers an area of 2,471 acres (10 km^2). The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by Range Control to stay on existing roads. Both tracked and wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is currently permitted, however, some off-road vehicle traffic will be needed for pallet recovery in support of Air National Guard training.

Mortar firing into Impact Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu (Figure 5, page 15). These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.

A portion of the Hubbard Assault Airstrip is located in Training Area Bravo and comprises a dirt assault strip/landing zone surveyed and approved by the US Air Force (USAF), which can accommodate C-130 aircraft (675 x 1600 meters).

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

The area contains the Humor DZ, an 825 x 1660 meter area (proposed to expand to 1800 x 3000 meters) of sparse vegetation on the northern half of the training area used for air drops during AZ ANG and MO ANG training maneuvers.

Training Area Bravo is also used for hunting activities. Hunters are required to observe a 0.25- mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.3 TRAINING AREA CHARLIE

Training Area Charlie covers an area of 2,100 acres (8.5 km^2). The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by Range Control to stay on existing roads. Both tracked and wheeled vehicles are permitted in this area on existing roads and trails.

Mortar firing into Impact Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.

This area also contains a portion of the approximately 5,172 acres within the East Range where off-road vehicle travel occurred up to 1994 (Figure 5, page 15). No off-road vehicle activity presently occurs or is planned in Training Area Charlie by Fort Huachuca.

This area contains a portion of the Hubbard DZ (850 x 1700 meters) and the majority of Havoc DZ (850 x 1700 meters). These areas of sparse vegetation on the eastern and southern half of the training area are used for air drops during AZ ANG and MO ANG training maneuvers.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Charlie is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.4 TRAINING AREA DELTA

Training Area Delta is located between Training Areas Charlie and Foxtrot and covers approximately 4,694 acres. Training Area Delta has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by Range Control to stay on existing roads. Both tracked and wheeled vehicles are permitted in this area on existing roads and trails. This area also contains a portion of the approximately 5,172 acres within the East Range where off-road vehicle travel occurred up to 1994 (Figure 5, page 15). No off-road vehicle activity presently occurs or is planned by Fort Huachuca.

Mortar firing into Impact Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.

This area contains a portion of the Hubbard Assault Airstrip which is a dirt assault strip/landing zone, surveyed and approved by the USAF, that can accommodate C-130 aircraft (675 x 1600 meters). The area also contains a portion of the Hubbard DZ (850 x 1700 meters) and a small portion of Havoc DZ (850 x 1700 meters). These areas of sparse vegetation on the northern edge of the training area are used for air drops during AZ ANG and MO ANG training maneuvers.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Delta is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.5 TRAINING AREA ECHO

With approximately 4,942 acres (20 km^2), Training Area Echo is the largest training area on the East Range. The area has a high desert terrain and is primarily used for intelligence and communications testing activities. During all such operations vehicles are required by Range Control to stay on existing roads. Only wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is permitted.

Mortar firing into Impact Area Zulu is permitted from this area upon approval from Range Control. Vehicle maneuvering on established roads and trails is authorized in this area. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.

The area contains Hyena DZ (300 x 300 meters). This area of sparse vegetation in the central portion of the training area is used for air drops during AZ ANG and MO ANG training maneuvers. The area also contains a preexisting dirt runway.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Echo is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.6 TRAINING AREA FOXTROT

Training Area Foxtrot is located between Training Areas Charlie and Echo and covers an area of 3,583 acres (14.5 km^2). The area is primarily used for intelligence and communications training and testing. The area has a higher level of military activity than other training areas on the East Range. Only wheeled vehicles are permitted in this area on existing roads and trails. No off-road vehicle use is permitted.

Mortar firing into Impact Area Zulu is permitted from this area upon approval from Range Control. This training area contains several surveyed firing points usable for mortar and artillery firing into Impact Area Zulu. These points support 60 and 80mm mortar, and 4.2-inch mortars, utilizing high explosive, illumination, smoke, and weapons piercing rounds for training. If use of areas outside of the pre-existing firing points is required, Section 7 consultation would be requested.
Located to the east of LAAF, air space over portions of this area is located within landing and departure zones of primary runways at LAAF (Figure 8, page 21).

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Area Foxtrot is divided into two game management areas: F1 and F2. Training Area F2 is closed to all hunting while area F1 can only be hunted with shotgun or bow and arrow.

2.9.7 TRAINING AREA GOLF

Training Area Golf is located on the West Range and covers and an area of 1,087 acres (4 km^2). This area has a high desert terrain and is primarily used for intelligence and communications training and testing. Only wheeled vehicles are permitted on the existing roads in the area. No off-road vehicle use is permitted.

Located to the north of LAAF, air space over portions of this area is located within landing and departure zones of secondary runways at LAAF (Figure 8, page 21).

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Echo is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.8 TRAINING AREA HOTEL

Training Area Hotel covers an area of 4,200 acres (17 km^2). This area is primarily used for intelligence and communications training and testing activities. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Portions of the installation grazing lands are located in this area (see Section 2.3.4). Training Area Hotel is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.9 TRAINING AREA INDIA

Training Area India is located on the West Range and covers a land area of 2,223 acres (9 km^2). This area is primarily used for intelligence and communications training and testing activities. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted. Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

A helicopter landing pad is located within this area. Patrolling and tactics training is conducted in this area.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area India is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. Antelope and Hidden Ponds are located in this area.

2.9.10 TRAINING AREA JULIET

Training Area Juliet is located on the West Range and covers a land area of 1,111 acres (4.5 km^2). This area is primarily used for intelligence and communications training and testing activities and UAV operations. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

The Black Tower Joint Services UAV Training Complex is located on area Juliet. This consists of a permanent block of structures, temporary trailers and buildings encompassing the Shadow Training Facility and runway, the Advanced Instruction Building, and paved Rugge-Hamilton UAV runway.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area India is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. The Sycamore II Pond is located in this area.

2.9.11 TRAINING AREA KILO

Training Area Kilo is located on the West Range and covers an area of 1,136 acres (4.6 km^2). This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

This area contains one Helicopter Landing Area for proficiency and emergency operations.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Portions of the installation's grazing lands are located in this area (see Section 2.3.4). Training Area Kilo is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. Laundry Ridge Pond is located in this area.

2.9.12 TRAINING AREA LIMA

Training Area Lima covers an area of 840 acres (3.4 km^2) and a large percentage of its land is under protected agave management. This area is primarily used for intelligence and communications training and testing activities. Patrolling and land maneuvering training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities). One large, (40 acre) permanent bivouac site is located in this area. This site is approximately 2000 meters from the protected agave management area.

Training Area Lima is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings and permanent test sites. The area has a picnic area for recreational activities.

2.9.13 TRAINING AREA MIKE

Training Area Mike is located on the West Range and covers an area of 1,087 acres (4.5 km^2). This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

A land navigation course consisting of 58 surveyed concrete points with ASA markers, is found in Training Area Mike.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities). One large, (40 acre) permanent bivouac site is located in this area. This site is approximately 500 meters from the Protected Agave management area.

Training Area Mike is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings and permanent test sites. The Kino and Sycamore I Ponds are located in the area.

2.9.14 TRAINING AREA NOVEMBER

Training Area November covers an area of 3,410 acres (14 km^2). As the general terrain of the area is of the mountainous type, the military activities in the area are restricted to the relatively flat areas only. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

This area contains one Helicopter Landing Area for proficiency and emergency operations.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

For the purpose of game management the area is divided into two parts, N1 and N2. Training Area November is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone

around buildings, permanent test sites, and houses near post boundary. Blacktail Pond is located in the N2 Game Management Area.

2.9.15 TRAINING AREA OSCAR

Training Area Oscar is part of the South Range and covers an area of 2,619 acres (10.6 km^2). As the general terrain of the area is of the mountainous type, the military activities in the area are restricted to the relatively flat areas only. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Oscar is among the areas heavily used for recreational activities. The Huachuca Canyon picnic area is located in the northern part of the area. Training Area Oscar is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.16 TRAINING AREA PAPA

Training Area Papa is located on the South Range and covers an area of 3,459 acres (14 km^2). As the general terrain of the area is of the mountainous type, the military activities in the area are restricted to the relatively flat areas only. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

The topography of the area contributes to the heavy use of the area for recreational activities. Three picnic areas are located in the Garden Canyon area. Facilities in these recreation areas include play areas, grills, and ramadas. There are numerous hiking and horseback riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Training Area Papa is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.17 TRAINING AREA QUEBEC

Training Area Quebec is located on the South Range and covers an area of 2,347 acres (9.6 km^2). As the general terrain of the area is of the mountainous type, the infrequent military activities in the area are restricted to the relatively flat areas and roads only. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

The topography of the area contributes to the heavy use of the area for recreational activities. There are numerous hiking and horseback riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Upper Garden Canyon Pond is located in this area. Training Area Quebec is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.18 TRAINING AREA ROMEO

Training Area Romeo is located on the West Range and has a land area of 1,359 acres (5.5 km^2). This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

This area contains one Helicopter Landing Area for proficiency and emergency operations.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Romeo is also used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings and permanent test sites.

2.9.19 TRAINING AREA SIERRA

Training Area Sierra is located on the South Range and covers a land area of 2,322 acres (9.5 km^2). This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

The topography of the area contributes to the heavy use of the area for recreational activities. There are numerous hiking and horseback riding trails in this area. Recreational users are prohibited from rock climbing and rappelling. Split Rock Cabin is located in this area. Training Area Sierra is also

used for hunting activities. Hunters are required to observe a 0.25-mile safety zone around buildings and permanent test sites.

2.9.20 TRAINING AREA TANGO

Training Area Tango is located south of the cantonment area and covers a land area of 5,312 acres (21 km^2). This area is characterized by 17 live firing ranges. See Table 1 (page 16) for range descriptions and the types of weapons used. See Figure 6 (page 17) for locations of firing ranges. Training Area Tango is used for personnel development training by most units on the installation.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

This is a small arms impact area and although no explosive munitions are used, testing and training is not permitted in this area.

Training Area Tango is divided into three game management areas: T1, T2, and T3. The area is used for hiking, hunting, and fishing. Hunters are required to observe a 0.25-mile safety zone around buildings and permanent test sites. Gravel Pit, Woodcutters, and Fly Ponds are located in this area.

2.9.21 TRAINING AREA UNIFORM

Training Area Uniform is located on the South Range and covers a land area of 2,347 acres (9.6 km^2). This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

A land navigation course is located on area Uniform. This course consists of 44 surveyed concrete points with ASA markers. Vehicles are required to stay on the existing roads and trails.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Uniform is also popular for its recreational facilities. Picnic areas are located in this portion of Garden Canyon. The area is used for hiking and hunting. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. Middle Garden Canyon and Tinker Ponds are located in this area.

2.9.22 TRAINING AREA VICTOR

Training Area Victor covers a land area of 1,599 acres (7 km^2) and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on the existing roads in the area. No off-road vehicle use is permitted.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

This area contains one Helicopter Landing Area for proficiency and emergency operations.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Victor is divided into two parts for game management: V and V1. Training Area V has a golf course and Golf Course Pond. Hunting is not permitted in this area.

2.9.23 TRAINING AREA WHISKEY

Training Area Whiskey covers a land area of 1,482 acres (6 km^2) and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

The Site Boston field training exercise (FTX) area is located in Training Area Whiskey. Large brigade-level exercises are conducted at Site Boston. The 86th Signal Bn conducts two battalion and one brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the battalion level training, 42 are used at the brigade level. Activities during these training exercises include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Whiskey is also used for hiking and hunting. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.24 TRAINING AREA X-RAY

Training Area X-Ray covers a land area of 1,235 acres (5 km^2) and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

Large brigade level exercises are conducted in this area. The 86th Signal Bn conducts two battalion and one brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the battalion level training, 42 are used at the brigade level. Activities during these training exercises include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area X-Ray is also used for hiking and hunting. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary.

2.9.25 TRAINING AREA YANKEE

Training Area Yankee covers a land area of 1,482 acres (6 km^2) and has a desert type terrain. This area is primarily used for intelligence and communications training and testing activities. Patrolling

and tactics training is conducted in this area. Only wheeled vehicles are permitted on existing roads in the area. No off-road vehicle use is permitted.

Large brigade level exercises are conducted in this area. The 86th Signal Bn conducts two battalion and one brigade level exercise each year, with about 42 and 100 personnel respectively participating in the training. While 17 vehicles may be utilized at the battalion level training, 42 are used at the brigade level. Activities during these training exercises include radio systems training, setting tactical field sites, tents, antennas, and mobile kitchens.

Testing and training sites located in protected agave management areas within this training area adhere to special use regulations:

1. No firing of blanks or pyrotechnics within 0.25 miles of these areas.

2. Training and test sites will not be used by personnel on foot unless the activity has a Range Control approved plan for fire suppression and minimal fire fighting equipment.

3. Night operations are prohibited from July 1 to October 31.

The AEROSTAT operations facility and tethered balloon is located in this area.

On occasion, locations across the area are utilized by training units for setting up bivouacs containing sleeping, mess, and other related facilities for the execution of field training exercises (see Section 2.2.6 for a discussion of mission and bivouac activities).

Training Area Yankee is also used for hunting. Hunters are required to observe a 0.25-mile safety zone around buildings, permanent test sites, and houses near post boundary. Lower Garden Canyon pond is located in this area.

2.9.26 IMPACT AREA ZULU

Impact Area Zulu, also known as the "Impact Zone" is a part of the East Range. This 6,954 acre (27 km^2) area contains various types of targets for artillery and mortars. High explosive ammunition may be fired in this area. Some areas may contain unexploded ordnance (UXO). Range Control Operations has declared off-road areas in this zone permanently "off-limits" to recreational activities and warning signs are posted in the area to alert visitors and troops.

This area is sometimes used for intelligence and communications training and testing activities and may have non-recoverable or explosive payloads dropped from UAVs or other aircraft in the future. ASA sites are located along existing roads and trails in this area and can be used for intelligence and communications testing and training. No off-road vehicle use is permitted.

No recreation or hunting is permitted in this area.

2.10 OFF-POST ACTIVITIES AUTHORIZED OR CARRIED OUT BY FORT HUACHUCA

For military training purposes the Fort leases approximately 2,600 acres from a variety of land owners, primarily in southeastern Arizona (Appendix E). An additional 27,387 acres on the Willcox Playa, Cochise County is withdrawn from public entry. Parcels leased vary in size from less than an acre to 1,280 acres on Willcox Playa. Although most leased/withdrawn land is in Cochise County, the Fort also leases land near Phoenix, Gila Bend, Oatman, Mount Graham, and Mount Lemmon, Arizona; Lordsburg, New Mexico; and Mount Diablo, California. Many are ASA or communications sites (antennas, microwave towers, etc.). Others are pull-off sites along roadways where equipment is temporarily operated. Uses of each site are described in Appendix E. Much of the equipment is temporarily operated. Many of the equipment tests and field training exercises conducted by a variety of training units at Fort Huachuca require placement of equipment over a large geographic area.

SECTION 3
ENVIRONMENTAL SETTING

This section describes the baseline elements of the land use, climate, soils, surface water and groundwater resources, population, economics, and biological resources of Fort Huachuca and the surrounding area.

3.1 LAND USE

Fort Huachuca is located on the western fringe of the Upper San Pedro River Valley in Cochise County in southeastern Arizona; 75 miles (121 km) southeast of Tucson and approximately 8 miles (13 km) north of the Mexican Border. Benson, Arizona is approximately 31 miles (50 km) north of the installation on Interstate 10. Fort Huachuca is comprised of approximately 73,142 acres situated adjacent to the City of Sierra Vista and near Huachuca City in the foothills of the Huachuca Mountains. The Huachuca Mountains form the southern and western boundaries of the Fort. The Fort's northern border parallels the Babocomari River; a tributary to the San Pedro River. The City of Sierra Vista lies immediately to the east of the installation and serves as a regional residential and commercial center. Huachuca City lies to the north of Fort Huachuca.

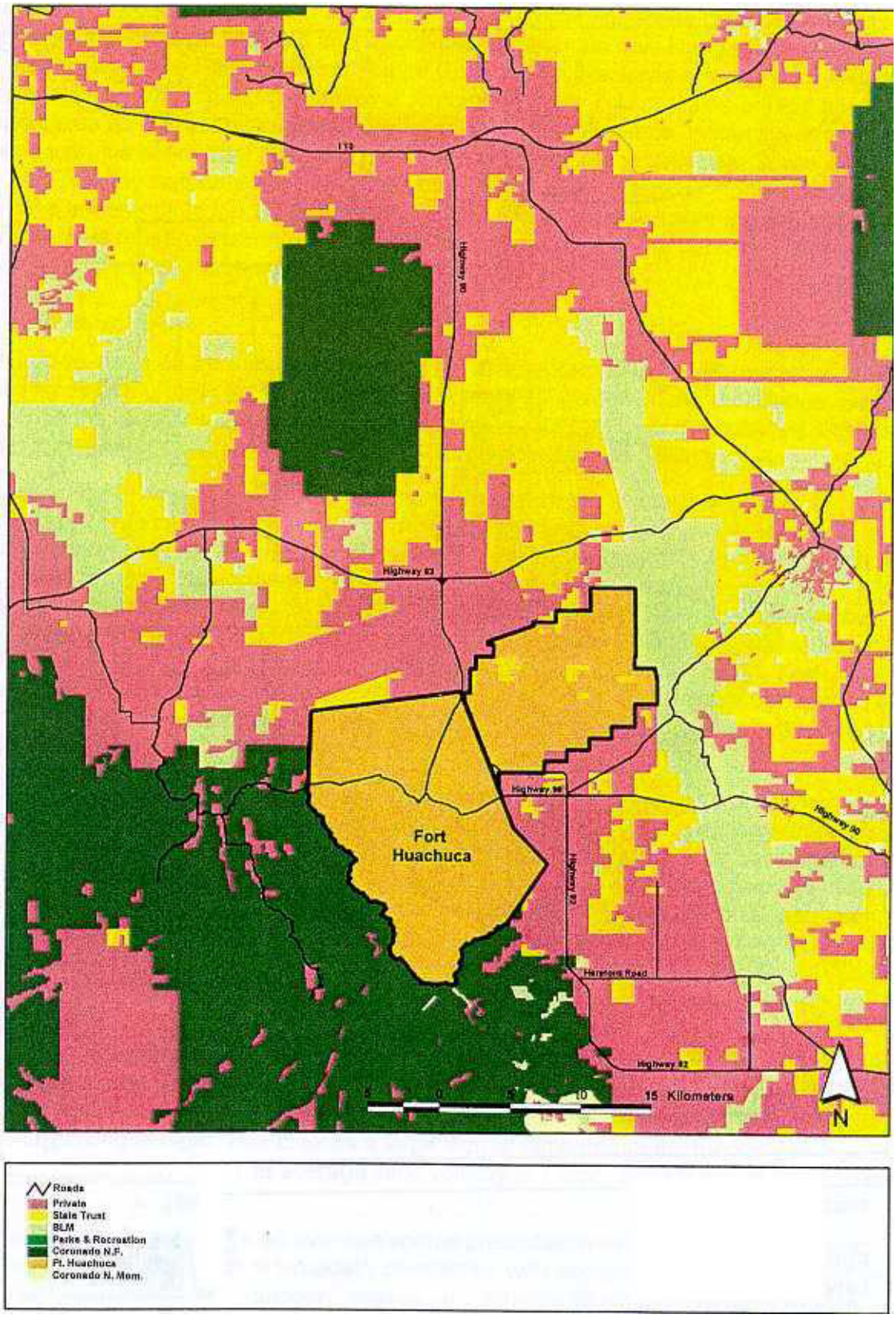
Lands surrounding Fort Huachuca are directly affected by Cochise County, Santa Cruz County, and the City of Sierra Vista's land use restrictions. A large portion of land adjacent to the installation falls under the land use control of the BLM and the USFS (Figure 12).

Cochise County zoning districts maintain land use throughout the county. Approximately 90% of the unincorporated areas of the county is zoned RU for rural development (Zillgens 1991). The lands adjoining the installation at the northern, southern, and portions of the western and eastern borders are zoned RU 4 and require a minimum lot size of four acres (Zillgens 1991). The Transitional Residence (TR) zones along the eastern border of the installation have a minimum lot size of 36,000 ft^2. Additional areas around Huachuca City and along State Highway 92 south of Sierra Vista are classified as urban growth areas.

The Sierra Vista Ranger District of the CNF encompasses 75,000 acres (117 square miles) of forestland in the Huachuca Mountains immediately to the south and west of the installation. This land is predominately undeveloped and contains very few major access roads, campgrounds, or other high volume recreation facilities. The Forest Management Plans for the CNF delineate management areas adjacent to the installation for visual resources, livestock grazing, game habitat, fuel wood harvest, and wilderness (Zillgens 1991).

The SPRNCA, established by Act of Congress in 1988, is the dominant geographic feature in the San Pedro Basin, and is managed for a variety of wildlife, environmental, and recreational uses (Figure 1, page 2). Managed by the BLM, the SPRNCA's purpose is to protect the riparian area and the aquatic wildlife, archaeological, paleontological, scientific, cultural, educational, and recreational resources within the authorized boundary of the area. It extends as a publicly owned corridor from the community of Curtis at its north end, to a few miles below Hereford, situated immediately north of the Mexican border. The SPRNCA corridor lies as close as 0.5

FIGURE 12 LAND OWNERSHIP



mile from the northeastern boundary of the installation, and approximately 10 miles separate the boundaries of the two federal reserves to the south. The SPRNCA is approximately five miles wide at its widest point and encompasses the San Pedro River.

3.1.1 INSTALLATION LAND USE

Fort Huachuca is divided into an East Reservation (28,544 acres) and West Reservation (44,598 acres) by Arizona Highway 90(Figure 13). These Reservations are classified generally as either open/operational, or built-up areas and are classified as training ranges or cantonment areas respectively.

The East Reservation includes the East Range and consists almost entirely of open/operational areas. This area includes approximately 13,463 acres of public domain land withdrawn from public use for military purposes pursuant to the Order of the Secretary of Interior (Public Land Order 1471, 8/22/57). These lands are managed primarily for military training purposes consistent with the stated purpose of the secretarial withdrawal. The Resource Management Plan of the Safford District of the BLM identifies these lands as being managed for military purposes and provides for resource management coordination with Fort Huachuca consistent with the requirements of the Federal Land Protection and Management Act (FLPMA).

The West Reservation includes the West Range, South Range, and cantonment or built-up area (5,720 acres). To clarify existing land use patterns and characteristics, the remaining discussion identifies facilities and training ranges based on their association or physical location within either open/operational or built-up areas.

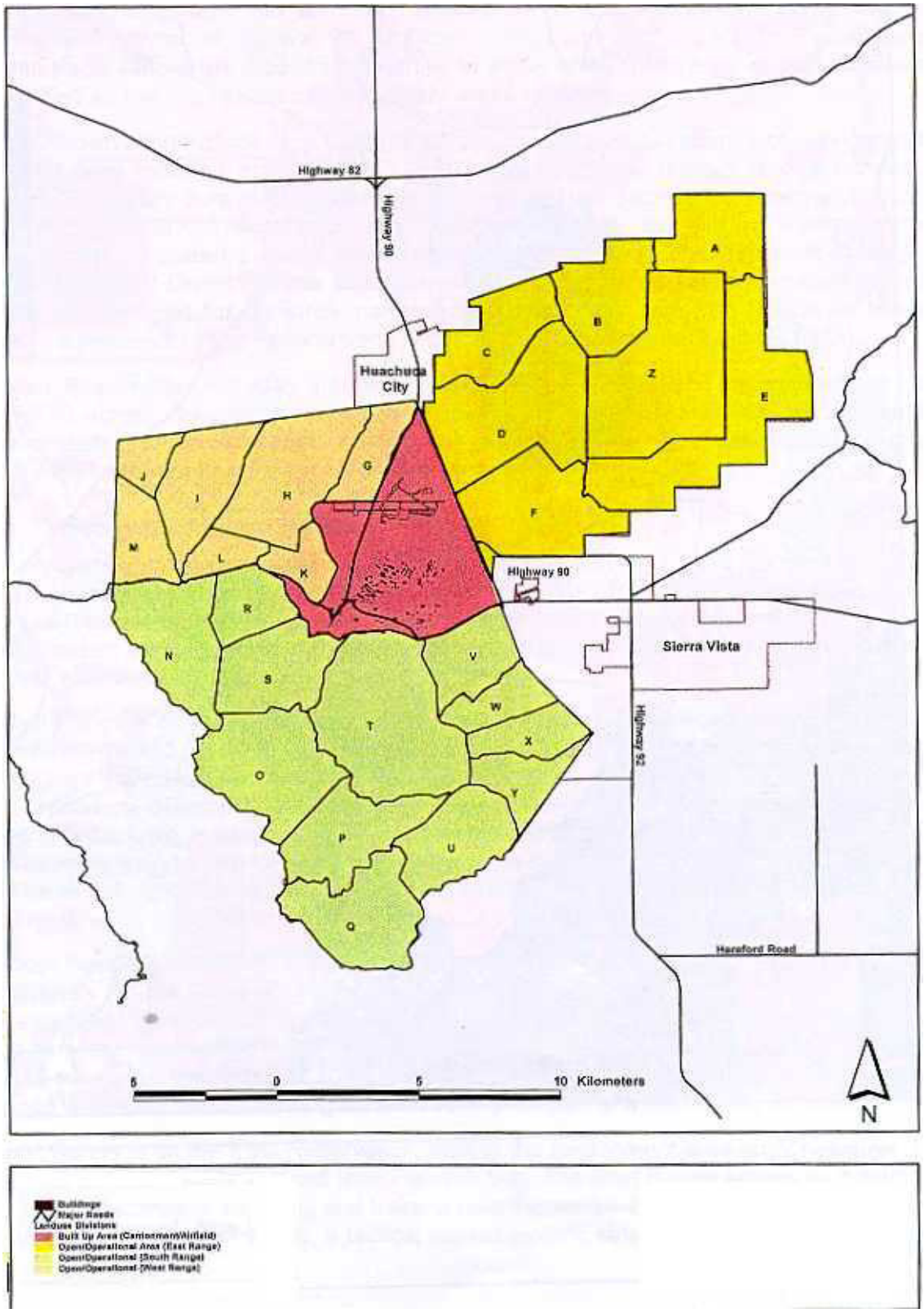
3.1.2 OPEN/OPERATIONAL AREAS

The open/operational areas on the West and East Reservations are used as training ranges and test ranges and comprise 67,872 acres or approximately 93% of the installation. Active and Reserve component units of all services use the training areas mainly for mountain/desert training, escape and evasion training, brigade-size field training exercises, and maneuver exercises.

The West Range is on the West Reservation, west of the cantonment area and covers approximately 16,000 acres of land (Figure 13). The West Range is used for training and testing. There are no live fire training areas in this range, and at specified times the range is used for research, development, and testing. The northwest corner of the West Range, known as Training Area Juliet, is predominantly used by the Intelligence School for training related to UAVs. The EPG also performs some research and development testing in this area. The launching of UAVs from a supporting facility is one of the tests performed on the West Range.

The South Range is on the West Reservation located south of the built-up area and covers approximately 23,000 acres including most of the installation's portion of the Huachuca Mountains (Figure 13). The eastern slopes of the southern portion of the mountains are used in part for impact areas from the firing positions located in the flat terrain of the eastern portion of

FIGURE 13 FORT HUACHUCA LAND USE



the range. Training and some testing occur in the northern portion of the mountains. The range is divided into 12 training areas, 17 firing ranges, and several impact areas.

The East Range is on the East Reservation, east of the cantonment area and covers 28,544 acres of land (Figure 13). The East Range serves as a platform for research and development testing and training. It contains six training areas, a demolition range, a tactical assault landing strip, an impact area, and four drop zones. Impact Area Zulu is a 6,954 acre (28 km^2) impact area for various types of self propelled artillery and mortars. When live fire exercises occur, the entire East Range is closed for all other training activities. Some areas within Impact Area Zulu may contain UXO. Fort Huachuca Range Control dictates strict adherence to the 'off-limits' policy of this impact area and warning signs are posted in the area to alert personnel of the potential danger. Aside from hunting, outdoor recreation is not permitted on the East Range (ENRD 2001).

3.1.3 BUILT-UP AREAS

The two built-up areas on the installation include the cantonment area and Libby Army Airfield (LAAF) and occupy 5,720 acres or approximately 8% of the installation. Both are located on the eastern edge of the West Reservation.

The majority of buildings and structures on the installation are located within the cantonment area. The cantonment area provides the location for a variety of housing and community support services, as well as administrative and operational directorates and training facilities. Major command headquarters are located in the cantonment area as well as maintenance and storage facilities, facilities for research, development and testing, medical care, and training. Within the cantonment and other built-up areas, land management activities and maintenance fall under the direction of the Fort Huachuca DIS. The DIS is responsible for ensuring that all parts of the installation are in compliance with environmental laws and regulations. More than 1,889 buildings are located within the cantonment area.

LAAF consists of a 12,000 foot Class 'B' main runway on an east-west axis, a 5,365 foot secondary runway on a southeast-northwest axis, and a 4,300 foot tertiary runway running parallel to the main runway. Support facilities include a flight control tower, a navigational aids building, an airfield operations building, and an airfield fire and rescue station. Storage buildings are located along the southern side of the main runway and within the operational land use zone. Maintenance facilities and the City of Sierra Vista air terminal are on the north side of the airfield (Zillgens 1991).

3.2 CLIMATE

The area of the Upper San Pedro Basin (USPB) has a dry climate with relatively mild winters and warm summers. The summer average high temperature is 88° F and the average winter low is 32° F. Clear skies or high thin clouds are common and permit intense surface heating during the day and radiant cooling at night. This creates a large diurnal temperature fluctuation which averages approximately 30° F. The average wind velocity is seven mph. Wind gusts of 20 to 30 mph are common during the daytime.

The Huachuca Mountains receive an average annual precipitation exceeding 30 inches per year (ADWR 1988). Precipitation is bimodally distributed, with approximately 60% of the total falling during the summer "monsoon" season (July – Sept), and roughly 30% occurring during winter months. Spring and fall are typically dry. Maximum "monsoonal" precipitation falls on the southeast (windward) side of the Huachuca Mountains (ADWR 1988).

The climate at Fort Huachuca is as varied as its topography, ranging from hot, dry valley bottoms to cool, moist mountain peaks. The principal meteorological station is located just south of LAAF, elevation 4,664 feet above msl. Other meteorological stations are also maintained at Fort Huachuca. Average minimum and maximum daily air temperatures at the LAAF station are 35° F in January and 90° F in June (ENRD 2001). Average annual precipitation at Fort Huachuca is 15 inches.

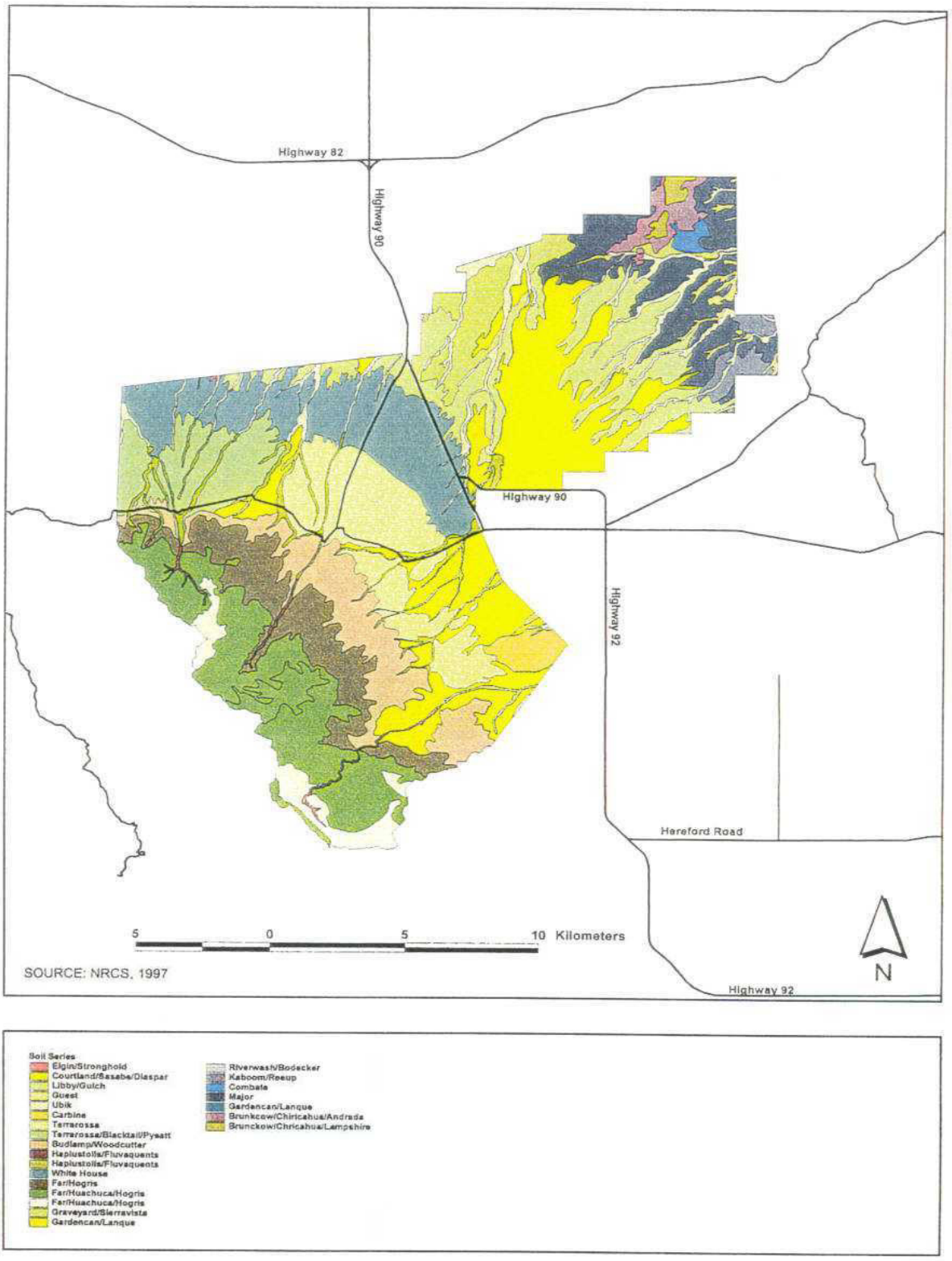
The area climate is semi-arid with warm summers and moderate winters. The annual precipitation is highly variable with amounts ranging from less than 12 inches per year near Benson to slightly more than 30 inches per year in the Huachuca Mountains. The valley average is about 15 inches per year (Roeske and Werrell, 1973).

Precipitation mainly occurs during two periods of the year, the first period being between May and October when Gulf of Mexico atmospheric moisture falls as afternoon and evening thundershowers. About 70% of annual rainfall occur during this time. The other period is during winter when Pacific frontal storms reach the area and can produce several days of gentle rains in the valley and snow on the surrounding mountains (Putman, *et. al*., 1988). Putman also states that the amount of snow is an insignificant contribution to annual precipitation totals though the snow may be visible on the mountains for several days to several weeks. Koehler and Ball (1998) found that a two year lag for El Nino events and one year lag for La Nina events were significant beyond the 95% level in explaining variation of the annual 7 day low flow series.

3.3 SOILS

Fort Huachuca has a diverse assortment of soil types. This diversity is directly related to differences in climate, parent material, and topography at the installation. The soils exhibit wide variations in depth, texture, and chemical properties. Roughly 30% of the soils are less than two feet in depth over bedrock. Soil's physical and chemical properties have an influence on the plant communities that exist at the installation and the uses and management of soils by the Army. Soil management is a significant operational consideration at Fort Huachuca. The Soil Survey of Fort Huachuca (NRCS 1997) characterizes the types of soils that occur at the installation, locations of the soil types, and potential uses (Figure 14).

FIGURE 14 FORT HUACHUCA SOILS



The Natural Resources Conservation Service (NRCS) system classifies soils into one of four groups based upon their infiltration capacity and their ability to transmit water through them. The mountain front property is dominated by soils classified as being in the hydrologic soil group "D", with some types being classified in hydrologic soil group "C". Group "D" soil types have very slow infiltration rates when saturated and have an extremely low water transmission rate. These properties are usually caused by a high percentage of clays, the existence of claypans or clay layers near the surface, or where shallow soils overlie nearly impervious bedrock near the surface. Group "C" types have moderate to slow infiltration rates when thoroughly wetted and have a slow water transmission rate. Both of these soil types promote higher amounts of runoff and streamflow from storm events.

Many soils in the hilly and mountainous areas, particularly on the South and West Ranges, are shallow with steep slopes; these soils tend to be droughty with a low available water capacity and susceptible to erosion. The high sodium and gypsum contents of many soils on the East Range make these soils subject to gully erosion and piping; they also are very corrosive to concrete and steel. The soil of the cantonment area consists of alluvial fan soils (White House complex, Lanque soil, Courtland-Sasabe-Diaspar complex, Blacktail-Pyeatt complex, Blakeney soil, and Combate soil (Svetlic 1994). Almost one-quarter of the land area of the post has deep red clay soils that have slow permeability and tend to be poorly drained. They become very slippery when wet and susceptible to compaction. Other properties of soils at the installation influencing land use and management are gravelly or rocky soils, soils with hard pans, and deep, droughty, sandy soils.

Cross-country maneuvering for tracked or other vehicles is not authorized on Fort Huachuca at this time. If off-road maneuvering were authorized in the future, it would be restricted to five off-road maneuvering lanes covering an area of approximately 3,450 acres and consisting of four soil complexes: the Courtland-Sasabe-Diaspar complex, the Libby-Gulch complex, the Tombstone-Caralampi complex, and the Ubik complex. These are very deep, well-drained soils formed from mixed alluvium on fan terraces, stream terraces, or floodplains. Permeability varies from slow and moderately slow in the Libby-Gulch complex to rapid in the Ubik complex. Surface runoff in all four soil complexes is rated slow to medium. Hazards from water erosion vary from slight to moderate and risk of wind erosion varies from slight to moderately high. Surface soil textures are consistently sandy loams, and subsoil textures include sandy loams, sandy clay loams, and clay loams.

Potential rooting depth in all soils is 60 inches or more. Soil-related management factors for these four soils include: hazard of flooding and water erosion for the Ubik complex; droughtiness and hazard of wind erosion for the Tombstone-Caralampi complex; droughtiness, slow permeability and high gypsum content for the Libby-Gulch complex; and hazard of wind erosion for the Courtland-Sasabe-Diaspar complex.

3.4 PHYSIOGRAPHY

The San Pedro River Basin is typical of the basin and range physiographic province, with elongated north-south trending block-faulted mountains surrounding a central valley filled with deep alluvium (Figure 15). The basin is divided into two distinct geographic units, referenced as

the upper (USPB) and lower (LSPB) basins. The USPB extends from the headwaters in Mexico to the "narrows" north of Benson, and the LSPB extends from the narrows to the Gila River (ADWR 1988). The USPB is further divided into the Benson and the Sierra Vista subwatersheds. The Sierra Vista subwatershed contains Fort Huachuca, the City of Sierra Vista, Huachuca City, and most of the SPRNCA.

The principal geographic features of the Sierra Vista subwatershed include: the Huachuca Mountains; pediment surface and floodplain; several unconnected washes, canyons, and draws; and a small tributary system feeding Soldier Creek. The San Pedro River is about 10 miles east of Fort Huachuca's main gate and 0.5 miles east of the installation's East Range boundary. The Babocomari River is within about 0.25 mile of the installation's northern boundary on the East Range.

The USPB comprises an area of approximately 2,500 square miles. The basin slopes gradually from south to north, resulting in a northward surface water flow. Surrounding mountain elevations range from 4,400 to 9,500 feet above msl, while valley floor elevations vary from approximately 4,800 feet near the headwaters in Mexico to 3,300 feet above msl at the narrows (ADWR 1988).

The Upper San Pedro River Basin is defined as the region upstream of "The Narrows" located north of Benson, Arizona with an area of approximately 2,500 square miles above the US Geological Survey (USGS) gaging station in Benson. Of this, 696 square miles lay within the northern parts of Republic of Mexico. Approximately 54 square miles drains from the west side of the Huachuca Mountains into Mexico then to the San Pedro River (Putman, Mitchell and Bushner, 1988). Fort Huachuca lies within the Upper San Pedro Watershed in southeastern Arizona (Figure 16).

Within the US, the west side of the San Pedro watershed is bounded by mountains of "diverse lithologies" and includes the Whetstone, Rincon and Huachuca Mountains along with the Canelo Hills. The Winchester, Little Dragoon, Dragoon and the Mule Mountains bound the east side of the watershed. Mountain elevations vary from 6,597 feet above msl for the Mule Mountains to more than 9,466 feet for the Huachuca Mountains. The elevation of the river where it enters the US is 4,260 feet at the international border with the Republic of Mexico and exits the subbasin at "The Narrows" at an elevation of 3,300 ft above msl (Huckleberry, 1996).

FIGURE 15 FORT HUACHUCA CONTOURS

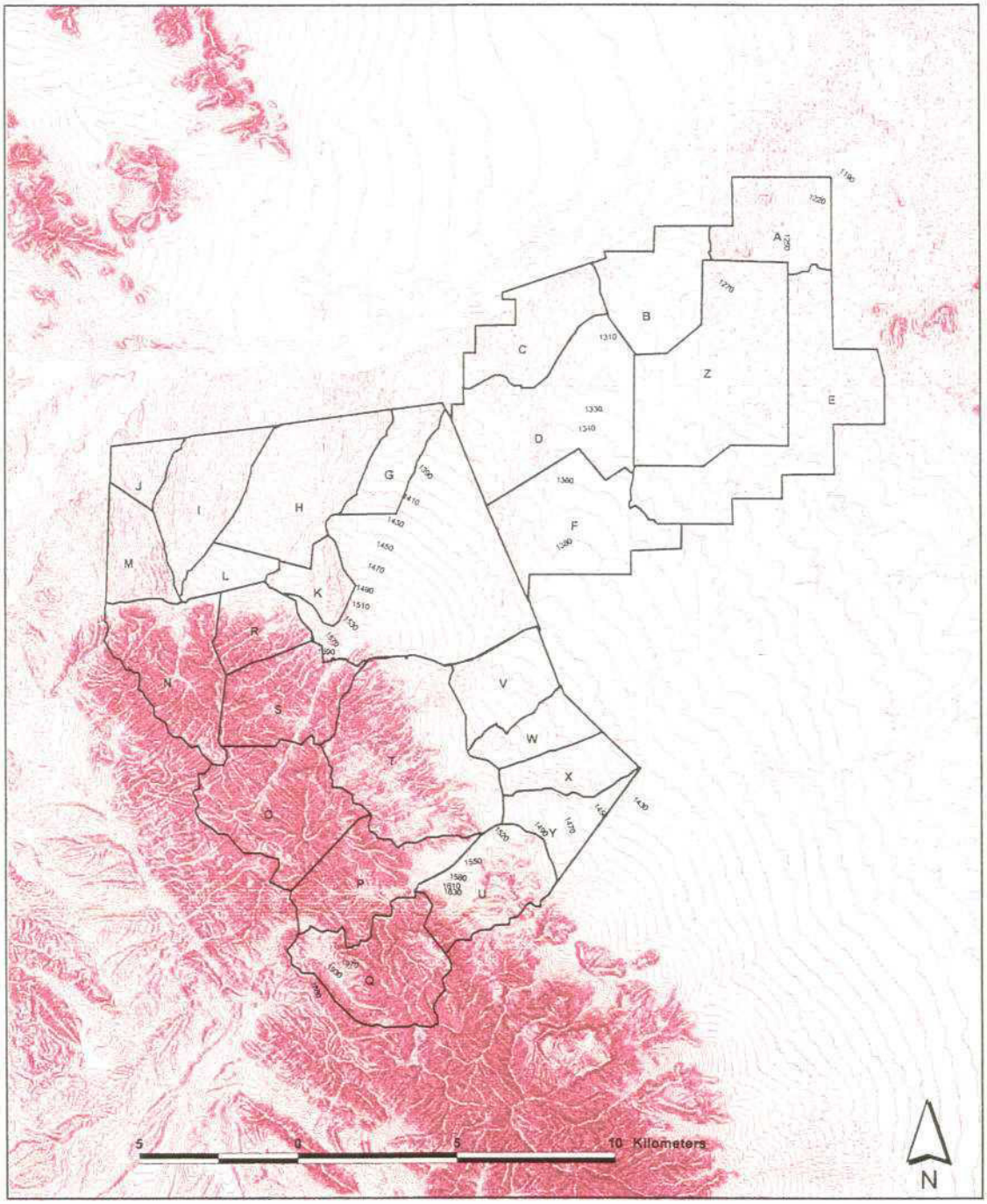
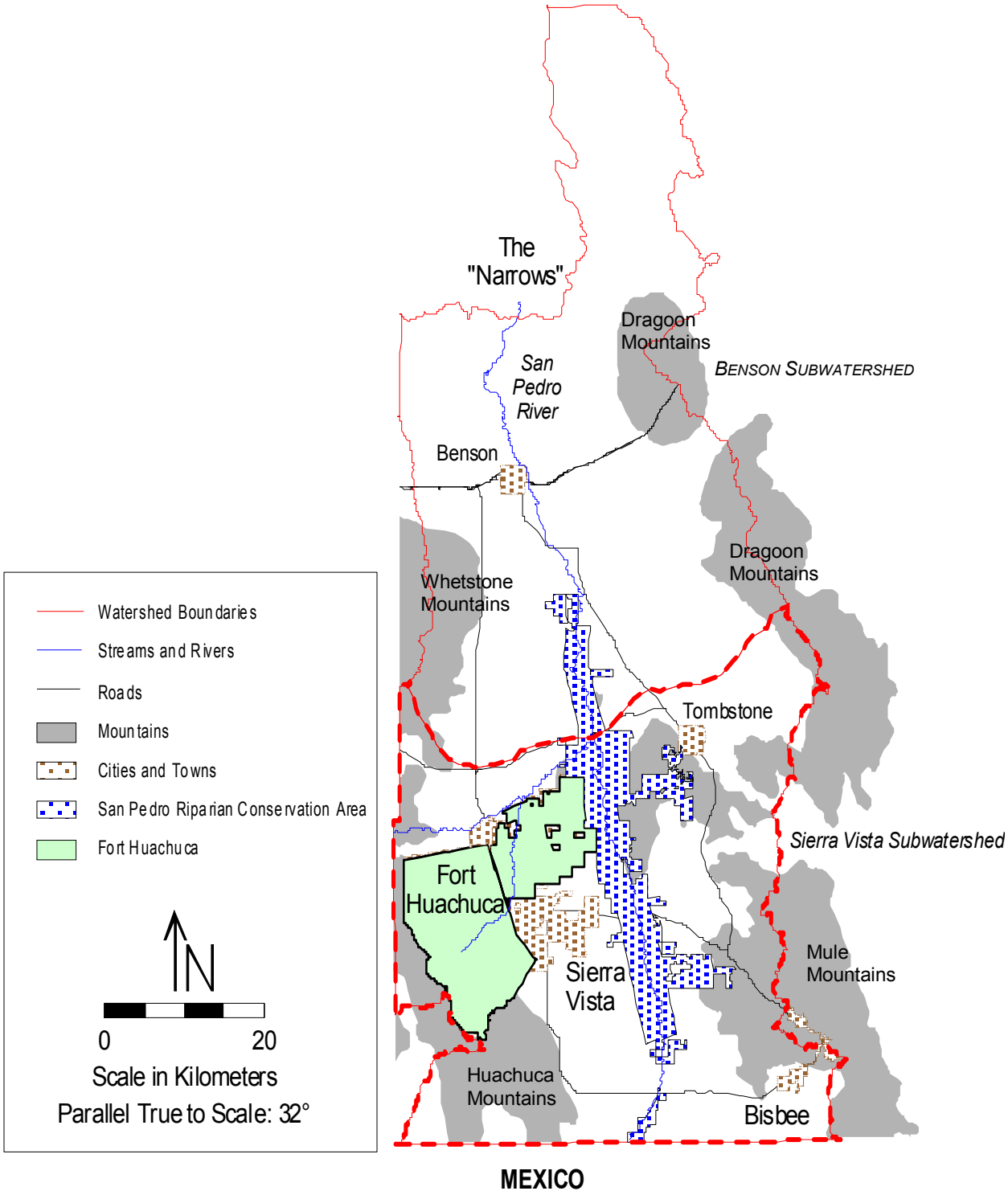


FIGURE 16 UPPER SAN PEDRO RIVER BASIN



3.5 WATER RESOURCES

This section summarizes regional and local surface and groundwater resources including the major streams, and relevant geologic and hydrogeologic information (Figure 17).

3.5.1 REGIONAL SURFACE WATER RESOURCES

The San Pedro River is a major regional stream, draining a land area of approximately 4,600 square miles and extending almost 200 miles from its headwaters in Sonora, Mexico to its confluence with the Gila River near Winkleman, Arizona.

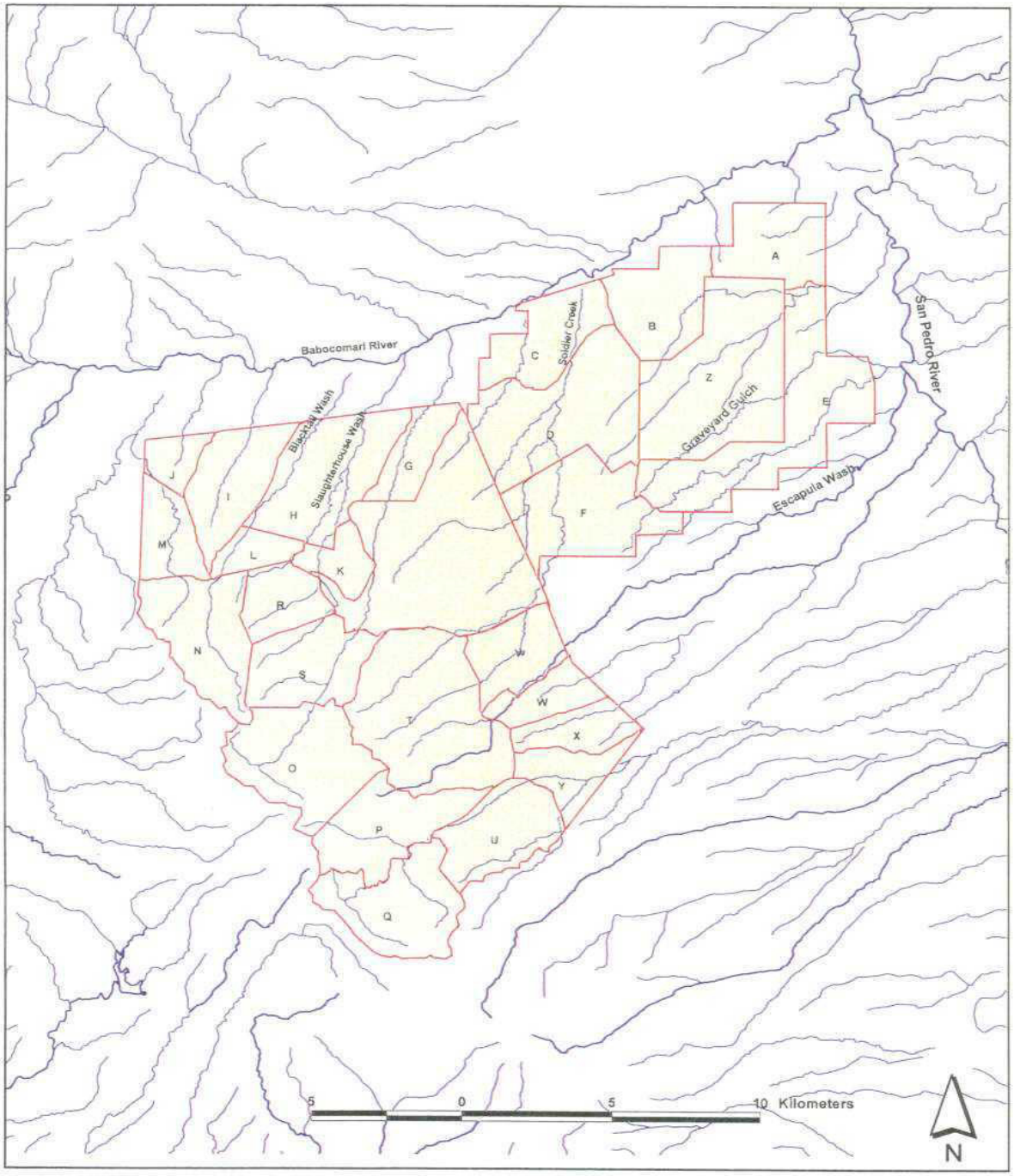
The San Pedro is one of the few rivers in southern Arizona with significant perennial reaches, representing a remnant of conditions that once characterized the region. Maintaining existing surface water flows, velocities, and patterns is essential to the preservation of the cienega/bosque environment and has been deemed a regional objective by federal and state resource management groups, organizations, and agencies (AZ ARNG 1997).

The San Pedro River is part of an alluvial river system; that is, a river which is formed in fluvial sediments transported, deposited, and reworked by the river itself. The river and its riparian zone are dynamic systems undergoing constant adjustments in response to changes in runoff, sedimentation rates, and channel and floodplain conditions (BLM 1989). Today, most of the main channel of the San Pedro River is incised. By most accounts, the San Pedro River system has degraded both in terms of historic hydrologic condition and habitat diversity. That degradation is associated closely with an episode of human and flood induced channel entrenchment that occurred between 1880 and 1926, which resulted in the loss of cienega habitat and further incised entrenched reaches (BLM 1987). The BLM (1989) reports that incision of the channel has resulted in declines in the local water tables.

Entrenchment set into motion a number of important adjustment processes: geomorphic, hydrologic, and biologic. Most of those adjustments are still continuing and may have an influence on future resource conditions along the San Pedro River (BLM 1987). Where floodplains are narrow, channel incision has been on the border of 10 feet. In other sections of the river, erosion has progressed laterally to create a broad channel occupied by a relatively narrow zone of river flow during periods of drought. During floods, the channel is filled by a turbid, erosive river.

Following the rapid sequence of entrenchment between 1880 and 1926, the San Pedro River has, and is continuing to undergo an evolution to a new dynamic equilibrium condition which reflects current hydrologic and land use conditions. That evolution consists primarily of widening, bar development, and the creation of floodplain. Widening is the primary prerequisite for re-establishment of stable floodplain vegetation communities, which contribute to sediment deposition and the development of properly functioning floodplains (BLM 1989).

FIGURE 17 FORT HUACHUCA WATER RESOURCES



Surface water in the San Pedro River is comprised of precipitation and snowmelt runoff and baseflow from groundwater. Much of the San Pedro River now exhibits an intermittent flow regime with seasonal appearance and disappearance of surface water due to the regional climate and the timing of water use along the river (ADWR 1991). During winter and early spring, the seasons of low water use, the rate of groundwater discharge to the river exceeds the rate of use by phreatophytes (deep-rooted plants that obtain water from the water table or soil above it) and agriculture. The result of the excess water supply versus demand is surface flow in the river. During other seasons, the rate of water use by riparian vegetation and by crops near the river exceeds the rate of groundwater discharge to the river and the surface flows disappear, except following rainfall events (ADWR 1991). River discharge rates are not only influenced by the amount and timing of runoff and groundwater discharges, but also by channel and floodplain characteristics and losses due to evaporation, groundwater recharge, and man-made diversions and withdrawals (BLM 1989).

Surface water discharges originating within the San Pedro Basin are tributary to either the San Pedro or Babocomari Rivers. The Basin also includes several smaller watersheds that are locally significant but contribute little to the regional surface and groundwater resources. The Babocomari drains the northwestern sections of the Sierra Vista subwatershed including the Mustang Mountains, Canelo Hills and the northern end of the Huachuca Mountains. It discharges into the San Pedro River just south of Fairbank. The Babocomari River is ephemeral throughout most of its length although a reach near the headwaters about 15 miles above its confluence with the San Pedro and another reach about four miles above the confluence sustain perennial flow due to special geologic conditions (ADWR 1988). These two reaches of the Babocomari sustain perennial flow for approximately 12 miles. The area near the Babocomari Ranch appears to be strongly influenced by the presence of a volcanic dike which may restrict the flow of groundwater and force it to the surface (ADWR 1991). Several drainages including O'Donnell Creek, Turkey Creek and Lyle Canyon flow into the Babocomari and probably contribute runoff during flood events. Flows in the Babocomari and its tributaries are not regularly gauged.

Most of the information concerning the flow regime in the Babocomari was acquired by Schwartzman (1990) during research conducted for a graduate thesis. Perennial and seasonally flowing portions of the Babocomari are supported by shallow water tables and generally exhibit stable baseflows between late October and early April. Winter rainfall may cause short-term runoff events between December and February. Stream flows are depleted during the hot summer months preceding the monsoon season of mid-July through late September. The monsoon rains generally restore stream flows to or above the winter baseflows. High runoff periods are associated with individual monsoonal rainfall events. Stream flows may fall below winter levels toward the end of the growing season in early October and return to winter conditions after the growing season. Schwartzman (1990) divided the Babocomari into ten sections and reported the results of stream gauging conducted in March and June of 1988. Streamflow ranged from 0.01 cubic feet per second (cfs) to 2.72 cfs depending on the stream section in March and from 0.29 cfs to 0.35 cfs in the only three sections where measurable flow occurred in June. Sharma *et. al.* (1997) reports measurements on the Babocomari ranging from no flow to 1.5 cfs for intermittent gauging between 1990 and 1995. However, Sharma *et. al.* (1997) did not feel their data were representative and stated that an accurate data set of generated surface flows at this site was not feasible.

3.5.2 SURFACE WATER AT FORT HUACHUCA

Fort Huachuca lies in the Babocomari and Garden Canyon watersheds, as defined by the NRCS. Combined, these watersheds represent a 539 square mile drainage area making up 31.7% of the USPB (ENRD 1997).

A majority of the surface water features on Fort Huachuca are ephemeral streams, consisting of dry washes, arroyos, or continuous and discontinuous gullies. Ephemeral streams are usually dry and only flow in response to precipitation events that are significant enough to achieve runoff conditions. Ephemeral streams on Fort Huachuca are typically narrow channels with a sand and gravel layer at the bottom of the channel. Some of these channels are deeply entrenched. The channels serve to carry runoff to larger drainage systems.

Fort Huachuca has approximately 4.5 miles of perennial streams. Garden Canyon has 3.5 miles of perennial reaches. Huachuca Canyon has 0.75 miles of perennial stream segments. Minor lengths of perennial reaches also occur in McClure and Blacktail Canyons.

3.5.3 WATER QUALITY

Surface water derived from the San Pedro and Babocomari Rivers is considered of relatively good quality (BLM 1989). Water quality in the San Pedro River has been monitored for decades by a number of state and federal agencies. Pollutant releases have historically occurred when intense rainstorms cause failure, breach, or emergency release from holding ponds, sewage lagoons, and tailings dams. On occasion, sewage or mining wastes not associated with the installation have been intentionally or accidentally released, usually to create additional storage capacity. Such events have significant impact on downstream water quality and have historically harmed downstream uses and users of San Pedro River water.

Generally, the chemical quality of the groundwater obtained by Fort Huachuca and other users in the USPB is good and is considered suitable for domestic uses. However, in several areas (St. David and Benson), fluoride and sulfate concentrations at or above drinking water standards have been noted. Groundwater on the installation is treated with chlorine. No other treatment is required.

3.6 HYDROLOGY OF THE UPPER SAN PEDRO RIVER BASIN

This section presents the existing hydrological conditions within the region, including detailed information on baseline conditions and groundwater usage. This baseline information will be used as a point of comparison when evaluating hydrological impacts that may be caused by ongoing and programmed future military operations and activities discussed in this BA.

3.6.1 BACKGROUND

Numerous studies have been conducted to gain a better understanding of the hydrogeology of the USPB. Some of these studies involved actual field survey and data collection, some were modeling efforts, and others provided a review of existing information. All of these studies differ

to some extent in purpose and scope but can be grouped into four general categories (which overlap): basic research, water supply, planning, and mitigation.

Because most of these studies are based upon the same data sources, there is much repetition, both in the data presented and in the interpretation of the data. Despite ongoing efforts to fill the gaps in the knowledge base, none of the studies available to date fully describes or explains the complex hydrogeology of the USPB.

The scientific community is debating the role and effect of regional volcanism on groundwater resources in the USPB (see Vionnet and Maddock 1992; ASL 1994; Geraghty and Miller 1995; Wynn and Gettings 1997). Recent geophysical data has produced a new conceptual model that differs from the previous models. The geographic region south of the confluence of the Babocomari and San Pedro Rivers is the focus of this debate. While immediately relevant to the geographic areas covered in this BA, it is clear that such controversial scientific and conceptual issues will not be resolved before this BA is completed. At present, there is not adequate scientific data to support definitive conclusions regarding the complexities of local hydrology; however, there is evidence to support general findings.

There has also been considerable speculation regarding the impact of groundwater development upon surface flows of the San Pedro River. These issues have been contested in both scientific and legal forums (USDC 1995). Given this level of controversy, it is clear that detailed questions regarding the long-range impact of regional groundwater development on surface water features can not be answered conclusively. The exact scientific cause and effect will remain the subject of future scientific investigation. However, there is an adequate volume of scientific evidence, including expert testimony provided by the State of Arizona that development and use of groundwater on Fort Huachuca has “not caused a change in groundwater discharge to the San Pedro River, nor has it diminished the river’s surface water flow rate or volume” (ADWR 1996).

A compilation of relevant data and reports is provided in Appendix F. This appendix is intended to provide the reader with additional information on hydrogeological reports discussed in this BA. Although not an exhaustive review, the documents summarized here represent the principal body of knowledge on the hydrogeology of the USPB.

3.6.2 RIVER FLOW AND TRENDS

The streamflow of the San Pedro River within the Sierra Vista subwatershed is recorded at three different locations. These locations are Palominas, Charleston, and Tombstone. The longest period of record for streamflow is at the Charleston site with continuous data from 1936 to present; however, the measuring site was moved several times before 1942 (Pool and Coes, 1999). Data collection along this section of the river dates from 1905.

Many researchers (Freethey, 1982; Jackson *et. al*., 1987; Putman *et. al*., 1988; Vionnet and Maddock, 1992; Hereford, 1993, Corell *et. Al.*, 1996; Sharma *et. al*., 1997; Koehler and Ball, 1998; San Pedro Expert team (1999); and Pool and Coes, 1999) have used the flow record from Charleston to determine long-term flow patterns of the San Pedro River.

Several smaller tributaries to the San Pedro River are located between the international border with Mexico and Fairbank. The Upper San Pedro Partnership's (USPP) Open Space Subcommittee evaluated streams that are "valuable components of a functioning San Pedro watershed". The Subcommittee listed streams in both "natural recharge" and "flow volume" categories. Highest rated streams include: High Knolls/Sandy Bob Springs Canyon, Spring Creek, Garden Canyon Wash, Ramsey Canyon Wash, Carr Canyon/Richards Ranch Wash, Miller Canyon Wash, Hunter Canyon Wash, Stump Canyon Wash, Soldier Creek, and Huachuca Creek. (USPP Open Space Subcommittee, 2001).

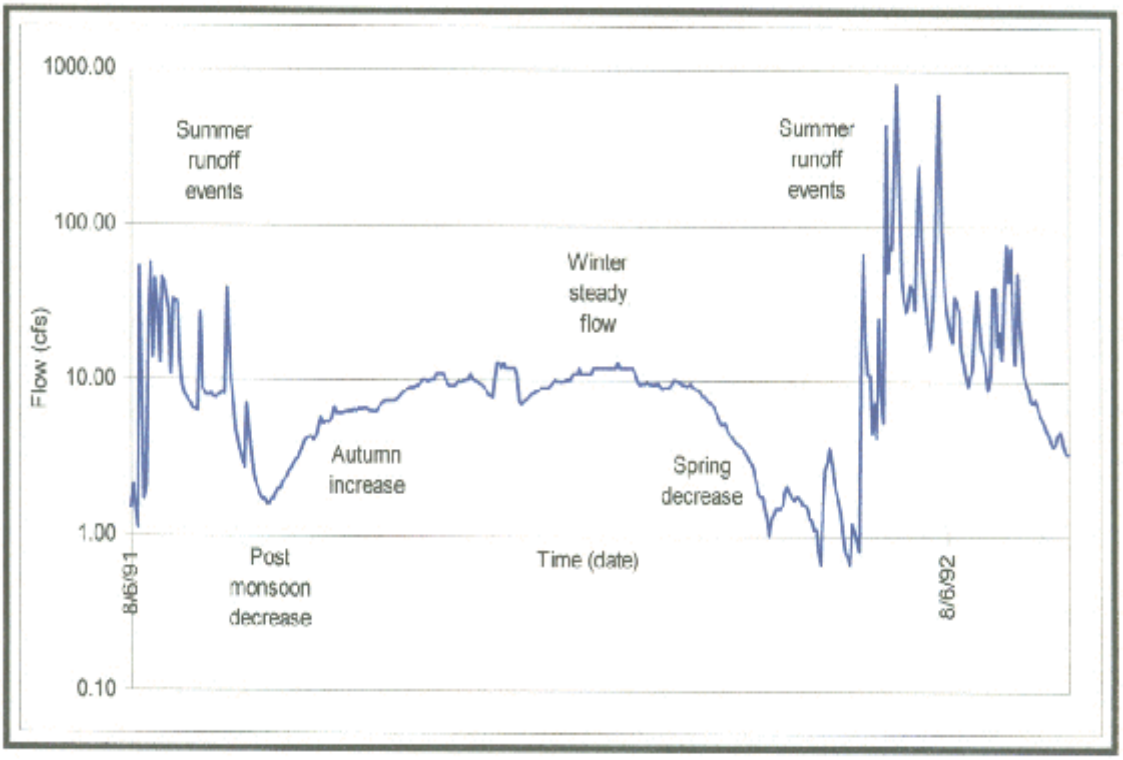
The 1999 USFWS BO for Fort Huachuca noted that flows in the upper San Pedro River are considered intermittent from the Mexican boundary to about four miles north of Palominas. The river is mostly perennial through the SPRNCA to about four miles north of the Charleston Stream Gage, after which it is intermittent. Flows largely correspond to precipitation in the watershed; and are lowest in May, June, and early July during the dry season, and are greatest during the summer monsoons in mid to late July and August, or in winter. (USFWS, 1999a).

Figure 18 shows the typical daily streamflow pattern of the San Pedro River at Charleston (Koehler and Ball. 1998). Koehler and Ball (1998) also present a graphing technique of the San Pedro River at Charleston showing the entire daily flow record from 1935 to 1999 (Figure 19). The typical seasonal patterns of winter, spring decline (pre-monsoon or dry season), monsoon (wet season), post-monsoon and fall recovery are readily seen using this technique. Also seen are regions of increased low flows (white areas) with an associated lack of monsoon flows after 1965. Large winter events were more prevalent during the same period.

Jackson *et. al*. (1987) evaluated trends in flows at the Charleston Gage during 1905-1985. Mean annual flows showed no significant trends over time; however, peak flows and mean annual low flows (lowest flow during any 1, 7, 30, and 90 day periods in a year) declined significantly. A similar significant declining trend in low flows was noted at the Palominas Gage. Geraghty and Miller, Inc. (1995) found that low flows at Charleston decreased substantially from 1905 to 1928, then increased until 1930. After 1930, the authors found that low flows generally declined. Winter baseflows at Charleston declined steadily prior to 1951, but since then no trends were detected at the 95% confidence level. (Pool and Coes, 1999).

MacNish states that interpretations of trends at Charleston before 1942 are questionable because the gage was at various locations in a six mile reach before 1942 (USFWS, 1999a). However, Steinkampf states that USGS procedures for stream flow monitoring include establishing and calibrating stage-flow curve specific for each site (William Steinkampf, USGS, Arizona Water Resources office, Tucson, AZ, pers. Com., 2002). Additionally, Jackson *et. al.*, (1987); and Pool and Coes (1999) used the entire record from 1905 as part of their respective studies. Koehler and Ball (1998) and the San Pedro Expert Team (1999) use daily flow records from 1935 to 1999 for their respective analyses.

FIGURE 18 SAN PEDRO RIVER STREAMFLOW PATTERNS FOR 1991 - 1992
Koehler and Ball, 1998

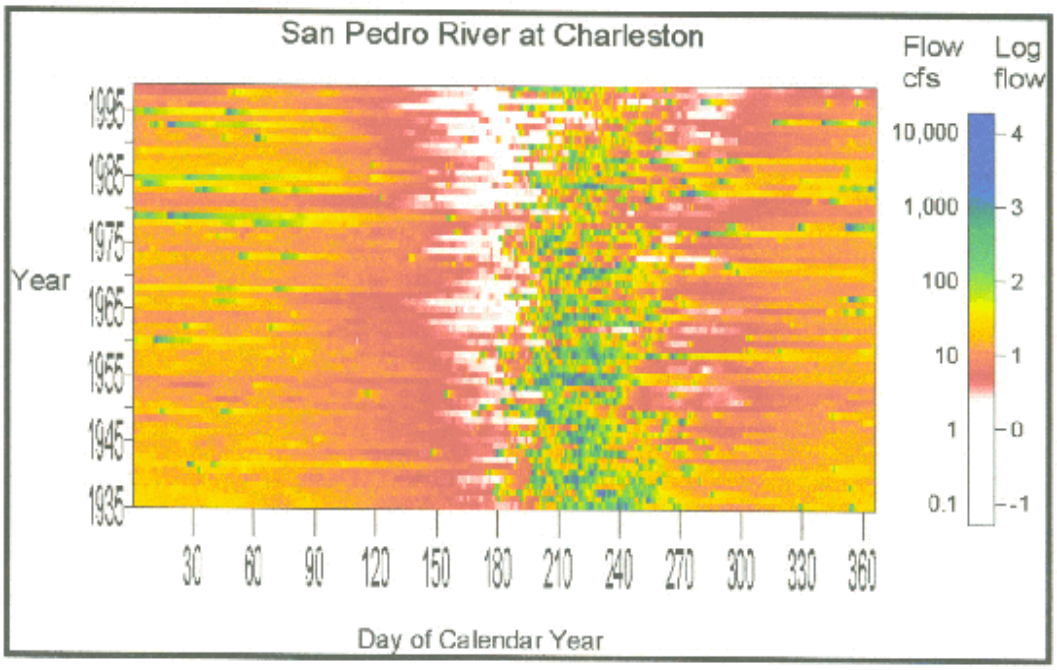


Analysis by Corell *et. al.* (1996) demonstrates that baseflow at Charleston declined from 9,470 ac-ft per year in 1940 to 6,332 ac-ft per year in 1951. Baseflow declined again at Charleston from 6,583 ac-ft per year in 1973 to 4,750 ac-ft per year in 1981. However, Koehler and Ball (1998) found that annual 7-day low flows at Charleston declined an average of 0.04 $\pm$ 0.01 cfs per year from 1935 to 1996, equivalent to an annual decrease of 29 ac-ft per year for this data series.

Pool and Coes (1999) showed that runoff volume at the Charleston site declined from more than 45,000 ac-ft before 1935 to about 30,000 ac-ft during the 1960s through early 1970s and less than 20,000 ac-ft during the 1990s. Most of the decline in annual runoff was caused by wet-season (monsoon) runoff declines that occurred. Volume ranged from 40,000 ac-ft before 1935 to less than 10,000 ac-ft during the early and mid-1990s. Some of the decline may be explained by declining wet-season precipitation. Earlier declines may be related to changes in precipitation and runoff characteristics caused by changes in land use and vegetation (Pool and Coes, 1999).

Jackson *et. al.* (1987) noted that at the Palominas Gage it is common to have zero flow for both the 1-day and 7-day periods, and not uncommon to have zero flow for the 30-day period since 1950. Although none of the upper San Pedro River gages are considered accurate to within 15% for low flows, the overall declining trends in annual low flow are highly significant statistically (Jackson *et. al.* 1987, Koehler and Ball 1998).

FIGURE 19 SAN PEDRO AT CHARLESTON DAILY FLOW RECORD 1935 - 1999
Koehler and Ball, 1998



Other possible causes for flow declines in the San Pedro could include: 1) changes in runoff from the watershed due to changes in watershed condition; 2) influences of near-stream groundwater pumping for agricultural purposes; 3) changes in water use in Mexico; 4) changes in water consumption by riparian vegetation along the river; and 5) groundwater pumping from the regional aquifer (ASL 1994, Jackson *et. al*. 1987).

Koehler and Ball (1998) conclude that there is little doubt that annual 7-day low flows are declining, but that evidence is lacking for a non-seasonal aquifer-wide phenomenon (such as groundwater pumping from the regional aquifer) being the sole cause of the decline and go on to say the lowest flows of the year usually occur during the summer months when riparian vegetation are highly stressed. Yet the winter 7-day low flows, which are an indicator of regional aquifer discharge to baseflow, do not show a similar declining trend over time at the 95% confidence level. Spring decreases and autumn increases also showed no discernible trends. Koehler and Ball (1998) also state that the river response to local weather patterns appears to be much more pronounced than has been assumed in the past. Part, but not all, low flow variability can be explained with meteorological inputs such as La Nina and El Nino events.

There is evidence that summer precipitation declines over the last 10-20 years has reduced recharge adjacent to the river and may have contributed to observed reduced baseflow (Pool and Coes, 1999). MacNish noted that a diversion in Mexico, constructed in 1946-48, might be responsible for an approximate 0.5 cfs decline in baseflow, equal to approximately 25% of the drop in baseflow at Charleston between 1942 and 1996 (USFWS, 1999a).

The BLM established nine stream gages on the San Pedro River and one gage on the Babocomari River in the SPRNCA in 1987. Sharma *et. al*. (1997) evaluated data from these gages, and correlation between these gages and the USGS gage at Charleston. The authors state that data could not be generated at International Border, Palominas, and Babocomari due to lack of measured data, or poor correlation of data collected at those sites with the USGS Charleston Bridge gaging station. No trends in stream flow could be calculated at these sites. Taking the lack of usable sites into account, the authors key findings from this report in regard to surface flows in the river included: 1) at low flows, the percentage of flow contributed by ground water discharge in the reach below Hereford has increased, possibly because of retirement of irrigated agriculture in the area, or as a result of diminished flows reaching Hereford from upstream; 2) there is a trend toward low flows becoming a greater percentage of daily discharge at Hereford - for instance, the number of days for which the flow was below 0.1 cfs was zero from 1987-1994, but from January-September 1995 the number of days below 0.1 cfs was seven; 3) inflows below Lewis Springs are diminished as a percentage of flow at the Charleston Gage, possibly as a result of increased water use by phreatophytes or pumping outside of the SPRNCA; 4) low flows are becoming increasingly frequent at the Charleston Bridge based on observed trends during 1987-1994; 5) flows at Charleston Hills have remained similar to discharge at Charleston Bridge during 1987-1994; there is evidence that there may be a slight reduction in percentage of flow lost to the groundwater system in this reach; and 6) at Fairbank, the loss of streamflow to the groundwater system has decreased, possibly due to consumption by phreatophytes, but low flows are increasingly common at this gage. Sharma *et. al*. (1997) lists several possibilities to cause of apparent decreased contribution of groundwater to stream flow in the Lewis Springs-Charleston Bridge reach. These include increased riparian activity in the area, increased upstream flow diversion, and pumping in regions outside the SPRNCA.

Putman (1997) commented on the work by Sharma *et. al.* (1997) that "while reasonable in its statistical analysis of relationships between measurements sites and gage locations, it is not an analysis in depth of possible causes in streamflow." He goes on to state that while pumping is one factor among many that influence streamflow (others include changes in riparian use, and species composition, climate and precipitation, Mexican water use, grazing and woodcutting), that "it seems inappropriate (for the authors) to assert changes seen in streamflow are due to pumping, phreatophyte growth, agricultural use or climatic factors without an in depth examination of these factors, which this report does not do" (Putman, 1997).

In a draft report, MacNish (1998) evaluated the effects of possible changes in climate, inflows from Mexico, water use by riparian vegetation, and extraction of groundwater on baseflow. MacNish concluded that climatic change, and reduced inflow from Mexico have had minor effects at most. Increased water use by riparian vegetation may be responsible for a little less than 25% of the observed decline in baseflow at Charleston. However, MacNish (1998) concludes that the most important cause of diminished baseflow is groundwater pumping, particularly in the southern portion of the basin where groundwater pumping was closer to the river, and that groundwater pumping in the Fort Huachuca/Sierra Vista area began impacting river baseflow about 1990.

The assumption by MacNish that climate has a minor affect is not supported by Pool and Coes (1999); Koehler and Ball (1998), Harrington, Cerveny, and Balling, (1992); or Swetnam and

Betancourt, (1998). Pool and Coes (1999) state that variations in the seasonal distribution of precipitation resulted in important hydrologic effects adding possible changes in rainfall-runoff relations have occurred. Some suggested mechanisms at work include increased capture of wet-season runoff by increased vegetation, more frequent occurrence of low intensity rainfall, increased surface water diversions, and increased recharge resulting from increased groundwater withdrawals by phreatophytes and by wells. Pool and Coes did not expand on the type of vegetation which increased capture of wet-season runoff.

While groundwater withdrawals close to the San Pedro are an important factor to understanding the decline in flows within the river, the suggestion by MacNish that decreases in baseflow in the southern part of the basin from groundwater pumping as the most important cause ignores the other possibilities listed by Pool and Coes (1999). MacNish (1998) also writes that his opinion that the cone of depression around Fort Huachuca/Sierra Vista has reached the river cannot be stated as fact until other possible explanations for the data anomaly are first disproved. MacNish's opinion is not supported by Koehler and Ball (1998). They found that comparisons of adjusted correlation coefficient r^2) values and root mean square (RMS) residuals showed no improvement when using higher order regressions over a simple regression. The linear trend from 1935 to 1999 was the best representation of the decline of annual 7-day low flows at Charleston and indicates that the decline has been an ongoing process. If MacNish's suggestion that the cone had reached the river were correct, then the rate of decline in the 7 day annual low flows would be expected to increase over time. The linear trend does not support this suggestion.

The San Pedro Expert Study Team (1999) assessed effects of groundwater pumping on riparian habitats and migratory birds. They found that modeling of the groundwater system in the basin suggests that groundwater pumping in the area probably began to have significant effects on discharge to the river in the 1960s or 1970s. Groundwater pumping was occurring in 1940, but significant withdrawals did not occur until the early 1960's (Vionnet and Maddock 1992).

Groundwater pumping and land uses upstream of the SPRNCA in Mexico affect flows as well but the San Pedro Expert Team (1999) stated that the transborder connection between sub-basins of the Upper San Pedro are not well know and that there is considerable uncertainty as to the overall effect of groundwater pumping in Mexico. The best information available indicates that approximately 3,200 acres of farmland are irrigated in the Mexican portion of the San Pedro River basin (Watts *et. al.* 1998). If this pumping in Mexico were eliminated, median flows at Palominas would increase from the current two cfs to about seven cfs and would yield an increase of 3,500 acre feet per year at Palominas (San Pedro Expert Study Team 1999).

The conclusions that groundwater pumping in the Fort Huachuca/Sierra Vista area has affected baseflow have been questioned by some hydrologists. Sharma *et. al.* (1997) did not specifically specify the location of pumping but rather stated, "pumping in regions outside the SPRNCA". In a May 28, 1997, letter to Michael Shaughnessey, Fort Huachuca, hydrologist Jon Fenske, Army Corps of Engineers, believed the finding by Sharma *et. al.* (1997) that groundwater pumping caused the observed changes in flow in the Lewis Springs-Charleston Bridge reach was premature and unsupported by physical evidence and justification. In a July 1, 1998, memorandum (Fenske 1998), Mr. Fenske presented monitoring well data suggesting that from April 1995 to April 1998 the groundwater gradient along a transect from Sierra Vista to the San

Pedro River at Charleston was reversed only within about 3.5 miles of Sierra Vista (i.e. the cone of depression had not reached the river in this area). However, in a letter to Mike Shaughnessey, Fort Huachuca, Mr. Fenske stated that several more years of data collection are needed to make conclusive statements based on the well data. In a June 6, 1997, letter to Dennis Sundie, ADWR, about the findings in Sharma *et. al*. (1997), Frank Putman, ADWR, stated it seems inappropriate to assert that changes seen in stream flow are due to pumping, phreatophyte growth, agricultural use, or climatic factors without an in-depth examination of these factors.

3.6.3 SUMMARY OF GROUNDWATER DATA

Groundwater elevation contour maps have been constructed for the Sierra Vista subwatershed from well data. These maps illustrate that groundwater enters the watershed in the form of mountain-front recharge, from the San Pedro River in losing reaches, and as groundwater flow moving northward from Mexico. Groundwater is transferred to the San Pedro River in gaining reaches, from evapotranspiration, groundwater pumping, and groundwater flow out of the basin to the north (ASL 1994). The aquifer is composed of a deep, regional aquifer that is mostly unconfined, except in some portions of the southern half of the subwatershed (ADWR 1994, Wynn and Gettings 1997).

The regional aquifer may contain an estimated 31.8 million ac-ft of recoverable water in storage to a depth of 1,200 feet (ADWR 1991), although a recent report suggests the storage may be less due to the presence of extensive clay deposits (Wynn and Gettings 1997). Another published estimate of regional aquifer volume is available from the Cochise County Water Resources Inventory. In that study, the regional aquifer volume of the entire USPB is estimated to be 40.4 million ac-ft (EEC, 2002). This would reduce the estimated storage within the Sierra Vista subwatershed to about 20 million ac-ft. The reason for the large difference is the way Engineering and Environmental Consultants, Inc. (EEC) and ADWR each addressed the unconfined aquifer storage coefficient. The ADWR report assumed a constant 0.08 coefficient throughout the entire depth of the aquifer while EEC assumed a coefficient of 0.08 from the surface to 700 feet below the surface, then 0.03 from 700 feet to 1,200 feet below the surface. Basis for choosing the 700 feet cutoff is consistent with the 1977 Arizona Water Commission report where ten different basins in Southern Arizona were evaluated using depths 700 and1,200 feet for determining groundwater resources. The EEC approach is consistent with the Putman *et. al.* (1988) report that states, “More water is available in the basin fill closer to the land surface because shallow fill is less compacted, more porous, and stores more water per unit volume. Deeper sediments have less porosity due to compaction from the weight of overlaying sediments, and thus store less water per unit volume”.

The floodplain aquifer is long, narrow, relatively shallow, and lies along the San Pedro River. Estimated water in storage on the floodplain aquifer ranges from 160,000 ac-ft (depth of 60 feet) by ADWR (1991) to 237,000 ac-ft (depth of 100 feet) by Putman *et. al*. (1988). By using the young alluvium geologic unit with an assumed depth of 100 ft, EEC estimated 366,000 ac-ft in the areas adjacent to the San Pedro River (EEC, 2002). All of these studies used an aquifer storage coefficient of 0.12. Groundwater elevation in the floodplain aquifer is closely associated with river flow.

Based on a 1990 water budget modeling effort conducted by ADWR (1991), annual water supply into the Sierra Vista subwatershed was estimated at a basin total of 56,820 ac-ft. Approximately 28,850 ac-ft were withdrawn for consumptive use, while 39,200 ac-ft flowed out of the system as surface flow in the San Pedro River. Major contributions to basin-wide consumptive use included water use by phreatophytes (~50 % or 14,425 ac-ft), irrigation (~16% or 4,616 ac-ft), and municipal and military (~23% or 6,635 ac-ft).

As part of a study for the USPP, Fluid Solutions (2001) estimated the total (not consumptive) 2000 municipal, agricultural, recreational and domestic water use at 19,450 ac-ft. Of this amount, 5,750 ac-ft (29%) was used by Sierra Vista and 1,900 ac-ft (10%) was used by Fort Huachuca. The Fort Huachuca value represents 7% of the basin-wide consumptive use listed by ADWR (1991). Other water users include Tombstone, Bisbee, Huachuca City, unincorporated area residents, and golf courses.

The ASL modeling demonstrated that use exceeded recharge by roughly 11,230 ac-ft per year, which is the amount that is lost in storage each year (ASL 1994). A reevaluation of the water budget shows the deficit is approximately 7,000 ac-ft per year (San Pedro Expert Study Team 1999, Corell *et. al*. 1996). The reduction in the deficit is due primarily to retirement of agricultural pumping. The San Pedro Expert Study Team (1999) estimated 500-900 acres of irrigated agriculture still remains in the subwatershed, using approximately 1,500-2,800 ac-ft of water use per year, while Fluid Solutions (2001) estimated 5,179 ac-ft was used for 917 acres of irrigated agriculture within the Sierra Vista subwatershed in 2000.

Groundwater pumping in excess of recharge has created local declines in groundwater elevation at Fort Huachuca/Sierra Vista and at Hereford/Palominas. The cone of depression in the vicinity of Fort Huachuca and Sierra Vista encompasses approximately 7.5 square miles running in a northwest-southeast direction, paralleling the Huachuca Mountains for at least 15 miles from approximately the Babocomari River to south of Sierra Vista (ADWR 1994, Wynn and Gettings 1997, Schwartzman 1990).

Groundwater elevations have declined 20-90 feet in the Fort Huachuca/Sierra Vista cone of depression (Corell *et. al*. 1996). Groundwater levels declined approximately 1.4 feet per year in this area from 1966-1986 (Putman *et. al*. 1988). In the ADWR well survey of 1998, there was an average decline of two feet depending on location. Cone of depression growth depends on where the measurement is made. Groundwater pumping at the north end of the cone of depression has affected flow patterns of the Babocomari River in the vicinity of northern Huachuca City and the Fort Huachuca East Range, where baseflow is severely depleted or absent during the pre-monsoon dry season (Schwartzman 1990). Current groundwater drawdown along the Babocomari River is attributed to pumping by Huachuca City, Fort Huachuca, and the City of Sierra Vista. Modeling predicts that pumping by Fort Huachuca and Sierra Vista will be responsible for 84-91% of the drawdown by 2015 (Schwartzman 1990). This modeling scenario used 1989 Fort Huachuca pumping levels and no recharge.

Schwartzman (1990) comments that the possible effects of the cone of depression on the Babocomari River appear to be consistent with maps from the Cochise County Water Resources Inventory (EEC, 2002). That report shows the cone of depression around Sierra Vista/Fort

Huachuca has grown in size and depth when comparing 1970 to 2000 depth to groundwater contours. The cone has extended to the northwest away from the San Pedro River, along the front of the Huachuca Mountains in the Babocomari drainage. There appears to have been minimal extension of the cone of depression toward the San Pedro River itself (EEC, 2002).

Another cone of depression in the Hereford-Palominas area is not as deep, but it underlies the San Pedro River and thus directly affects river flow. However, recent retirement of agricultural pumping in the area has apparently allowed or contributed to some recovery of groundwater elevation (Sharma *et. al*. 1997).

Most investigators do not believe the Fort Huachuca/Sierra Vista cone of depression has intercepted the San Pedro River (Fenske 1998; ADWR 1991; ASL 1995; Putman (1997); EEC 2002); however, the cone of depression captures water that would have otherwise reached the San Pedro River in pre-development conditions (Corell *et. al*. 1996, ADWR 1991). Indirect interference by the cone of depression will affect baseflow by reducing the amount of groundwater that would have flowed into the river but does not remove water already in the river. In the case of direct inference (the cone "reaching" the river) water is diverted from the river.

The cone of depression will decrease the hydraulic head adjacent to the river before it reverses the flow of groundwater. However, there is uncertainty as to how much of the currently observed decline in baseflow can be attributed to the reduced hydraulic head caused by the Fort Huachuca/Sierra Vista cone of depression. Koehler and Ball (1998) noted that winter 7-day flows did not show the same decline as annual (summer) 7-day declines. The authors reasoned if the cause of the annual series decline was the result of a non-seasonal aquifer-wide phenomenon, such as the existing cone of depression around the Sierra Vista/Ft. Huachuca area, it would be reasonable to assume that this decline would be present regardless of the season. Conversely, if such a decline is not present in the winter dataset, it weakens the theory that the cone of depression is solely responsible for baseflow decreases on the San Pedro River as appears to be the case.

Modeling by Water and Environmental Systems Technology (W&EST), Inc. (1996) estimated that agricultural users were responsible for 94% of the historic loss of river flow through 1988, while municipal and military users were only responsible for 6%. However, the authors did not calculate such estimates for present or future conditions. The San Pedro Expert Study Team (1999) speculated that river flow was affected by groundwater pumping as early as the 1960s or 1970s.

MacNish (1998) believes the Fort Huachuca/Sierra Vista cone of depression began affecting baseflow about 1990, but that current declines are due primarily to pumping (mostly agricultural) in the Hereford/Palominas area. He speculates that without mitigation, it is likely that the perennial reach of the San Pedro River north of Lewis Springs will become intermittent, if not ephemeral perhaps within a decade.

Clay deposits occur in the San Pedro River Valley near Palominas and St. David (Putman *et. al.*, 1988). Recent information developed by Pool and others at USGS indicates clay deposits also

occur along the west side of the river downslope from Sierra Vista that extend in a north-south direction. The extent of the clay deposit is unknown, but the eastern edge of the deposit intersects the river at about one to two miles south of Highway 90 (USFWS 1999a, San Pedro Expert Study Team 1999). The location of the deposit suggests the reach in the vicinity of the Babocomari confluence would likely be the first area affected by groundwater pumping at Fort Huachuca and Sierra Vista, followed by the reach north of Charleston, and then the reach from Highway 90 to Charleston (USFWS 1999a). This finding is supported by Pool and Coes 1999, Corell 1996 and ASL,1995. Although the hydraulic conductivity is low in the area of the deposit, Pool does not believe the clay deposit would slow the spread of the cone of depression or effects to river baseflow. Of particular concern are wells that draw water from below the clay deposit, which would have the greatest potential to affect river baseflow. Mark Gettings (USFWS, 1999a) has stated that the presence of an intermediate conductor (clay deposit) would not prevent the cone of depression from spreading eastward to the San Pedro River. He said that a clay layer may slow the spread of the cone, but depending on the nature of underlying substrates, a siphon effect under the clay layer could cause the cone of depression to spread very rapidly to the east. The deposit also limits the size of the groundwater reservoir, which could also speed enlargement of the cone of depression. South of Highway 90, the river probably flows, at least in part, atop the clay deposit, and flows probably reflect recharge near the river or inflow from upstream. In this reach, changes in the regional aquifer, such as groundwater pumping at Fort Huachuca and Sierra Vista, are less likely to affect baseflow (USFWS, 1999a).

3.6.4 SUMMARY OF PREDICTIVE MODELING

Modeling of groundwater relationships in the San Pedro basin began in the early 1970s with the development of a groundwater flow model by the Arizona Water Commission (1974). Recent modeling has been conducted by ADWR (Putman *et. al.* 1988, ADWR 1994, Corell *et. al.* 1996), University of Arizona (Braun *et. al.* 1992, Vionett and Maddock 1992), W&EST, Inc. (1994, 1996), Schwartzman (1990), and ASL (1995, 1998). Some reports model historic conditions (transient models); while others predict future conditions. Models developed by ADWR and the University of Arizona are based on a model developed by USGS (Freethey 1982). The ASL modeling efforts were developed specifically to evaluate the effects of various effluent recharge scenarios on groundwater hydrology and river flow. These models provide the basis for predicting the effects of groundwater pumping on flows in the San Pedro River, or in the Babocomari River (Schwartzman 1990), under varying future scenarios, such as continued human population growth at current rates and patterns, elevated growth at Sierra Vista and Fort Huachuca, drought, holding population static, etc. The results of recent modeling efforts in regard to effects on river flow or extent of riparian vegetation under varying scenarios are presented in Table 5 (Page 80).

Table 5 summarizes the results of predictive modeling efforts; however, many of these studies are comprehensive and detail many modeling outputs not presented here. See specific reports for a more detailed review of a particular model. Also, these models will need to be reviewed and revised in regard to new information about the presence of clay deposits within the San Pedro River Valley, new census population counts, Fort Huachuca water conservation efforts, conservation easement purchases to reduce irrigated agriculture, and effluent recharge by both Sierra Vista and Fort Huachuca. However, some generalizations and commonalities can be

drawn from the results of these various modeling exercises given the need to update base information.

Modeling assumptions such as continued current growth patterns in the subwatershed without implementation of new recharge, water conservation or other measures to reduce water use or enhance recharge, or continued drought have produced model outputs with declining flows and loss of riparian vegetation on the San Pedro River [see scenarios (2) of W&EST, Inc. (1994), scenarios (A) and (D) of Braun *et. al*. (1992), scenario (2) of ASL (1998) - Table 1].

Authors disagree as to when flows in the San Pedro may be significantly affected, but MacNish (1998) and the San Pedro Expert Study Team (1999) speculate river flow has been affected for some time, while others believe flow may not be significantly affected for 40 years or more (ADWR 1991). The modeling efforts summarized in Table 5 estimate effects to the river as early as 2000 (W&EST, Inc. 1994, ASL 1998); or 2010 (Braun *et. al*. 1992).

Drought would exacerbate the effects of groundwater pumping on baseflow (Braun *et. al*. 1992) and there is some evidence that low summer precipitation over the last 10-20 years has reduced recharge adjacent to the river and may have contributed to reduced observed baseflow (Pool and Coes, 1999).

The University of Arizona Climatic Assessment (CLIMAS) Project for the Southwest report "Sensitivity of Water Resources in the USPB to Climatic Variability" (Tschakert, *et al*, 1999) examined climate as a factor for water resources management.

Tschakert *et. al.*(1999) state that within the Benson subwatershed, worst-case climate conditions (most severe five year drought on record and area growth based on recent trends) could result in a three-fold increase in groundwater overdraft. Within the Sierra Vista subwatershed similar worst-case conditions could cause the current overdraft to increase four-fold. Population projections are based on actual growth rates from 1990 to 1998, but no breakout for growth attributable to Fort Huachuca.

If all groundwater pumping in the Sierra Vista subwatershed ceased and agricultural pumping rates were fixed at 1988 levels, modeling efforts show that average annual flows would still decline at Charleston, Fairbank, and Benson Narrows (W&EST, Inc. 1994). This would occur because over time the cone of depression is expected to flatten out, even if the volume of the cone is decreasing. As it flattens out, it could capture the baseflow of the San Pedro River (USFWS, 1999a). This indicates that balancing water use and water supply may not be enough to prevent the capture of groundwater flows by the cone of depression. Effluent or other enhanced recharge adjacent to the river could establish a groundwater mound between the river and the pumping center and halt or slow the expansion of the cone of depression and create a hydraulic gradient from the mound towards the river (ASL 1998). Temporarily pumping groundwater directly into the river may also mitigate effects of an expanding cone of depression, at least in the short term (San Pedro Expert Study Team 1999).

Science Applications International Corporation (SAIC) (1998a) maintains that studies and models that conclude that groundwater pumping in the Fort Huachuca area will, in time, result in

reduced flows on the San Pedro River do not take into account recent findings of Wynn and Gettings (1997). SAIC contends that these studies show the cone of depression is at least somewhat isolated from the San Pedro River, and therefore continued pumping from the cone in excess of recharge is less likely to affect the San Pedro River than suggested by earlier studies. This may be the case for the Hereford to Highway 90 reach, where the clay deposit underlies portions of the river, but flows downstream of Highway 90 (and particularly in the vicinity of the Babocomari confluence) could be affected by groundwater pumping at Fort Huachuca and Sierra Vista.

The modeling efforts summarized in Table 5 show that several water management options are available and have potential to mitigate or eliminate adverse effects on river flow and riparian vegetation, at least over the next 15-100 years. Recommendations for reducing the deficit in the water budget can be found in reports by the San Pedro Expert Study Team (1999), the Advisory Panel on the Upper San Pedro River (1998), the recommendations of a local consortium of water users that was known as the Water Issues Group (WIG), recommendations of the USPP, the Cochise County Comprehensive Plan, the Sierra Vista/Cochise County Joint Taskforce, and the City of Sierra Vista General Development Plan.

One of the most effective means to reduce effects on the river is to retire agricultural pumping [compare scenarios 1.1 and 1.2 of Corell *et. al.* (1996), and see scenarios (A) and (D) of Braun *et. al.* (1992)]. Modeling by W&EST, Inc. (1996) estimates that agricultural users were responsible for 94% of the historic loss of river flow through 1988, while municipal and military users were only responsible for 6%. Retirement of agricultural pumping in the SPRNCA has resulted in apparent increases in groundwater discharge to the river below Hereford Bridge (Sharma *et. al.* 1997) (although the increases are small), and modeling suggests that cessation of agricultural pumping is one of the most important potential water management tools (Table 5). The San Pedro Expert Study Team (1999) found that 1,100 ac-ft could be saved per year by retiring the remaining 500-900 acres of irrigated agriculture in the subwatershed. The Fluid Solutions analysis showed that irrigated agriculture water use in the Sierra Vista subwatershed for the year 2000 was 5,179 ac-ft. This does not include an estimated 800 ac-ft of groundwater used on area golf courses (Fluid Solutions, 2001).

Potential also exists for decreasing groundwater withdrawals by about 3,500 ac-ft annually if agricultural lands in Mexico were retired (San Pedro Expert Study Team 1999). A significant threat to the river is possible as a result of future development of new agriculture in the subwatershed or upstream in Mexico. Purchase of agricultural development rights, an Arizona state government designation of an active management area (AMA) or irrigation non-expansion area (INA) which prohibit any new irrigation uses, or other such mechanisms could be used to reduce this type of water use. If put into place, existing irrigated areas would be grandfathered but no new irrigated areas would be allowed thus preventing new water use. If the grandfathered areas were retired the result would reduce existing water use.

TABLE 5 SUMMARY OF GROUNDWATER MODELING EFFORTS

Source and Scenario	Effects on Upper San Pedro River Flows or Riparian Vegetation
Water and Environmental Systems Technology, Inc. (1994) **This effort used the MODFLOW model with modifications by the authors. Outputs are annual average flows which lump flood flows with baseflows. Flows are modeled from 1988-2088.**	
(1) No pumping at the Fort/Sierra Vista after 1988, pumping in rural/agricultural areas at 1988 rates.	Annual average flows decline at Charleston (42.7 cfs in 1988 to 41.5 cfs in 2088), at Fairbank (44.8 cfs in 1988, 43.6 cfs in 2088), at Benson Narrows (42.0 cfs in 1988 to 39.6 cfs in 2088)
(2) Very little pumping at the Fort/Sierra Vista, pumping in rural/agricultural areas at 1988 rates	Annual average flows decline at Charleston (42.7 cfs in 1988 to 40.9 cfs in 2088), at Fairbank (44.8 cfs in 1988, 43.0 in 2088) and at Benson Narrows (42.0 cfs in 1988 to 39.0 cfs in 2088)
(3) Same as 2nd scenario, but pumping in Fort/ Sierra Vista area at 100% of projected demand if no expansion of the Fort occurs	Annual average flows decline at Charleston (42.7 cfs in 1988 to 40.0cfs in 2088), at Fairbank (44.8 cfs in 1988, 42.1cfs in 2088) and at Benson Narrows (42.0 cfs in 1988 to 38.1 cfs in 2088)
(4) Same as 2nd scenario but assumes a new command is established at the Fort	Annual average flows decline at Charleston (42.7 cfs in 1988 to 39.9 cfs in 2088), at Fairbank (44.8 cfs in 1988, 41.9 in 2088) and at Benson Narrows (42.0 cfs in 1988 to 37.9 cfs in 2088)
(5) Same as 4th scenario but assumes effluent	Annual average flows increase at Charleston (42.7 cfs in 1988 to 42.8 cfs in 2088), at Fairbank (44.8 cfs in 1988, 44.9 in 2088) and at Benson Narrows flows decreased (42.0 cfs in 1988 to 40.8 cfs in 2088)
(6) Same as 5th scenario, but pumping locations in the Sierra Vista area are spread over a larger area	Annual average flows increase at Charleston (42.7 cfs in 1988 to 43.6 cfs in 2088), at Fairbank (44.8 cfs in 1988, 45.7 in 2088) and at Benson Narrows flows decreased (42.0 cfs in 1988 to 41.6 cfs in 2088)
(7) Same as 5th scenario, but assumes greater effluent recharge	Annual average flows increase at Charleston (42.7 cfs in 1988 to 46.8 cfs in 2088), at Fairbank (44.8 cfs in 1988, 49.0 in 2088) and at Benson Narrows (42.0 cfs in 1988 to 44.7 cfs in 2088)
(8) Pumping in the Sierra Vista subwatershed increases at 3% per year, no effluent recharge	Annual average flows decline at Charleston (42.7 cfs in 1988 to 34.3 cfs in 2088), at Fairbank (44.8 cfs in 1988, 36.6 in 2088) and at Benson Narrows (42.0 cfs in 1988 to 27.7 cfs in 2088)
(9) Same as scenario 8, but assumes effluent is recharged at the Sierra Vista water treatment plant, and recharge increases at 3% per year	Annual average flows decline at Charleston (42.7 cfs in 1988 to 36.3 cfs in 2088), at Fairbank (44.8 cfs in 1988, 38.3 in 2088) and at Benson Narrows (42.0 cfs in 1988 to 23.5 cfs in 2088)

Correll (1996): This modeling effort used the ADWR Sierra Vista subwatershed USPB groundwater flow model. Population growth projections were provided by the Arizona Department of Economic Security. In scenarios with effluent recharge, recharge is assumed to occur at the Sierra Vista water treatment plant.	
(0) Assumes no population growth in the Sierra Vista subwatershed after 1990, agricultural pumping in the Palominas/Hereford area is phased out by 2000, no effluent recharge	Stream flow (baseflow) increases at Palominas (1.13 cfs if 1990 to 2.2 cfs in 2030), at Charleston (4.81 cfs in 1990 to 5.74 cfs in 2030), and decreases at Tombstone gage (8.32 cfs in 1990 to 7.86 cfs in 2030, and on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.46 cfs in 2030)
(1.1) Assumes growth from current population of 51,400 to 73,870 in 2030, effluent recharge of 2,994 ac-ft/yr., agricultural pumping in the Palominas/Hereford area phased out by 2000.	Stream flow (baseflow) increases at Palominas (1.13 cfs if 1990 to 2.19 cfs in 2030), at Charleston (4.81 cfs in 1990 to 6.25 cfs in 2030), at Tombstone gage (8.32 cfs in 1990 to 8.46 cfs in 2030, and declines on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)
(1.2) Same as 1.1, but assumes agricultural pumpage in Palominas/Hereford area at 1624 ac-ft/yr.	Stream flow (baseflow) increases at Palominas (1.13 cfs if 1990 to 1.63 cfs in 2030), declines at Charleston (4.81 cfs in 1990 to 4.74 cfs in 2030), and declines on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)
(2) Population increases to 68,330 in 2030, effluent recharge at 2,994 ac-ft/yr., agricultural pumping in the Hereford/Palominas area phased out by 2000	Stream flow (baseflow) increases at Palominas (1.13 cfs if 1990 to 2.19 cfs in 2030), at Charleston (4.81 cfs in 1990 to 6.25 cfs in 2030), and on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.47 cfs in 2030)
(3) Population increases to 77,724 in 2030, no effluent recharge at 2994 ac-ft/yr., agricultural pumping in the Hereford/Palominas area phased out by 2000	Stream flow (baseflow) increases at Palominas (1.13 cfs if 1990 to 1.81 cfs in 2030), at Charleston (4.81 cfs in 1990 to 4.56 cfs in 2030), at Tombstone gage (8.32 cfs in 1990 to 6.4 cfs in 2030, and on the Babocomari River at canyon entrance to Babocomari Hills (1.14 cfs in 1990 to 0.35 cfs in 2030)
Braun *et. al.* (1992): This modeling effort used the model -WATERBUD" developed by a team of hydrologists at the University of Arizona. The model has many outputs. Only scenarios examining simulated future changes in riparian acreage are summarized here.	
(A) Effects of water management in the Sierra Vista subwatershed are modeled in regard to effects on acreage of riparian vegetation. In scenario A, population growth patterns are assumed to remain static, and over 150 parameters are modeled at default settings, which approximate conditions in 1989-90. Under scenario A, various water management policies to curb use or enhance recharge are evaluated	Increases in riparian acreage of up to 100 acres to 2010 occur under policies that result in increased river discharge and retirement of agricultural acreage. Such policies include enforcing a ceiling on domestic water consumption, requiring minimum irrigation efficiencies, retirement of irrigation water rights, and placing a pump tax on well withdrawals. Decreased riparian acreage of less than 100 acres by 2010 results from other policies, including maximal water conservation, and recharging effluent and cloud seeding. Without water policies, riparian acreage declines by approximately 60 acres.

(D) Population and agricultural water use are identical to scenario A, but this scenario assumes a worst case drought, which is the hottest and driest recorded in the previous 20 years.	Half of the policy scenarios result in decreased riparian acreage of approximately100-250 acres, the other half result in modest gains of less than 50 acres by 2010. Policies leading to increased acreage include a pump tax and one variant of enforcing a ceiling on domestic water use, requiring minimum irrigation efficiencies, and allowing buy outs of irrigation water rights. Other variants of the latter, cloud seeding and effluent recharge, and maximal water conservation lead to declines in riparian acreage. Without these water policies, riparian acreage declines approximately 225 acres by 2010.
ASL Hydrologic & Environmental Services (1998): Using the model "MODFLOW", river baseflow is modeled through 2040 under three scenarios: no recharge, and "partial" and "full" recharge at the Sierra Vista wastewater treatment plant. All scenarios assume agriculture pumping at 1624 ac-ft/yr., population growth based on latest estimates from AZ Department of Economic Security, and evapotranspiration remains at 1990 levels	
(0) No effluent recharge in Sierra Vista	Baseflow at Hereford remains near zero through 2040. At the Charleston Gage, river baseflow declines from 4.95 cfs in 1990 to 3.75 cfs in 2040. At Fairbank Gage, baseflow declines from 6.57 cfs in 1990 to 4.34 cfs in 2040. Declines begin from 6.57 cfs in 1990 to 4.34 cfs in 2040. Declines begin by 2000. Baseflows decline from a point between Hereford and Lewis Springs downstream to at least Fairbank. Small increases in baseflow occur from the international boundary to near Hereford. Declines in baseflow begin by 2000.
(1) 1516 ac-ft would be recharged per year from 2000-2010 and 1762 ac-ft per year from 2010-2020. No recharge would occur after 2020	Baseflow increases at Hereford remains near zero through 2024. At Charleston gage, baseflow declines from 4.95 cfs in 1990 to 4.00 cfs in 2040. At Fairbank Gage baseflow declines from 6.57 cfs in 1990in 1990 to 4.34 cfs in 2040. Declines begin by 2000. Baseflows decline from a point between Hereford and Lewis Springs downstream to at least Fairbank. Small increases in baseflow occur from the international boundary to near Hereford. Declines in baseflow begin by 2000.
(2) Recharge rates would increase from 2336 ac-ft in 2000-2010 to 3647 ac-ft in 2030-2040	Baseflow at Hereford remains near zero from 2000-2040. At the Charleston Gage baseflow increases from 4.95 cfs in 1990 to 5.46 cfs in 2040. At Fairbank Gage, baseflow decreases from 6.57 cfs in 1990 to 6.13 cfs in 2040. Changes in flow begin by 2000. Small increases in baseflow occur from the international boundary to near Hereford and in the Lewis Springs-Charleston reach.

Schwartzman (1990) **This study used the Theis equation to predict the effects of groundwater pumping on the Babocomari River. The model assumes that the regional aquifer is an isotropic homogeneous aquifer with an initially flat water table, infinite aerial extent, and no sinks or sources besides the pumping wells. The model assumes that the relative proportion of pumping between individual water users remains constant over the next 100 years. Pumping rates were based on existing conditions and remain constant throughout the 100-year period.**	
Continuation of pumping at current rates in wells at Huachuca City (3 wells), Fort Huachuca (>7 wells), and City of Sierra Vista (>5 wells)	Groundwater declines in an area of considerable riparian vegetation downstream of Huachuca City by an estimated at 5.8 to 11.5 feet in 50 years and 8.6 to 20.5 feet in 100 years. Groundwater decline is attributable mostly to pumping by Fort Huachuca and City of Sierra Vista.

Effluent recharge by the Fort, City of Sierra Vista, and others in the subwatershed is an important conservation measure. In scenarios evaluated by ASL (1998), recharge of effluent at the City of Sierra Vista wastewater treatment plant resulted in increased baseflow over the zero recharge scenario in a reach from approximately Highway 90 downstream to at least Fairbank (Table 5, page 80). The ASL partial recharge scenario corresponds to a project pursuant to a 1996 cooperative agreement among the City, Bureau of Reclamation, and the Arizona Water Protection Fund that calls for the City to recharge all of the effluent it owns and controls from 2000 through 2020.

Under this scenario baseflow remains essentially the same at that point and downstream from 2000 to 2020; whereas in the no recharge scenario, baseflow declines by as much as ~0.8 cfs between 2000 and 2020. Under the full recharge scenario, all effluent received at the wastewater treatment plant would be recharged through 2040, including all of the Pueblo del Sol (a local developer and water company) effluent. However, under the full recharge scenario, baseflow increases over the year 2000 conditions in the reach from Lewis Springs to upstream of Charleston by as much as 0.5 cfs through 2040. Baseflows remain essentially unchanged in the Fairbank area (ASL 1998). The Sierra Vista recharge facility came on-line in May 2002 (pers. com. Brian Bauer, City of Sierra Vista, 2002).

Because of the importance of this project, an examination of the underlying assumptions of the model and the input variables is warranted to determine if the model output may provide a prediction of future conditions that may or may not be helpful. In their partial recharge scenario, which corresponds to current plans, ASL (1998) assumed 1,516 ac-ft would be recharged per year from 2000-2010 and 1,762 ac-ft per year from 2010-2020. No effluent recharge would occur after 2020. All effluent controlled by the City would be recharged. Currently about 25% of effluent entering the wastewater plant originates at Pueblo del Sol constructed subdivisions. If Pueblo del Sol constructed the infrastructure, it could take delivery of its effluent and use it for irrigating golf courses or other uses. Construction of that infrastructure is uncertain.

In the partial recharge scenario, ASL assumed that effluent from Pueblo del Sol would not be available for recharge, and that 50% of new development in Sierra Vista would occur on Pueblo del Sol lands. If the infrastructure is not built, and Pueblo del Sol does not take delivery of its effluent, then effluent available for recharge would be greater than that modeled. Thus, the scenario is conservative in regard to effluent provided by Pueblo del Sol, if 50% or less of new development in Sierra Vista occurs on Pueblo del Sol lands. Population growth projections for the subwatershed were provided by the Arizona Department of Economic Security (ADES) and are based on May 1997 projections, which are higher than actual 2000 Census figures. These projections are similar to those used by Corell *et. al.* (1996) and the San Pedro Expert Study Team (1999). The model also assumed 1,624 ac-ft of agricultural pumping per year in the subwatershed, which is similar to estimated current agricultural pumping (San Pedro Expert Study Team 1999, Corell *et. al.* 1996.) but lower than the estimate of 5,179 ac-ft modeled by Fluid Solutions (Fluid Solutions, 2001). Thus, in regard to population projections and agricultural pumping, the model does not accurately account for these values. No other recharge or reuse facilities are assumed to exist in the subwatershed through 2040, again an inaccurate assumption given current projects since Fort Huachuca has constructed recharge basins, and plans are being made to recharge additional effluent from Huachuca City. Thus, the model is conservative in regard to future recharge efforts. The model also assumes evapotranspiration remains at the rate that ADWR (1991) assumed was occurring in 1990 (8,000 acre feet per year). This is similar to the evapotranspiration estimated by the San Pedro Expert Study Team (1999) (7,900 acre feet per year). In summary, the ASL partial recharge modeling scenario is of some use in terms of the amount of effluent that would be recharged but the model does not accurately account for consumptive uses based on recent data.

Uncertainties about the accuracy of input variables and future conditions suggest the model should be used cautiously. There is much uncertainty in the evapotranspiration estimate, particularly when projected into the future. If groundwater declines in the floodplain aquifer, evapotranspiration would be expected to decline (Stromberg *et. al.* 1996, ADWR 1994). BLM and AGFD have introduced beavers to the SPRNCA, which may cause additional changes in riparian vegetation communities and evapotranspiration rates. Because evapotranspiration is a relatively large percentage of consumptive water use in the subwatershed [~30% (San Pedro Expert Study Team 1999)], relatively small errors in estimating this variable would translate into significant changes in the model output. Qi *et. al.* (1998) calculated that evapotranspiration from Lewis Springs to four miles north of Fairbank was roughly 7,040 ac-ft per year, suggesting that 8,000 ac-ft may be an underestimate for the subwatershed. However, 86% of the 7,040 ac-ft was attributed to mesquite evapotranspiration, whereas, other research suggests mesquite on the upper San Pedro River may use less groundwater than previously thought (Scott *et. al.* 1998).

Other model inputs are also uncertain. Changes in water use in Mexico (San Pedro Expert Study Team 1999), possible future long-term drought or wet periods (Braun *et. al.* 1992, Tschakert *et. al.*(1999), changes in the watershed brought about by fire or changing grazing practices, the fate of Fort Huachuca in future base relocation and closure actions, and other elements of uncertainty could all be very important in shaping the water budget in the future. Furthermore, Wiesenborn (1995) finds that recharging aquifers by way of recharge basins is not always successful; basins clog with sediments and/or microorganisms requiring regular maintenance. It is unknown how long such facilities can be feasibly operated. ASL (1998) notes that their simulations are not

meant to be a precise prediction of what will happen in the future, but more a qualitative representation of how various pumping/recharge scenarios may affect the groundwater and surface water systems in the future. The model is more valuable in estimating relative differences among alternative futures (i.e. is one project alternative better than another at maintaining baseflow), rather than determining absolute future conditions.

There are additional points to consider in evaluating whether the model output corresponds to a reasonable estimate of future conditions. The model used by Corell (1996), the same model used by ASL (1998), found that in later years of the simulations (which were run through 2030), model cells at the base of the Huachuca Mountains were pumped dry. The model shut down pumping in those cells and thus pumping was under-simulated in the later years by 5-8% depending on the scenario. In other words, the model reduced pumping in the later years by 5-8% over what was inputted into the model. This same problem occurred in the model when used by ASL (USFWS, 1999a). The result is that somewhat less pumpage was simulated than indicated by the input variables and thus the effects on river baseflow may have been underestimated slightly in later years. The underestimate is probably small due to the relatively small reduction in pumpage (5-8%), and the distance from the San Pedro River to the cells that went dry (Huachuca Mountain front). Another potential problem was that the model assumes recharge begins in 2000. Since the treatment plant is online, this is no longer a valid concern.

Although the above discussion indicates the model should be used cautiously, the presence of a clay deposit in the vicinity of the proposed facility adds uncertainty into the results of the ASL modeling effort. The proposed site of the recharge project lies atop the clay deposit, which according to Pool could result in the recharged effluent emerging as spring flow at Murray Spring or other nearby springs. The model recognizes the presence of finer materials in the area, as evidenced by lower transmissivity values in these cells. However, the spring flow would be subject to evaporation and transpiration, which would reduce water available to recharge the aquifer (but evaporation and transpiration would probably amount to no more than a few hundred acre feet per year). The clay deposit could alter the effluent flow path, possibly increasing or decreasing the amount of recharge that flows to the river. Since this plant is online, it is doubtful if relocation will take place.

Regardless, effluent recharge projects are an important link in maintaining baseflow in the San Pedro River, at least in the near term. Despite the clay deposit, the project should increase the flow of groundwater to the river and reduce the deficit in the water budget. The facility should delay effects of groundwater pumping on water umbel habitat in the San Pedro River and provide additional time to develop and implement other water management strategies. These other strategies would hopefully emerge from the USPP Regional Plan. How long the treatment plant must recharge before a change in baseflow occurs is unknown.

The Fort currently routes 1,013 ac-ft of its effluent per year to a wastewater treatment plant. Approximately 450 ac-ft of the treated effluent is used to irrigate landscaping, of which 350 ac-ft was used in 2001 on the Mountain View golf course. Historically, the remainder was routed to evaporation ponds on the East Range. These ponds were replaced as part of a Military Construction Army project (Phase I of the Effluent Recharge Project, $ 6M) with recharge basins and infrastructure for increased effluent and stormwater recharge. In addition, the Fort has plans

to modernize the golf course irrigation system which uses treated effluent. The irrigation upgrade is estimated to reduce golf course use to about 245 ac-ft per year, allowing an additional 100 ac-ft per year to be recharged. The Fort recharge facility is located west of the clay deposit; thus effluent recharged at this locality would likely flow into the cone of depression (USFWS, 1999a). The location of the recharge facility is located between the Sierra Vista/Fort Huachuca cone of depression and the Babocomari River based on maps from Cochise County Water Resources Inventory (EEC, 2002).

Measures other than effluent recharge that lead to increased baseflow or increases in riparian acreage under the various modeling efforts include a pump tax, enforcing a ceiling on domestic water use, requiring minimum irrigation efficiencies, authorizing buy-outs of irrigation water rights (Braun *et. al.* 1992), capture and use of surface flows in the watershed outside of the San Pedro River (ASL 1995), and reduced pumping of groundwater (W&EST, Inc. 1994, Corell *et. al.* 1996). The San Pedro Expert Study Team (1999) and Advisory Panel on the Upper San Pedro Initiative (1998) also suggest pumping groundwater directly into the river during extreme drought, housing density restrictions, reduction of irrigated agriculture in Mexico, importation of water from another location within the USPB, importation of water from another basin such as the Douglas basin or from the Central Arizona Project, water conservation measures, and regulatory mechanisms, such as an AMA and/or INA under the Arizona Groundwater Management Act, and pursuing water rights issues under the Gila River adjudication.

3.7 WATER USE AND MANAGEMENT

This section describes water supply, water use and water demand for the Fort Huachuca and regional area including trends and projections.

3.7.1 REGIONAL WATER SUPPLY

Sierra Vista and Huachuca City depend entirely on groundwater (ADWR 1990). The commercial water company and municipal water wells servicing these population centers are located within six miles of Fort Huachuca. All have depths exceeding 800 feet. Most have pumping capacities exceeding 500 gallons per minutes (gpm). The municipal wells are typically pumped at a high continuous rate throughout the peak demand period.

There are more than 80 registered wells in the two townships adjacent to Fort Huachuca (ADWR 1995). Of these, 30 are high-capacity wells tapping the regional aquifer, with pumping capacities exceeding 100 gpm, and well depths exceeding 400 feet. Fifteen of these wells are categorized as municipal water supply wells. Ten are categorized as agricultural or industrial water supply wells. The uses of the remaining five are unidentified. These wells are part of the well field of more than 46 high-capacity wells on or within six miles of Fort Huachuca. The privately owned wells, which are not the installation's well fields, have a combined pumping capacity exceeding 18,000 gpm.

3.7.2 FORT HUACHUCA WATER SUPPLY

Local surface water is generated as storm runoff, snowmelt, and discharge from springs into the stream channels of Garden and Huachuca Canyons. Other canyons located within the boundaries of Fort Huachuca yield little water except for short durations after precipitation events. Springs were at one time the sole source of water for Fort Huachuca. By 1983, Fort Huachuca no longer used springs as a source of potable water.

Fort Huachuca predates most development in the USPB. The installation has some of the oldest reserved surface water claims in the State of Arizona. Most on-post surface water features are ephemeral, fed only through snowmelt and runoff from the Huachuca Mountains. Under current conditions, there are few exploitable surface water supplies on Fort Huachuca. Almost all on-post water uses are met by a series of groundwater wells.

Groundwater is the source of Fort Huachuca's potable water supply. The total quantity of groundwater pumped by the post in 2001 was 1,655 ac-ft. Eight wells on Fort Huachuca are considered municipal water supply wells with well depths between 710 and 1230 feet. Two of the wells (800 gpm pump capacity) are located on the East Range and six wells (500-700 gpm pump capacity) are located on post between the main gate and the east gate. Another five wells support military testing and research activities across the post and have minimal production.

Water consumption at the installation has steadily decreased (Figure 20) as a result of the use of treated effluent for irrigation, demolition of WWII buildings and water infrastructure, leak detection surveys and an aggressive water conservation program. Fort Huachuca uses effluent to irrigate the Chaffee Parade Field, the golf course, and the new outdoor sports complex. Fort Huachuca's golf course is the only golf course in the subwatershed irrigated with treated effluent. In 2001, Fort Huachuca produced approximately 1,013 ac-ft of treated effluent.

3.7.3 GROUNDWATER DEFICIT IN THE SIERRA VISTA SUBWATERSHED

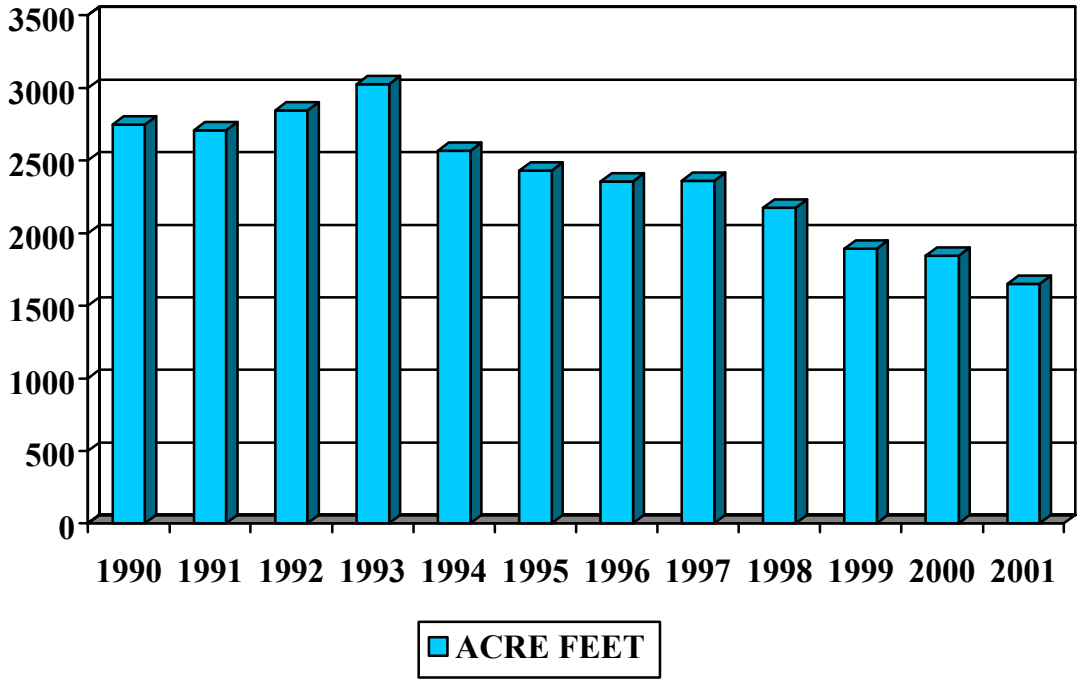
The purpose of subsections 3.7.3 through 3.7.7 is to determine the amount of the groundwater deficit that is attributable to the presence of Fort Huachuca in the Sierra Vista subwatershed. The remainder of the groundwater deficit is attributable to cumulative effects. In order to make this determination, there are three critical components or numbers which must be known or determined. These three numbers include: (1) the amount of the current groundwater deficit in the Sierra Vista subwatershed; (2) the total number of people in the Sierra Vista subwatershed; and (3) the total number of people attributable to Fort Huachuca in the Sierra Vista subwatershed.

Once these three numbers are known, the amount of the current groundwater deficit in the Sierra Vista subwatershed attributable to Fort Huachuca will be determined as follows: Number of people attributable to Fort Huachuca divided by the total number of people in the Sierra Vista subwatershed. This percentage will be multiplied by the current groundwater deficit in the Sierra Vista subwatershed.

Based on the analysis detailed below, the amount of the current groundwater deficit in the Sierra Vista subwatershed attributable to Fort Huachuca is 2,784 ac-ft. (33,624/64,655 times 5,144 ac-ft

equals 2,675 ac-ft plus 109 ac-ft for the increased personnel in the proposed action). The remainder of the groundwater deficit in the Sierra Vista subwatershed which is attributable to cumulative effects is 2,360 ac-ft.

FIGURE 20 FORT HUACHUCA WATER USE (PUMPING) HISTORY



In order to determine the amount of the groundwater deficit attributable to Fort Huachuca's presence in the Sierra Vista subwatershed, Fort Huachuca first had to determine the amount of the current groundwater deficit. To do this, Fort Huachuca contracted with EEC to prepare a water budget for the Sierra Vista subwatershed. This water budget is shown in Appendix K. As reflected in that spreadsheet, current withdrawals including irrigated agriculture are 19,072 ac-ft. Recharge from treated wastewater and septic tanks is 4,719 ac-ft. Natural recharge is 9,209 ac-ft. Subtracting recharge from withdrawals equals a current groundwater deficit in the Sierra Vista subwatershed of 5,144 ac-ft. This is a reduction of 1,856 ac-ft from a previous estimate in 1999 by the CEC. The reduction of the groundwater deficit is due to a number of factors to include a 700 ac-ft reduction in pumping by Fort Huachuca, increased effluent recharge of 622 ac-ft by the City of Sierra Vista beyond that calculated by the CEC and a lower population in the City of Sierra Vista than previously forecast, etc.

3.7.4 TOTAL POPULATION IN THE SIERRA VISTA SUBWATERSHED

In order to determine the amount of the groundwater deficit attributable to Fort Huachuca's presence in the Sierra Vista subwatershed, Fort Huachuca next had to determine the total number of people in the Sierra Vista subwatershed. Using 2000 data from the US Bureau of Census

(Census 2000), the total population in the Sierra Vista subwatershed is currently 64,655 people, APPENDIX J. This figure includes Sierra Vista, Sierra Vista Southeast, Bisbee, Naco, Tombstone, Huachuca City, Whetstone, and unincorporated areas within the Sierra Vista subwatershed.

3.7.5 DIRECT, INDIRECT, INTERRELATED, AND INTERDEPENDENT POPULATION ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED

To determine the amount of the groundwater deficit attributable to Fort Huachuca's presence in the Sierra Vista subwatershed, Fort Huachuca next had to determine the number of people who live in the Sierra Vista subwatershed due to the presence of Fort Huachuca. As described below, the total population attributable to Fort Huachuca (to include projected growth) in the Sierra Vista subwatershed is 34,993 people. This includes a population of 26,531people (military, government civilian, contractors, retirees, survivors and family members) and an interrelated and interdependent population of 7,093 of induced employees and family members. An indirect population of 1,369 is projected for potential personnel increases at Fort Huachuca in the future and included in the proposed action.

Demographic Study to Eliminate Double Counting

In order to accurately determine Fort Huachuca's population one must first understand how the Fort's population is determined. The following is a thorough discussion on how the Fort's population is derived.

Fort Huachuca publishes an Annual Economic Impact Statement (AEIS) with population numbers reported for several categories of personnel. Numbers for these personnel categories are derived from independent databases. Because the databases do not cross-reference, and the labor pool is small and often contains multiple members of the same family, significant double counting occurs in the report. Thus the number of "personnel" reported in the AEIS is higher than the number of people who are actually in each of the "personnel" categories.

In 1999, Fort Huachuca contracted with SAIC to conduct a demographic survey to determine the extent of the double counting of employees and family members associated with the installation (SAIC 1999). Factors determined from the 1999 Fort Huachuca Demographic Survey were used to correct the inferred population numbers for family members and the actual population numbers for people who fall into multiple categories (Appendix G). For example, a military family member who is a retired military member and is currently employed as a contractor would appear as personnel in three categories in the report, despite actually being only one person who uses water. Double counting also occurs between off-post employment and military retirees or family members of personnel reported below (Table 6). However, no correlation factors for off-post employees related to on-post employees were determined in the 1999 survey. Because of the similarity in the type of contractor jobs and the potential employee pool, it is assumed for the purposes of this BA, the same double counting adjustment factors may be applied to both on and off-post contractor personnel.

Table 6, adjusted for double counting as previously discussed, provides the population for all military, government civilian and contractor personnel, military retirees, and family members. In

addition to the 3,149 contractors working on post, as determined by the 2001 AEIS, another survey was conducted by the Directorate of Resource Management, Fort Huachuca, to determine the number of off-post contractors working for Fort organizations in the Sierra Vista subwatershed. Results of that survey determined that 298 additional off-post contract personnel (included in Table 7 along with their family members) were working directly for on-post

TABLE 6 FORT HUACHUCA POPULATION ADJUSTED FOR DOUBLE COUNTING

Personnel Category	Number in AEIS	Number of people after adjustment for double counting
Active Military living on Post	4840	4840
Military family members on post	4151	4151
Active Military living off Post	1884	1884
Military family members off post	1895	1895
Government Civilian employees	2432	2016
GC household family members	N/A	2868
Contractors working on post	3149	2542
Contractors working off post[2]	N/A	298
Total contractor family members	N/A	3881
2 Wage Earners in Household family members	N/A	998
Military Retirees	3427	796 (Interrelated and Interdependent)
Military Retirees Family members	N/A	796 (Interrelated and Interdependent)
Retiree survivors	258	258 (Interrelated and Interdependent)
Retiree survivors Family Members	129	129 (Interrelated and Interdependent)
Subtotal	N/A	27352
3% do not live in subwatershed Total	-821	26,531

TABLE 7 FORT HUACHUCA POPULATION AND WATER USE 1997 - 2001

	1997	1998	1999	2000	2001
Military Assigned	4,455	4,310	4,272	4,219	4,066
DoD Civilian Employees	2,466	2,442	2,426	2,367	2,432
Other Civilian Employees	1,947	2,499	2,836	1,925	3,149
Total Permanent Parties	**8,868**	**9,251**	**9,534**	**8,511**	**9,647**
Students	1,248	1,111	1,606	2,864	2,658
Total Employees	**10,116**	**10,362**	**11,140**	**11,375**	**12,305**
Military Family Members Residing on Post	4,734	4,431	4,326	4,143	4,151
Total Noonday Population*	**14,850**	**14,793**	**15,466**	**15,518**	**16,456**
Total Effective Population (effective water users)**	**10,475**	**10,038**	**10,190**	**10,438**	**10,383**
Total Water Pumping (AF)	**2,357**	**2,176**	**1,893**	**1,843**	**1,655**

Source: DRM 1998, 1999, 2000, 2001, 2002

*Note: The noonday population includes assigned military, their family members living on post, and all civilians employed on post.

**Effective Population counts personnel according to water use impact: permanent party and family members = 1, contractors and civilians count as 0.15 for their daily use at work, and students count as 0.5.

[2] Fort Huachuca is aware of the allegation that growth has merely shifted off post by hiring contractors. Consequently, a survey was performed to get an accurate count of government contractors working off the installation. There are a total of 298 contractor employees working off post.

organizations, for a total of 3,447 contractors in the Sierra Vista subwatershed (Appendix H). Family members of military personnel on and off post, as shown in the table above, were taken from the AEIS for 2001. The family members for civilian, contractor and military retiree personnel were estimated using factors from the 1999 Demographic Survey, after correcting the initial employee numbers for double counting, and the correction for households having more than one employee.

The 1999 demographic survey also indicated that approximately 3% of all employees and their families do not live in the Sierra Vista subwatershed. This equates to 821 people. Therefore, the number of Fort Huachuca's military personnel, government civilians, contractors, retirees and family members in the Sierra Vista subwatershed is estimated to be 26,531.

3.7.6 INDUCED POPULATION ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED

Based on the amount of salaries, purchases and contracts in the Sierra Vista subwatershed there are additional induced jobs which are created due to the presence of Fort Huachuca. This constitutes an additional component of the interrelated and interdependent population related to Fort Huachuca. Using the data in Table 8 below, Fort Huachuca calculated the number of induced jobs and associated personnel using two different methods.

TABLE 8 FORT HUACHUCA SPENDING IN COCHISE COUNTY (IN MILLIONS)

Year	Purchases and Contracts	Military Salaries	Civilian Salaries	Schools	Total*
2001	233.1	151.3	135.8	7.1	**528.0**
2000	199.4	128.2	146.6	5.1	**480.1**
1999	208.9	154.0	117.6	4.5	**485.8**
1998	158.1	152.9	116.5	4.6	**443.2**
1997	223.0	144.2	129.9	3.3	**501.5**
Average	**204.5**	**146.1**	**129.3**	**4.9**	**487.7**

* Includes small expenditures not shown in the table, such as loans and claims.

Method One. Economic Income Forecasting System. The federal government uses a number of economic models to address different economic issues. The Army uses the Economic Impact Forecast System (EIFS) to address regional economic effects and to measure the significance of these effects. The EIFS has been used to assist in determining the economic impact of base realignments/closures on local communities. It is a good tool available within the Army for determining probable economic impacts of military operations, and is maintained by the Army Environmental Policy Institute. The tables below show the EIFS inputs to calculate the economic impact by the Fort on Cochise County and the results from the EIFS Model Runs.

Inputs for EIFS Model Run for Cochise County

# of military personnel	Average salary	# of government civilian employees	Average salary	Local Contracts & Purchases*
6724	$22,501.50	2432	$55,838.82	$233.1 million

*Includes salaries of contractors.

Results from EIFS Model Runs for Cochise County (EIFS 2002)

Sales Volume-Direct	Sales Volume Induced	Sales Volume Total	Employment direct	Employment induced	Employment Total	Off-Post Population
$387.9 million	$473.2 million	$861.1 million	12,509	4091	16,660	8,065

The EIFS model addresses the Fort's economic impact on all of Cochise County (which is larger than the subwatershed), and thus includes impacts beyond the Sierra Vista subwatershed. Approximately, 36% of the jobs in the County are held outside the Sierra Vista subwatershed. If the figure of 4,091 induced jobs was adjusted to reflect only the induced jobs in the Sierra Vista subwatershed, the number of induced jobs would be less than Method Two described below. To be conservative, Fort Huachuca will use the induced job number of 3,536 based on Method Two.

Method Two. As detailed in APPENDIX I, the Center for Economic Research at Cochise College calculated that there are 3,536 induced jobs due to the presence of Fort Huachuca in the Sierra Vista subwatershed. As shown in Appendix J, the available family member labor pool after adjustments for double counting is 12,270. Assuming that the subwatershed ratio of jobs to labor pool is valid, 4,663 of these family members hold jobs off post. This represents 26.75% of the available jobs. It is reasonable to assume that this percentage applies to the induced jobs as well. Consequently, 946 family members of military, civilians, and contractors hold induced jobs. The remaining 2,590 (3,536 minus 946) induced jobs are attributable to Fort Huachuca's economic presence in the Sierra Vista subwatershed, and are not held by a person already accounted by Fort Huachuca elsewhere. Based on APPENDIX J, each induced job supports an average of 2.74 people, therefore the total number of induced people interrelated and interdependent due to the presence of Fort Huachuca is 7,093 people.

3.7.7 INDIRECT POPULATION ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED

In order to determine the amount of the groundwater deficit attributable to Fort Huachuca's presence in the Sierra Vista subwatershed, the final component that Fort Huachuca had to project was its potential indirect population growth in the future.

During the period 1990 through 2001, the workforce on Fort Huachuca remained relatively stable from 12,119 in 1990 to 12,305 in 2001. Although the Fort Huachuca workforce remained relatively stable during this time period, it should be noted that the workforce is very dynamic and varies from year to year. In recent years, most population increases or decreases at the Fort can be attributed to fluctuations in the student population. Because of this variation, the average workforce

for Fort Huachuca is a better number to use when comparing data from year to year. Fort Huachuca's average annual workforce from 1991- 2001 was 11,175.

Despite relative stability in the past, the post-9/11 National Defense environment is one of rapid change. As requirements are identified, solutions are put in place in short time periods to meet the challenges. This environment extends to Fort Huachuca, home of the Army's MI Center. Several actions have been proposed for implementation at the Fort, though some of these actions have not been implemented to date (e.g., plus up of MI students). Predicting reasonably foreseeable mission increases for the installation in a national crisis environment is difficult.

The installation's primary method for projecting future personnel requirements, which drives the requirement for infrastructure, is the Army Stationing and Installation Plan (ASIP). This document does not consider off post contractors; it forecasts personnel needs for the following six years based on the installation needs and Army requirements. Fort Huachuca's most recent ASIP is from July 2001. This document provides a rational basis for projecting future population at the installation. Over the last several years, Fort Huachuca's actual manning has been approximately 90% of the ASIP projected authorizations. Currently, Fort Huachuca exceeds ASIP projections which is primarily due to current and projected national defense needs. Consequently, future personnel requirements at the installation will be projected to be 100% of the ASIP for FY 2004, which reflects the highest personnel projection in the current ASIP (12,812). For ease of planning and for the purpose of this BA, the Fort will use a projected personnel increase of 500 permanent party personnel, for a total of 12,805 personnel, not including off post contractors. The Fort projects that with family members this could be up to 1369 people depending on the mix of personnel e.g., students, military on-post, or off-post civilians. If further mission requirements are needed, IAW the mitigation policy, Fort Huachuca will completely offset water usage associated with these personnel in addition to the commitments made in Section 5.

3.7.8 TOTAL WATER USE ATTRIBUTABLE TO FORT HUACHUCA IN THE SIERRA VISTA SUBWATERSHED

The amount of the current groundwater deficit in the Sierra Vista subwatershed attributable to Fort Huachuca is 2,784 ac-ft. (33,624/64,655 times 5,144 ac-ft equals 2,675 ac-ft plus the 109 ac-ft projected increase). This includes all direct, indirect, interrelated and independent effects associated with the presence of Fort Huachuca in the Sierra Vista subwatershed. As discussed in Section 5, Fort Huachuca will completely zero out this water usage by the year 2011. If Fort Huachuca has further mission personnel growth it will completely mitigate water usage associated with these personnel as well.

The remainder of the groundwater deficit in the Sierra Vista subwatershed which is attributable to cumulative effects is 2,360 ac-ft. Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed zero out this water usage and any water usage associated with future growth.

3.7.9 CUMULATIVE EFFECTS - POPULATION AND WATER USE PROJECTIONS

Cumulative effects are "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area" (50 CFR 402.02).

As previously noted, based on the 2000 Census data, there are approximately 64,655 people who live in the Sierra Vista subwatershed. The Sierra Vista subwatershed area includes the cities of Sierra Vista, Tombstone, Huachuca City, Bisbee, Whetstone, Naco and unincorporated areas southeast of Sierra Vista. Some of these municipalities have not grown or have grown very little over the past 10 years. From 1990 to 2000, the City of Sierra Vista increased its population by 14.5% (37,775) while Cochise County increased by 20.4% (117,755). However, a large portion of the increase in Sierra Vista during this 10 year period was in the south and east portions of the City. In the county, the largest population increases occurred in the Palominas and Hereford areas (Sierra Vista Economic Focus 2001-2002).

Overall the growth rate was approximately 2% per year. Using Fluid Solutions USPP Report (July 2001), the annual forecast for future population growth is 2% for Sierra Vista, 0.4% for Tombstone, 0.5% for Bisbee, 1.5% for Huachuca City, and 1.3% for unincorporated areas. Using an average of 2% this would equate to a total of approximately 77,586 people in the Sierra Vista subwatershed by 2010. Of the approximately 13,000 people, 6,500 people would be living in the City of Sierra Vista and 6,500 would be outside Sierra Vista. Fort Huachuca's population has remained relatively stable, and obviously there are many factors affecting growth in the area beyond Fort Huachuca. (Jones 2002).

Another important cumulative effect associated with population growth is the potential impact on groundwater resources. Due to Fort Huachuca's ongoing water conservation efforts (reduced water consumption by over 1,000 ac-ft since 1993) and the City's effluent recharge project, the water deficit in the Sierra Vista subwatershed is 5,144 ac-ft, instead of the previous CEC estimate of 7,000 ac-ft. The groundwater deficit attributable to cumulative effects, not related to Fort Huachuca, is 2,360 ac-ft.

This figure of 2,360 ac-ft does not include the projected population growth in the future. Pumping projections for the subwatershed are shown in Appendix K using growth percentages for cities and assuming that only the Fort conservation measures are implemented. Recharge is included in the analysis. For growth percentages projected in the Fluid Solutions (2001), the deficit in 2011 would be 3,599 ac-ft. In other words, projected growth in the basin would contribute an estimated 1,239 ac-ft to the deficit if not mitigated. However, as shown in Appendix K, there are feasible alternatives available.

Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects (3,599 ac-ft) associated with groundwater usage by 2011 as well.

This is a very achievable accomplishment. Bisbee alone is currently planning to begin construction of an effluent recharge plant in two years. When constructed in six years the effluent recharge plant is projected to recharge approximately 392 ac-ft which would reduce the

cumulative water deficit in 2011 to 3,207 ac-ft. Therefore, not only has Fort Huachuca agreed to zero out all direct, indirect, interrelated and interdependent effects of its proposed action, but Fort Huachuca anticipates that the communities and agencies in the region will also agree to zero out all the cumulative effects associated with groundwater usage in the Sierra Vista subwatershed. The bottom line is that by the year 2011 the groundwater deficit in the Sierra Vista subwatershed will be reduced to zero and there will be no effect on threatened or endangered species or their critical habitat at that time.

Fort Huachuca will continue to provide vigorous leadership, technical support, funding, and other resources to assist the efforts of its regional partners (local, State and Federal) to address the impact of these cumulative effects in the Sierra Vista subwatershed. The USPP consists of the following Federal, state, and local agencies and non-governmental organization: Fort Huachuca, BLM, USFS, National Park Service (NPS), US Geological Survey, Agricultural Research Service, Arizona Land Department, Arizona Department of Water Resources (ADWR), Arizona Department of Environmental Quality (ADEQ), Arizona Association of Conservation Districts, Cochise County, Sierra Vista, Huachuca City, Bisbee, Tombstone, Hereford Natural Resource Conservation District, and The Nature Conservancy (TNC). The USPP is the regional interagency group analyzing and/or implementing a number of conservation projects, including some of those recommended in the July 1999 report from the Commission on Environmental Cooperation (CEC). Most of the specific projects recommended in the CEC report, along with additional projects, are currently being analyzed for technical feasibility through the USPP or are being implemented.

For a detailed discussion of on-going and proposed USPP efforts, see conservation measures in Section 5 and Appendix L. As shown in Appendix K, there are several feasible initiatives which would create a surplus of groundwater in the Sierra Vista subwatershed if they were implemented.

3.8 BIOLOGICAL RESOURCES

3.8.1 VEGETATION

The vegetation of Fort Huachuca is representative of the basin and range region of southeastern Arizona. Plant species composition and vegetation productivity is largely determined by rainfall distribution (as influenced by topography). At lower elevations within the San Pedro River Valley, xerophytic (adapted to life in dry environments) shrubs and grasses provide sparse vegetative cover, while on the moister slopes of the Huachuca Mountains, stands of trees and shrubs predominate. Fort Huachuca includes vegetation types ranging from shrublands, open grasslands, and mesquite-grass savannas of the lowlands, through the oak-grass savannas and oak woodlands of the foothills, to the pinyon-juniper and pine woodlands of upper elevations. Over 10 vegetation types have been mapped on Fort Huachuca (Figure 21). Table 9 compares occurrence of these vegetation types at the South, West, and East Ranges at Fort Huachuca.

FIGURE 21 FORT HUACHUCA VEGETATION

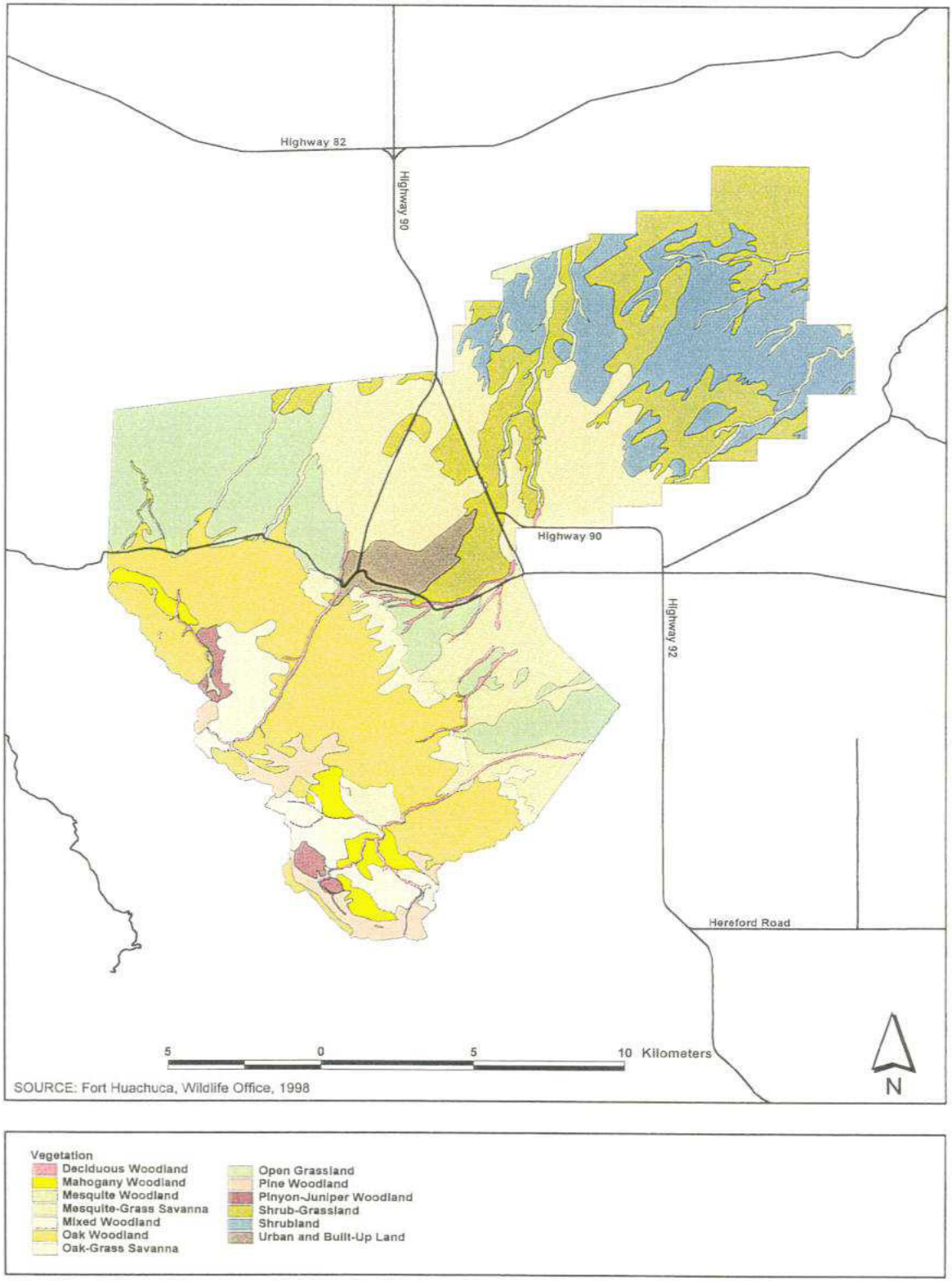


TABLE 9 VEGETATION TYPES PRESENT ON FORT HUACHUCA RANGES

VEGETATION TYPE	SOUTH RANGE ac	(ha)	WEST RANGE ac	(ha)	EAST RANGE ac	(ha)	TOTAL ac	(ha)
Shrubland	0	(0)	0	(0)	10414	(4217)	10414	(4217)
Open Grassland	2872	(1163)	5483	(2221)	0	(0)	8355	(3384)
Shrub-Grassland	3	(1)	1487	(602)	10805	(4374)	12295	(4977)
Mesquite Woodland	0	(0)	0	(0)	1108	(449)	1108	(449)
Mesquite-Grass Savanna	4296	(1739)	3687	(1492)	6199	(2509)	14182	(5740)
Oak-Grass Savanna	1703	(689)	200	(81)	0	(0)	1903	(770)
Oak Woodland	7548	(3056)	3961	(1604)	0	(0)	11509	(4660)
Mixed Woodland	2459	(996)	510	(205)	0	(0)	2969	(1201)
Pine Woodland	1800	(729)	27	(11)	0	(0)	1827	(740)
Deciduous Woodland	759	(307)	230	(93)	18	(7)	1007	(407)
Mahogany Woodland	1117	(452)	234	(95)	0	(0)	1351	(547)
Pinyon-Juniper	318	(129)	184	(74)	0	(0)	502	(203)
Urban and Built-Up Land	0	(0)	5270	(2317)	0	(0)	5720	(2317)
TOTAL	22875	9261	21723	8795	28544	(11556)	73142	(29612)

In addition to the above upland vegetation types, three riparian vegetation types have been identified on Fort Huachuca: (1) Sonoran Riparian Deciduous Woodland (Mesquite Bosque Series); (2) Interior Riparian Deciduous Forest (Cottonwood-Willow Series and Mixed Broadleaf Series); and (3) Madrean Montane Riparian Forest. Garden, Huachuca, and McClure Canyons support most of the riparian habitat at Fort Huachuca. Descriptions of the various vegetation types and land uses are summarized below. The present distribution and composition of vegetation in the region has been affected by a series of natural and human-caused disturbances. These include intense grazing until 1887, a major earthquake in 1887, fires and heavy rainfall following the earthquake, intermittent drought, woodcutting, continued moderate grazing, fire suppression, and troop training. Large areas of semi-desert grassland have been invaded by velvet mesquite, *Prosopis velutina,* since the turn of the century. Other "native" grassland areas on post have been invaded by Lehmann lovegrass, *Eragrostis lehmanniana*; a warm seasonal perennial from Africa introduced to the area in the 1930s and 1940s.

3.8.2 SOUTH RANGE

Open grasslands and mesquite-grass savanna cover approximately 7,100 acres and occur in the predominantly flat expanses and shallow drainages in the eastern portion of the south range (Figure 21, page 96). Woodlands of various types cover approximately 14,000 acres and occupy the western portion of the range, which has hilly and often steep terrain including several large canyons. In the firing range areas, existing disturbance includes paved and unpaved roads, parking areas, towers, and firing structures in the predominately flat areas.

The predominant vegetation in the eastern portions of the south range is open grassland and mesquite-grass savanna with elevations for this habitat type ranging from approximately 4,200 to 5,100 feet. This is the largest habitat type occurring at Fort Huachuca. Common species include velvet mesquite, agaves (*Agave* spp.), yuccas (*Yucca* spp.), sotol (*Dasylirion wheeleri*), rabbit brush (*Chrysothamnus nauseosus*), and a variety of grasses including gramas (*Bouteloua* spp.), lovegrass (*Eragrostis* spp.), and muhly (*Muhlenbergia* spp) Cacti, such as cholla and prickly pear

(*Opuntia* spp.), pincushion (*Mammillaria* spp.), and hedgehog (*Echinocereus* spp.) are also common.

An oak-grass savanna covers approximately 1,700 acres and occurs from approximately 5,000 feet to 5,800 feet. Typical tree species are evergreen oaks (including *Quercus arizonica* and *Q. emoryi*) and alligator juniper (*Juniperus deppeana*). Mesquite also occurs in this type. Canopy cover of trees is generally less than 15%. Major grasses include bullgrass (*Muhlenbergia emersleyi*), deergrass (*M. rigens*), sideoats grama (*Bouteloua curtipendula*), pinyon ricegrass (*Piptochaetium fimbriatum*), prairie junegrass (*Koeleria macrantha*), plains lovegrass (*Eragrostis intermedia*), dryland sedge (*Carex occidentalis*), and beggartick (*Aristida orcuttiana*). Woodlands dominate the higher elevations of the range. These types include oak, mahogany, and mixed woodlands. These types occur at elevations ranging from 5,200 to 7,200 feet. Arizona white, Emory, and silverleaf (*Quercus hypoleucoides*) oaks dominate, while alligator juniper and Mexican pinyon (*Pinus cembroides*) are important co-dominants. On limestone parent materials, mountain mahogany (*Cercocarpus* spp.) is a dominant species. Within this type of woodland in canyon bottoms or on cool northern exposures, pine species such as Apache (*Pinus latifolia*), Chiricahua (*Pinus chihuahuana*), and ponderosa (*Pinus ponderosa*) occur as well as unique species such as Arizona madrone (*Arbutus arizonica*) and Arizona rosewood (*Vauquelinia californica*). Important shrubs include sacahuista (*Nolina microcarpa*), Schott yucca (*Yucca schottii*), manzanita (*Arctostaphylos* spp.), Wright silktassle (*Garrya wrightii*), skunkbush sumac (*Rhus trilobata*), sotol, agave, Mearn's sumac (*Rhus virens*), narrowleaf hoptree (*Ptelea angustifolia*), prickly pear, hedgehog, and rainbow cactus (*Echinocereus rigidissimus*). Common grasses and forbs are prairie junegrass, pinyon ricegrass, bullgrass, muttongrass (*Poa fendleriana*), sedges (*Carex* spp.), bouvardia (*Bouvardia glaberrima*), meadow rue (*Thalictrum* spp.), wild beans (*Phaseolus* spp.), goosegrass (*Eleusine indica*), wood-sorrel (*Oxalis* spp.), gentian (*Gentiana* spp.), and crane's-bill (*Geranium* spp.).

Pine woodlands of the Madrean montane conifer type occur at higher elevations ranging from 6,000 to 8,600 feet. The pine woodland is dominated by ponderosa pine and covers approximately 1,800 acres. Co-dominants include Chiricahua and Apache pine. On steep northern exposures, Douglas-fir (*Pseudotsuga menziesii*) and southwestern white pine (*Pinus strobiformis*) form associations with ponderosa pine. Quaking aspen (*Populus tremuloides*) is found in a few places usually in moist soil areas. Important understory trees include silverleaf oak, Arizona white oak, alligator juniper, Mexican pinyon, Arizona madrone, and Gambel oak (*Quercus gambelii*). The major shrubs are Fendler buckbrush (*Ceanothus fendleri*), netleaf oak (*Quercus rugosa*), New Mexico locust (*Robinia neomexicana*), snowberry (*Symphoricarpos* spp.), Schott yucca, sacahuista, mountain mahogany, and southwest thimbleberry (*Rubus neomexicanus*). Important grasses include mountain muhly (*Muhlenbergia montana*), longtongue muhly (*Muhlenbergia longiligula*), bullgrass, sideoats grama, muttongrass, prairie junegrass, nodding brome (*Bromus anomalus*), fringed brome (*Bromus ciliatus*), bulb panic grass (*Panicum bulbosum*), screwleaf muhly (*Muhlenbergia virescens*), pine dropseed (*Sporobolus* spp.), and wedgescale (*Spenopholis* spp.). Common forbs are mule ears (*Wyethia* spp.), meadow rue, goosegrass, wood-sorrel, crane's-bill, sneezeweed (*Helenium* spp.), goldenrod (*Solidago* spp.), avens (*Geum* spp.), gentian, rock cress (*Arabis* spp.), and pussytoes (*Antennaria*in spp.).

Several riparian zones are found within the South Range. Deciduous riparian woodland communities are associated with the floors of Garden, Woodcutters, Scheelite, and McClure Canyons and near Cave Spring (ENRD 2001). The proportions of dominant species vary depending on elevation and soil but include Arizona sycamore (*Platanus wrightii*), Fremont cottonwood (*Populus fremontii*), Arizona black walnut (*Juglans major*), Goodding's black willow (*Salix gooddingii*), bigtooth maple (*Acer grandidentatum*), Arizona ash (*Fraxinus velutina*), and Arizona white and silverleaf oak. Shrub species include canyon grape (*Vitis arizonica*), red-osier dogwood (*Cornus stolonifera*), skunkbush sumac, creeping barberry (*Berberis repens*), Schott yucca, and cat-claw mimosa (*Mimosa biuncifera*). Common grasses and forbs are horsetail (*Equisetum* spp.), sedges, rushes (*Juncus* spp.), giant wildrye (*Elymus* spp.), deergrass, watercress (*Rorippa* spp.), water speedwell (*Veronica anagallis-aquatica*), false tarragon (*Artemisia dracunculus*), annual sunflower (*Helianthus* spp.), and goldenrod.

3.8.3 WEST RANGE

Vegetation on the West Range is similar to that of the South Range, with open grassland on the lower portions of the range in the north and east, transitioning through oak-grass savanna to oak and mixed woodlands in the south and west (Figure 21, page 96). Disturbed areas include paved and unpaved roads, parking areas, a concrete helipad, powerlines, a pipeline, several buildings and antenna installations, and the UAV site. Deciduous riparian vegetation is found near Antelope Pond and Blacktail, Slaughterhouse, and Huachuca drainages.

3.8.4 EAST RANGE

The East Range consists of approximately 28,544 acres dominated by shrub-grassland plant communities (Figure 21, page 96). Mesquite woodlands in the East Range occur primarily in the drainages and washes. None of the washes within the maneuvering area contain well-developed riparian communities. Grasslands occur in areas in the northern portion of the site, and upland areas are dominated by mesquite and creosote associations. The area has been disturbed to varying degrees. Unpaved roads, tracks, and jeep trails are common. An unpaved airstrip is present in the east-central region of the site and roads have been changed to circumvent this area. This area in the northwestern corner contains a large amount of litter and debris from a neighboring landfill located off the installation in Huachuca City. An old agricultural field and an observation platform are present near the center of the northern border.

The major plant community occurring on the East Range is shrublands of the Chihuahuan desert scrub type. Elevations for this habitat type range from 3,900 to 4,400 feet. The desert scrub community was historically desert grassland but was altered by livestock overgrazing prior to government ownership. Dominant woody plants include creosote bush (*Larrea tridentata*), mesquite (*Prosopis* spp.), desert broom (*Baccharis sarothroides*), tarbush (*Flourensia cernua*), and whitethorn acacia (*Acacia constricta*). Other important species include bush muhly (*Muhlenbergia porteri*), black grama (*Bouteloua eriopoda*), blue threeawn (*Aristida purpurea*), fluffgrass (*Tridens muticus*), false goldfields (*Bahia* spp.), and twinberry (*Lonicera* spp.). Since 1960, when the Army fenced the East Range, the area has been improving but bushy and non-native species have largely replaced the natural desert grassland. Lehmann lovegrass, an

introduced, invasive annual grass indicative of disturbance, is abundant within most vegetation associations on the East Range.

3.8.5 FAUNA

The significant wildlife diversity found in the Fort Huachuca area is directly related to the habitat diversity in this region. The isolation of the Huachuca Mountains from the other mountain ranges in the area results in "mountain islands." These areas are known for their diversity of vegetation types, usually along an elevational gradient, and typically exhibit high degrees of species endemism. In addition, proximity to Mexico results in some wildlife species here that are not known to occur elsewhere in the US, or are more commonly associated with the tropics. As a result, southeastern Arizona possesses one of the greatest diversities of bird species of any similarly-sized region in North America (Taylor 1995). More than 400 species occur here each year, and a total of almost 500 species has been recorded (Taylor 1995). Another example of the diversity of the region is the 75 species of amphibians and reptiles that occur in the Huachuca Mountains and Upper San Pedro River (Taylor 1995). Also, more than 180 species of butterfly have the potential to occur in various habitats throughout Fort Huachuca.

The biotic diversity on Fort Huachuca mirrors similar habitats outside installation boundaries. Information on species abundance and trends generally has not been collected in recent years on post.

Fort Huachuca has a very diverse population of mammals. Large mammals include Coues white-tailed deer (*Odocoileus virginianus couesi*), desert mule deer (*O. hemionus crooki*), pronghorn antelope (*Antilocapra americana*), collared peccary or javelina (*Tayassu tajacu*),mountain lion (*Felis concolor*), coati (*Nasua nasua*), and black bear (*Ursus americanus*). At least 14 species of bats occur on the installation, many of which are Arizona species of special concern.

Pronghorn were introduced by the Arizona Game Commission on the installation in 1949, and a population remains on the West Range. In addition, the Chihuahuan subspecies of pronghorn was introduced on the South Range of the installation beginning in 1987. Although this species formerly existed in southeastern Arizona, it was extirpated in the 1900s.

No native fish have been observed during brief electrofishing surveys conducted in Garden Canyon on Fort Huachuca in 1988 and 1995.

Rainbow trout are stocked for a "put and take" fishery each year in ponds on Fort Huachuca. Actual stocking numbers vary annually depending on the number of fish available from the hatchery, water conditions and funding.

3.9 FEDERALLY LISTED, PROPOSED, AND CANDIDATE SPECIES

The USFWS provided Fort Huachuca with a list of threatened, endangered, proposed, and candidate species known to occur or have occurred in Cochise County. The Fort removed a number of species from the county list that are not known to occur or have suitable habitat in the proposed project area, and developed the list of species that will be considered in this BA (Table

10). This list includes all of the federally listed, proposed and candidate species that have occurred or may have occurred historically, and those with potential habitat in the proposed project area. Although Fort Huachuca is not required by the ESA to consider candidate species, AR 200-3 requires the Army to consider candidate species in all action that may affect them. Hence, all candidate species with that may occur in the proposed project area have also been included in this BA, and the potential effects of the proposed action on these species are also considered.

The description, ecology, status, distribution and abundance of all federally listed, proposed and candidate species considered in the proposed action are discussed below. General locations of threatened and endangered species and critical habitat on Fort Huachuca or in the SPRNCA are shown in Figures 22 and 23.

3.9.1 COCHISE PINCUSHION CACTUS

Description

The Cochise pincushion cactus, *Coryphantha robbinsorum,* is a small unbranched cactus that is typically 5 cm or 2 in tall with few, if any, central spines (SFB 1996b). The 11 to 17 white radial spines are long and needle-like. In juvenile plant, there are 10 spines, more even in length, white, and densely covered with fine hairs. The flowers of this cactus are bell-shaped and pale yellow-green in color while the fruit is orange to red in color when ripe (SFB 1996b).

General Ecology

This cactus occurs in semi-desert grasslands associated with small shrubs, agave, other cacti, and grama grass. This cactus inhabits the cracks of limestone rocks found on hilltops (SFB 1996b).

Status and Date of Listing

The Cochise pincushion cactus was listed as a federally threatened species on 09 January 1989. The USFWS (1986) did not designate critical habitat for this species because of its restricted distribution, accessibility, and the potential threat of collection by cactus collectors. This plant is classified as “highly safeguarded” by the Arizona Native Plant Law of 1993.

Distribution and Abundance in the Region and at Fort Huachuca

The Cochise pincushion cactus occurs in the southeastern corner of Cochise County and in adjacent Sonora, Mexico (SFB 1996b). The Cochise pincushion cactus is not known nor likely to occur on Fort Huachuca or the SPRNCA due to lack of suitable habitat (Warren 1998).

TABLE 10 FEDERALLY LISTED, PROPOSED, AND CANDIDATE SPECIES AND THEIR OCCURRENCE AT FORT HUACHUCA AND THE SPRNCA

SPECIES	FEDERAL STATUS	OCCURRENCE FT HUACHUCA	SPRNCA
PLANTS			
Cochise pincushion cactus (*Coryphantha robbinsorum)*	threatened	3	6
Canelo Hills Ladies' tresses (*Spiranthes delitescens)*	endangered	3	5
Huachuca water umbel (*Lilaeopsis schaffneriana)*	endangered	1	4
Lemmon fleabane (*Erigeron lemmonii)*	candidate	1	6
INVERTEBRATES			
Huachuca springsnail (*Pyrgulopsis thompsoni)*	candidate	1	5
BIRDS			
Bald eagle (*Haliaeetus leucocephalus)*	threatened	1	4
Mexican spotted owl (*Strix occidentalis lucida)*	threatened	1	6
Southwestern willow flycatcher *Empidonax traillii extimus)*	endangered	3	4
Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum)*	endangered	3	5
Northern aplomado falcon (*Falco femoralis septentrionalis)*	endangered	2	5
Yellow-billed Cuckoo (*Coccyzus americanus*)	candidate	1	4
Mountain plover (*Charadrius montanus*)	proposed	2	5
Whooping crane (*Grus americana*)	endangered	3	6
MAMMALS			
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae)*	endangered	1	6
Jaguar (*Panthera onca)*	endangered	2	5
Ocelot (*Felis pardalis)*	endangered	3	5
Mexican gray wolf (*Canis lupus baileyi)*	endangered	2	5
Black-tailed prairie dog (*Cynomys ludovicianus*)	candidate	2	5
AMPHIBIANS			
Sonora tiger salamander (*Ambystoma tigrinum stebbinsi)*	endangered	1	6
Ramsey Canyon leopard frog (*Rana subaquavocalis)*	Conservation agreement	1	6
Chiricahua leopard frog (*Rana chiricahuensis)*	threatened	2	5
NM ridge-nosed rattlesnake (*Crotalus willardi obscurus*)	threatened	2	6
FISH			
Gila Topminnow (*Poeciliopsis occidentalis occidentalis)*	endangered	2	5
Desert pupfish (*Cyprinodon macularius*)	endangered	2	5
Loach Minnow (*Rhinichthys cobitis)*	threatened	3	5
Spikedace (*Meda fulgida)*	threatened	3	5
Razorback sucker (*Xyrauchen texanum)*	endangered	3	5
Gila Chub (*Gila intermedia*)	candidate	3	5

DEFINITIONS:

Federal status as defined by the USFWS under the ESA:

endangered: species which are in imminent jeopardy of extinction
threatened: species which are in imminent jeopardy of becoming endangered
candidate: species for which there is sufficient information to support a proposal for listing under the ESA (formerly known as category 1 candidates).
proposed: species which is proposed for federal listing under Section 4 of the ESA

Occurrence Status:

1. Species occurs on Fort Huachuca
2. Potential habitat present but species is not known to occur on Fort Huachuca
3. No potential habitat present and species is not known to occur on Fort Huachuca
4. Species occurs in SPRNCA
5. Potential habitat present, species may have occurred historically, by species is not known to occur in SPRNCA
6. No potential habitat present and species is not known to occur in SPRNCA

FIGURE 22 HUACHUCA WATER UMBEL AND CRITICAL HABITAT LOCATIONS IN THE SPRNCA

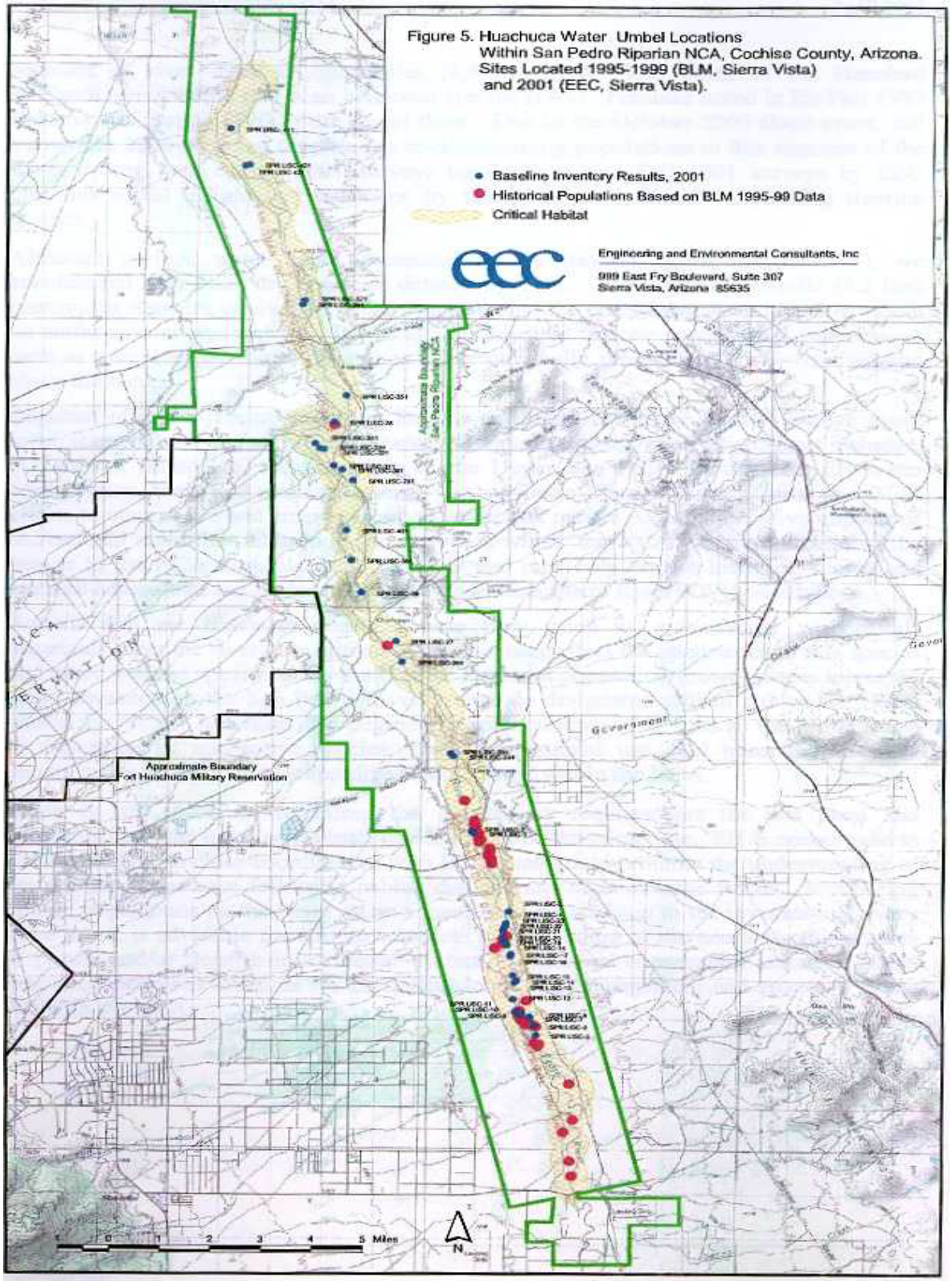
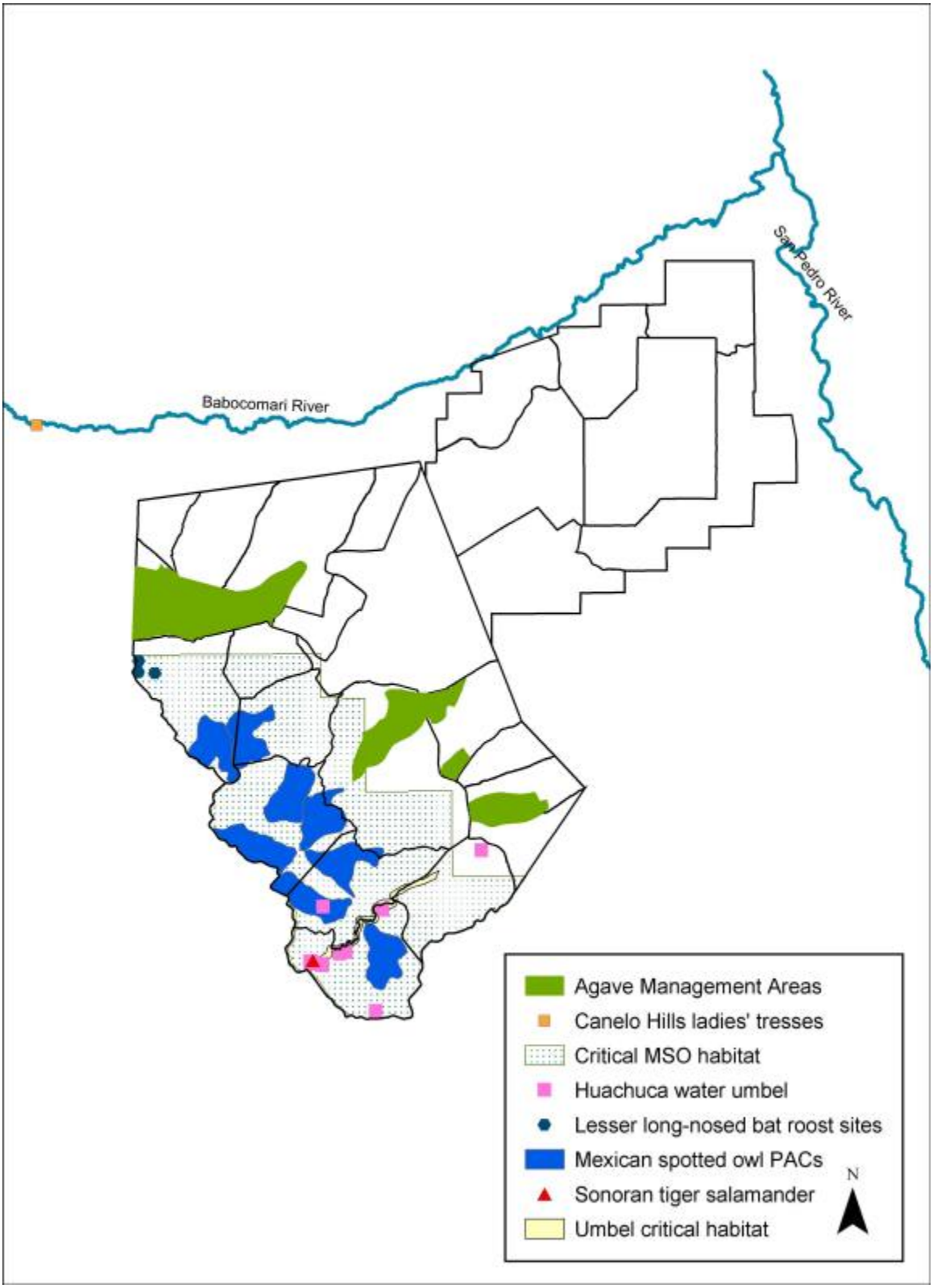


FIGURE 23 LOCATION OF LISTED AND SENSITIVE SPECIES ON FORT HUACHUCA AND THE BABOCOMARI RIVER



3.9.2 CANELO HILLS LADIES' TRESSES

Description

A herbaceous perennial, the Canelo Hill's ladies' tresses, *Spiranthes delitescens*, is a slender, erect terrestrial orchid with 5-10 grass-like leaves. The leaves grow, basally on stem, up to 18cm long and 1.5cm wide. Spiral inflorescence contains up to 40 white tubular flowers consisting of wide-spreading lateral sepals and linear petals with a pleated lip (Arizona Rare Plant Committee 2001). Flowering occurs in late July to early August when precipitation averages between 15-20 inches. Fruits mature three weeks after flowers form.

General Ecology

A cienega wetland orchid, the Canelo Hills ladies' tresses occurs in finely grained, highly organic soils that are seasonally or perennially saturated Orchids are intermixed with tall grasses and sedges and are found between an elevational range of 4,000-5,000 feet (1,220-1,525 m). Dominant associated plant species include Spanish needles (*Bidens* spp.), sedges (*Carex* spp.), rushes (*Juncus* spp.), spike rush (*Eleocharis* spp.), cattails (*Typha* spp.), and horsetail (*Equisetum* spp.), bluegrass (*Poa pratensis*), Johnson grass (*Sorghum halepense*), scratchgrass (*Muhlenbergia asperifolia*), aparejo grass (*Muhlenbergia utilis*). The Canelo Hill's ladies' tresses grow on slopes near water where the finely grained, highly organic soil is seasonally or perennially saturated but well drained. This plant is rarely found where scouring floods occur (USFWS 1997a). Orchid population numbers fluctuate between years, appear to thrive with properly managed livestock grazing, and may increase in response to prescribed burning (Arizona Rare Plant Committee 2001).

As with most terrestrial orchids, successful seedling establishment probably depends on the successful formation of endomycorrhizae (a symbiotic association between plant root tissue and fungi) (McClaran and Sundt 1992). The time needed for subterranean structures to produce aboveground growth is unknown. Plants may remain in a dormant, subterranean state or remain vegetative (non-flowering) for more than one consecutive year. Plants that flower one year can become dormant, vegetative, or reproductive the next year (McClaran and Sundt 1992, Newman 1991). The saprophytic/autotrophic state of orchid plants may be determined by climatic fluctuations and edaphic factors, such as pH, temperature and soil moisture (Sheviak 1990).

Status and Date of Listing

The Canelo Hills ladies' tresses (*Spiranthes delitescens*) was federally listed as endangered on 6 January 1997 (62 FR 3 1997) and is classified as "highly safeguarded" by the Arizona Native Plant Law of 1993. Critical habitat has not been designated for this plant species (USFWS 1997a). Threats to this species include groundwater pumping, water diversions, sand and gravel mining, recreational impacts, illegal collection, and invasion of cienega habitats by nonnative plant species, such as Johnsongrass and bermuda grass (USFWS 1997a). Limited numbers of populations and individuals threaten this taxon with demographic and environmental extinction as a result of stochastic events that are often exacerbated by habitat disturbance. For instance, the restriction of the species to a relatively small area in southeastern Arizona increases the chance

that as single environmental catastrophe, such as a severe tropical storm or drought could eliminate populations or cause extinction.

Distribution and Abundance in the Region and at Fort Huachuca

This species was first identified as, *Spiranthes graminea,* in 1968 by Martin from a specimen collected in Santa Cruz County, Arizona (USFWS 1997a). In 1990, Sheviak found distinct morphological and cytological characteristics among samples collected previously that had been named *S. graminea*, and named them *S. delitescens*. (USFWS 1997a).

This species is known from five sites at about 5,000 feet elevation in the San Pedro River watershed in Santa Cruz and Cochise counties, southern Arizona (Newman 1991; Mima Falk, CNF, pers. comm. 1996). The total amount of occupied habitat is less than 200 acres. Four of the populations are on private land less than 23 miles north of the US/Mexico border; one additional small site containing four individuals was discovered on public land in 1996 (Mima Falk, pers. comm. 1996). This site is located near a previously known population and may not be a distinct population. Potential habitat in Sonora, Mexico, has been surveyed but no *Spiranthes delitescens* populations have been found.

Estimating Canelo Hills ladies' tresses population size and stability is difficult because non-flowering plants are very hard to find in the dense herbaceous vegetation, and yearly counts underestimate the population because dormant plants are not counted. McClaran and Sundt (1992) monitored marked individuals in a Canelo Hills ladies' tresses population during two, three-year periods. They concluded that the subpopulations at both monitored sites were stable between 1987 and 1989, although Newman (1991) later reported that one monitored site was reduced to one non-flowering plant in 1991.

Four of the five populations of Canelo Hills ladies' tresses occur to the west of Fort Huachuca in the San Rafael Valley and Canelo Hills. TNC, USFS (CNF), and private landowners maintain management responsibility for these known populations (Arizona Rare Plant Committee 2001). The fifth population occurs on private land at the Babocomari Cienega, located approximately 1.5 miles north of the northwest corner of Fort Huachuca (Figure 23, page 104). This population was identified in 1981 but has not recently been surveyed. TNC has purchased two of the known sites and is monitoring the plants at one of the sites (AGFD 2000). Because the Babocomari River downstream of this population does not contain perennial, transitional wet meadows, it is not considered good potential habitat for this orchid. An informal survey was conducted in 1999 at the Sheehy Springs location (Santa Cruz River); 731 blooming plants were documented (AGFD 2000). Canelo Hills ladies' tresses are not known to occur on Fort Huachuca and no potential habitat for this plant is present on the Fort (Warren 1996).

3.9.3 HUACHUCA WATER UMBEL

Description

The Huachuca water umbel, *Lilaeopsis schaffneriana recurva*, sometimes referred to as the Cienga False-rush, is a herbaceous, semi-aquatic to aquatic perennial plant belonging to the

parsley family (USFWS 1997a). This plant can be confused with various members of the spikerush, *Eleocharis* genus, however, water umbel leaves curve slightly above water surface and are semi-succulent which distinguishes it from young or small spikerush. The Huachuca water umbel has bright yellow-green, cylindrical, hollow leaves with no pith, and typically borne 2 or 3 per node, having septa (thin partitions) at regular intervals (AGFD 1997). The flowers of this plant (3 to 10) are very small and are borne on an umbel shorter than the leaves and arising from the root nodes. The fruits are globose (1.5 to 2.0 mm or less than 1 in) and are usually slightly longer than they are wide (USFWS 1997a). The Huachuca water umbel sexually reproduces via flowering and also asexually from rhizomes (USFWS 1997a). The rhizomes of this plant are often submerged 5 to 40 cm (2 to 16 in) in sand, mud and/or silt, making it difficult to identify individual plants (Warren and Reichenbacher 1991b).

General Ecology

The Huachuca water umbel inhabits cienegas and associated vegetation within Sonoran desert-scrub (low elevation sites), grassland/oak woodland (mid-elevation sites), and coniferous forests (high elevation sites). This plant is found at elevations of 1210 to 1980 m (4,000 to 6,500 ft) and requires perennial water, gentle stream gradients, small to medium sized drainage areas and (apparently) mild winters. It is found in shaded and unshaded sites in shallow water, saturated soils near seeps, springs, and streams (AGFD 1997). The Huachuca water umbel has an opportunistic life-history strategy that ensures its survival in healthy riparian systems of cienegas, wetlands, and low gradient streams. In the upper portions of watersheds, where scouring floods generally do not occur, the Huachuca water umbel occurs when interspecific plant competition is low. It can be found in these sites along the periphery of the moist channels where plant density is low (USFWS 1997a). In stream and river habitats, this plant can occur in side channels and backwaters. Following a flood event, it can rapidly occupy the disturbed site and flourish until interspecific competition exceeds its tolerance (USFWS 1997a). This response was recorded at Sonoita Creek in August 1988, when a scouring flood removed about 95% of the Huachuca water umbel population (Gori *et. al.* 1990). One year later, the umbel had re-colonized the stream and was again co-dominant with watercress, *Rorippa nasturtium-aquaticum* (Warren *et. al.* 1991a). The expansion and contraction of Huachuca water umbel populations appears to depend on the presence of refugia where the species can escape the effects of scouring floods, a watershed that has an unaltered hydrograph, and a healthy riparian community that stabilizes the channel. It appears that this species is best adapted to periodic, low-intensity disturbances (Warren *et. al.* 1991a).

Density of umbel plants and size of populations fluctuate in response to both flood cycles and site characteristics. Some sites, such as Black Draw, have a few sparsely distributed clones, possibly due to the dense shade of the even-aged overstory of trees, dense nonnative herbaceous layer beneath the canopy, and deeply entrenched channel. The Sonoita Creek population occupies 14.5% of a 5,385 square foot patch of habitat (Gori *et. al.* 1990). Some populations are as small as 11-22 square feet. The Scotia Canyon population, by contrast, has dense mats of leaves. Scotia Canyon contains one of the larger Huachuca water umbel populations, where in 1995 it occupied about 64% of a 1,420 m (4,660 foot) reach.

While the extent of occupied habitat can be estimated, the number of individuals in each population is difficult to determine because of the intermeshing nature of the creeping rhizomes and the predominantly asexual mode of reproduction. A population of Huachuca water umbel may be composed of one or many genetically distinct individuals.

Status and Date of Listing

The Huachuca water umbel, *Lilaeopsis schaffneriana recurva,* was listed as a federally endangered plant on 6 January 1997 (62 FR 3, 1997), is classified as "highly safeguarded" by the Arizona Native Plant Law of 1993, and is also listed as a Sensitive Species by the USFS, Region 3 (USFS 2000). A total of 83.9 km (139.8 miles) of streams or rivers in Cochise and Santa Cruz counties, Arizona, was designated as critical habitat, including 6.1km (3.8 miles) within the Garden Canyon watershed on Fort Huachuca and 53.9 km (33.7 miles) within the upper San Pedro floodplain, on July 12, 1999 (65FR132, 1999).

This subspecies was first identified as *Lilaeopsis recurva* in 1881 by A.W. Hill from a type specimen found near Tucson, Arizona. In 1985, J.M. Affolter applied the name *L. schaffneriana* ssp. *recurva* to plants found in Arizona while plants from Mexico and northern South America were referred to as *L.s*. ssp. *schaffneriana*.

The primary threat to this species is alteration of ground and surface water flows, which may degrade or destroy wetland habitat (USFWS 1997a). In addition, wildfires are of concern because of increased erosion, reduced water infiltration, and other negative impacts that can occur after a fire (Rinne and Neary 1996). An additional dispersal opportunity occurs as a result of the dislodging of clumps of plants which then may reroot in a different site along aquatic systems.

Distribution and Abundance in the Region and at Fort Huachuca

The Huachuca water umbel has been documented from 28 sites in Santa Cruz, Cochise, and Pima counties, Arizona and in adjacent Sonora, Mexico (EEC 2001a). These sites occur in four major watersheds: the San Pedro River, Santa Cruz River, Rio Yaqui, and Rio Sonora (USFWS 1997a). Prior to 1988, this plant was known from only seven locations in southern Arizona (Warren and Reichenbacher 1991b).

At and in the vicinity of Fort Huachuca, extant *Lilaeopsis* populations occur on the San Pedro River on lands managed by the BLM, in canyons of the Huachuca Mountains on the Fort, and on lands managed by the CNF or owned by private individuals. The Huachuca water umbel also occurs off-post on the west slope of the Huachuca Mountains in Scotia and Sunnyside canyons, and in Bear Canyon and its tributaries. Populations in upper Scotia Canyon are located within one mile of the western boundary (Gate 7) of Fort Huachuca.

Two extirpated populations in the upper San Pedro watershed occurred at Zinn Pond in St. David and the San Pedro River near St. David.

There are eight populations of this subspecies on Fort Huachuca in Garden, Sawmill, and McClure Canyons within the South Range of the installation (Figure 23, page 104) (EEC 2000 2001b). It is not known how long these populations have existed in these locations, however, water umbel have been documented in Garden Canyon since 1958 and in Sawmill Canyon since 1979 (EEC 2000 2001b). Warren and Reichenbacher (1991b) surveyed Fort Huachuca for rare plant species from June to September 1989, and located Huachuca water umbel in upper Garden Canyon and at Sawmill Spring. Microhabitats where the plants were found were low-gradient cienega habitats with apparently permanent water and stable, non-eroded channels. The population in McClure Canyon was documented in 1997 (Hessil 1998). Since 2000, annual monitoring efforts have taken place on the Fort in these three watershed zones and an installation inventory of potential habitat was completed in 1999 with a second inventory scheduled to be completed in during the fall survey season in 2002.

Erosion and stability of perennial water systems are the primary management factors of concern for this species. In addition, wildfires are of concern because of increased erosion, reduced water infiltration, and other negative impacts that can occur after a fire (Rinne and Neary 1996). Excessive rates of erosion and disturbance near a site from wildfires, recreationalists, or road construction could increase the chance of a flash flood that could scour a population. Likewise, the reduction or diversion of water could eliminate a site (AGFD 1997).

Overgrazing, mining, hay harvesting, timber harvest, fire suppression, and other activities in the nineteenth century led to widespread erosion and channel entrenchment in southeastern Arizona streams and cienegas when above-average precipitation and flooding occurred in the late 1800's (Bahre 1991, Bryan 1925, Dobyns 1981, Hastings and Turner 1980, Hendrickson and Minckley 1984, Martin 1975, Sheridan 1986, Webb and Betancourt 1992). A major earthquake near Batepito, Sonora in 1887, approximately 40 miles south of the upper San Pedro Valley, resulted in land fissures, changes in groundwater elevation and spring flow, and may have preconditioned the San Pedro River channel for rapid flood-induced entrenchment (Hereford 1993, Geraghty and Miller, Inc. 1995). These events, along with increased precipitation and a major flood event (September 1926) contributed to long-term or permanent degradation and loss of cienega and riparian habitat on the San Pedro River and throughout southern Arizona and northern Mexico. Much of the habitat of the Huachuca water umbel and other cienega-dependent species was presumably lost at that time.

Wetland degradation and loss continues today. Human activities such as groundwater overdrafts, surface water diversions, impoundment, channelization, improper livestock grazing, chaining, agriculture, mining, sand and gravel operations, road building, nonnative species introductions, urbanization, wood cutting, and recreation all contribute to riparian and cienega habitat loss and degradation in southern Arizona. The local and regional effects of these activities are expected to increase with the increasing human population.

Dredging extirpated the Huachuca water umbel from House Pond, near the extant population in Black Draw (Warren *et. al.* 1991a). The umbel population at Zinn Pond in St. David near the San Pedro River was probably lost when the pond was dredged and deepened. This population was last documented in 1953 (Warren *et. al.* 1991a).

Livestock grazing can affect the umbel through trampling and changes in stream hydrology and loss of stream bank stability. However, existence of the umbel appears to be compatible with well-managed livestock grazing (USFWS 1997a). In overgrazed areas, stream headcutting can threaten cienegas where the umbel occurs. Such headcutting occurs at Black Draw just south of the international boundary and at Los Fresnos, in the San Rafael Valley, Sonora. Groundwater pumping has eliminated habitat in the Santa Cruz River north of Tubac, and threatens habitat in the San Pedro River. Severe recreational impacts in unmanaged areas can compact soils, destabilize stream banks, and decrease riparian plant density, including densities of the Huachuca water umbel. Populations in Bear Canyon in the Huachuca Mountains have been impacted by trampling and off-highway vehicles.

A suite of nonnative plant species has invaded wetland habitats in southern Arizona (Stromberg and Chew 1997), including those occupied by the Huachuca water umbel (ADWR 1994). In some cases, their effect on the umbel is unclear. However, in certain microsites, the nonnative Bermuda grass, *Cynodon dactylon*, may directly compete with the umbel. Bermuda grass forms a thick sod in which many native plants are unable to establish. Watercress is another nonnative plant now abundant along perennial streams in Arizona. It is successful in disturbed areas and can form dense monocultures that can out-compete Huachuca water umbel populations.

Limited numbers of populations and the small size of populations make the Huachuca water umbel vulnerable to extinction because of stochastic events that are often exacerbated by habitat disturbance. For instance the restriction of this taxon to a relatively small area in southeastern Arizona and adjacent Sonora increases the chance that a single environmental catastrophe, such as a severe tropical storm or drought, could eliminate populations or cause extinction.

Populations are in most cases isolated, as well, which makes the chance of natural recolonization after extirpation less likely. Small populations are also subject to demographic and genetic stochastically, which increases the probability of population extirpation (Shafer 1990, Wilcox and Murphy 1985).

San Pedro River Localities of the Huachuca Water Umbel

The upper San Pedro River is characterized by a relatively broad floodplain that meanders through the San Pedro River Valley. The riparian zone consists of cottonwood-willow and herbaceous associations near the river channel, to mesquite bosque on the higher terraces. Pond and marshland communities, saltcedar, *Tamarix chinensis*, four-wing saltbush, *Atriplex canescens*, and sacaton, *Sporobolus* spp., associations also exist in the riparian zone of the river. The upper San Pedro River is perennial from approximately Hereford to about four miles north of the Charleston Stream Gage. The Babocomari River, which drains portions of the Mustang, Huachuca, and Whetstone Mountains, and the Canelo Hills, is the largest tributary and enters the San Pedro River just south of Fairbank. O'Donnell Creek, Ramsey Canyon, and Miller Canyon are other important tributaries (ASL 1994).

The SPRNCA was designated in 1988 as part of the Arizona-Idaho Conservation Act. The SPRNCA, which is managed by the BLM, includes roughly 57,000 acres in a strip approximately 36 miles long and 2.6 miles wide that runs from the international boundary north

to about 3 miles south of St. David (but there is an approximate two mile gap in the SPRNCA just north of Palominas and a section just north of Lewis Springs.) The purposes of the SPRNCA as defined in the legislation are to conserve, protect, and enhance the riparian area and the aquatic, wildlife, archeological, paleontological, scientific, cultural, educational, and recreational resources of the area. The legislation established a Federal reserve water right adequate to fulfill the purposes of the SPRNCA. The riparian corridor through the SPRNCA is one of the most extensive, contiguous reaches of cottonwood-willow gallery forests in the southwestern United States (BLM 1998).

The Huachuca water umbel was located in the SPRNCA in 1994. Mark Fredlake (BLM, Sierra Vista, AZ), Peter Warren and Dave Gori (TNC, Tucson, AZ) located 43 patches of Huachuca water umbel during 1995 and 1996. Haas and Frye (1997) identified eight additional patches in 1997. These patches were found in six disjunct areas, including approximately 2 miles downstream of Fairbank, near Brunchow Hill upstream of Charleston, in the river at Lewis Springs, approximately one mile north and south of Highway 90, approximately 2.5 miles downstream of Highway 90, and from Hereford Bridge north for approximately 1 mile. Haas and Frye (1997) also documented the species on the San Pedro River approximately 0.5 mile south of the international boundary. Joanne Kirchner and Karen Blumenthal (EEC 2001b), under contract by the Fort, inventoried 51.0 km (31.7miles) of the 53.9 km (33.7 miles) of the designated critical habitat within the SPRNCA. Kirchner and Blumenthal identified 43 populations during the inventory (Figure 22, page 103). Of these 43 populations, 17 appear to be new locations when compared with BLM records dated 1995-1999.

The umbel is sensitive to flooding and populations may disappear while others become established during and after severe flood events. In 1999, Fredlake documented the absence of Huachuca water umbel in an historical site north of the Hereford Bridge/river crossing. In October 2000, a major flooding event occurred which restricted access to the River to conduct surveys. Fredlake re-documented this population during spring 2001 surveys. Additionally, Kirchner and Blumenthal documented this population during fall 2001 inventory. After the October flood in 2000, it appears that water umbel colonized downstream of the historically most densely populated areas within the SPRNCA, demonstrating persistence by this plant in a natural functioning riverine system (EEC 2001b). Two patches of Huachuca water umbel on the San Pedro River were lost during a winter flood in 1994 and had not recolonized that area as of May of 1995, demonstrating the dynamic and often precarious nature of occurrences within a riparian system (Al Anderson, Grey Hawk Ranch, *in lit.* 1995). However, after high flows in 1996, no apparent loss or reduction in approximately 12 Huachuca water umbel patches was noted by Dr. Peter Warren (TNC, Tucson, pers. comm. 1997). The entire SPRNCA is considered potential habitat for the Huachuca water umbel. It is the largest contiguous potential habitat of the umbel, and as such is considered the most important site for recovery.

Comparison of current conditions with accounts of explorers and others who visited the San Pedro River more than a century ago suggest that cienegas and wetlands have largely disappeared or has been replaced by riparian woodlands. When Padre Kino visited the San Pedro River in the late 1600's, he encountered an unincised marshy river where the native Sobaipuris people were living and irrigating several types of crops with water diverted from the river through canals (Kino 1919, Hendrickson and Minckley 1984). The Sobaipuris vacated the area

after intense raiding by Apaches in 1762, leaving the valley to sporadic cattle operations run by Mexicans. The riverbottom was heavily stocked by cattle in the early part of the 1800's, but ranches were abandoned due to Apache raids. Wild livestock left behind by the ranchers were abundant when explorers visited the San Pedro in the mid-1800s, but despite this grazing, the river in 1846 was described as a "marshy bottom with plenty of grass and water" (Cooke 1938), and was characterized by tall grasses that were difficult to pass through (Evans 1945, Cooke 1938). Boggy banks and swampy conditions were described by Eccleston (1950). Cottonwoods, willows, and other riparian trees were present (Leach 1858, Parke 1857), but most descriptions suggest they were less evident than today, and that cienega conditions prevailed (Hendrickson and Minckley 1984). This characterization is however, contrary to some descriptions from the period indicating the river was incised near St. David and Benson (Parke 1857, Bartlett 1854). Hendrickson and Minckley (1984) suggest entrenchment was local and discontinuous in the mid 1800's. The marshy, cienega conditions encountered by explorers in the 1800's were likely ideal habitats for the Huachuca water umbel.

A series of large floods resulted in channel entrenchment between 1880 and 1908 (Hereford 1993), and possibly as late as 1926 (Jackson *et. al.* 1987). Flooding and downcutting left the river channel 3-30 feet below the former floodplain (Hereford 1993), which would have left most of the marshy bottomlands, and the habitat of the water umbel, high and dry. Completion of two cross-continental railways across Arizona in the 1880's, military conquest of the Chiricahua Apaches, and discovery of extensive silver deposits near Tombstone in the late 1870's spurred a boom in the mining and livestock industries and facilitated settlement and development of the area (Rogers 1965). Watershed degradation caused by extensive mining, wood cutting, and heavy grazing exacerbated the effects of unusually heavy rainfall, resulting in entrenchment of the river channel and loss of cienega habitats (Hereford 1993, ADWR 1994, Jackson *et. al.* 1987, Geraghty and Miller, Inc. 1995). Other factors that affected the distribution and abundance of cienega conditions on the San Pedro River include elimination of beavers and a major earthquake (San Pedro Expert Study Team 1999, DuBois and Smith 1980, Geraghty and Miller, Inc. 1995). Through construction of dams, beaver, *Castor canadensis*, probably contributed to the abundance of marshy, boggy conditions on the San Pedro River observed by explorers prior to entrenchment. However, because of overharvest, beaver were eliminated from the upper San Pedro, possibly near the turn of the century (Fredlake 1996). Following a major earthquake in 1887, the epicenter of which was located approximately 40 miles south of the upper San Pedro Valley, cienegas near St. David dried up, while in other areas artesian flows developed. The earthquake may have contributed to conditions that lead to channel entrenchment (Geraghty and Miller, Inc. 1995, Hereford 1993). With resulting loss of cienega conditions, the Huachuca water umbel probably became extremely limited in distribution or disappeared from the San Pedro River at this time. It was collected from the San Pedro River in 1958 (Warren *et. al.* 1989), which may have represented a remnant population.

Since entrenchment during 1880-1926, the river channel has widened substantially, peak flows have declined, sinuosity of the channel has increased, and riparian woodlands have developed on the floodplains (Hereford 1993). Hereford (1993) suggests that "increased sinuosity produced a reservoir effect that attenuated flood waves, and the development of floodplains enabled flood waters to spread laterally, thereby increasing transmission losses". Improvements in watershed

condition and resulting increased infiltration and reduced runoff may have also contributed to reduced peak flows.

Few direct human impacts to umbel habitat in the San Pedro River have occurred since establishment of the SPRNCA. However, recreation and associated impacts are becoming increasingly evident. Approximately 13 fires have burned within the SPRNCA since its acquisition by BLM. In 1998, 780 acres of riparian woodlands and grasslands were destroyed. Another fire, apparently caused by a downed power line, burned approximately 800 acres in the SPRNCA in March 1999. In May 2000, approximately 375 acres of habitat burned near Highway 90 bridge to Lewis Springs. The cause of the fires is unknown, but recreational activities are likely to increase the incidence of fire in the future. Recreation may be adversely affecting the umbel through trampling and bank erosion in some areas, particularly at the Highway 90 locality. Removal of most livestock after establishment of the SPRNCA stimulated a recovery of riparian and wetland plant communities. Trespass cattle along the river were causing localized trampling of water umbel sites near the Highway 90 crossing in 1997, and continue to be a problem in some areas of the SPRNCA, but the BLM has stepped up efforts to control trespass cattle. The immediate watershed of the upper San Pedro River continues to be degraded to some extent by livestock grazing. Disturbance of soils and cryptobiotic crusts, and removal of vegetation in the watershed by grazing combine to increase surface runoff and sediment transport, and decrease infiltration of precipitation (Belsky and Blumenthal 1997, Busby and Gifford 1981, DeBano and Schmidt 1989, Belnap 1992, Gifford and Hawkins 1978, Blackburn 1984). Degraded watershed condition due to grazing is particularly evident along Highway 90 north of Huachuca City where grasses have been largely eliminated. Between 1974 and 1987, grassland communities in the USPB decreased in cover by 35% (EPA 1997) and have been replaced by desert scrub communities.

As mentioned above, the beaver was eliminated from the upper San Pedro River basin probably circa 1900. In 1999, The BLM and AGFD reintroduced several beavers into the SPRNCA between the Hereford Bridge and the Highway 90 bridge. The effects of reintroducing beaver into the river system were the subjects of formal Section 7 consultation between the USFWS and BLM. In the BO, the Service found that proposed reintroduction would not jeopardize the continued existence of the Huachuca water umbel. Beaver could facilitate reestablishment of cienega conditions through construction of dams and ponding of water. Effects on existing individual plants or populations of plants cannot be determined and would depend on the location and extent of beaver activity and the level of success of the beaver reintroduction program.

The greatest threat to umbel habitat on the San Pedro River is continued groundwater pumping in excess of recharge, which has the potential to lower groundwater elevation under portions of the river, eliminate base flows, and result in desiccation of the riparian and wetland vegetation communities (BLM 1998, Stromberg *et. al.* 1996, ADWR 1994.) The hydrology of the USPB and associated topics has been studied by numerous investigators, particularly in the last decade (as discussed previously in this section). Much of the recent work has been driven by a water rights adjudication in the Gila River basin, which includes the upper San Pedro River; and concerns that groundwater pumping in the Sierra Vista subwatershed may result in declining groundwater elevations and loss of baseflow and riparian values along the San Pedro River.

3.9.4 LEMMON FLEABANE

Description

Lemmon fleabane, *Erigeron lemmonii,* is a small, flowering, prostrate perennial belonging to the sunflower family found in dense clumps on vertical cliffs (Warren *et. al.* 1991c). This plant has stems spreading 10 to 20 cm (4 to 8 in) in length. The stems and leaves are covered with long, non-glandular hairs (0.4 to 0.6 mm long or 0.02 in). Flowers are daisy-like in appearance with white or light-purple outer petals and yellow inner petals at the end of leafy branches (Warren *et. al.* 1991c). *Erigeron lemmonii* is distinguished from other *Erigeron* species by its characteristic prostrate growth habit (low, ground-level), its perennial nature, and its affinity for growing on vertical cliffs.

General Ecology

This plant grows in dense clumps (up to 0.5 m or 20 in diameter) within crevices, ledges, and boulders of rugged peaks and vertical, quartzite cliffs of the Huachuca Mountains (Warren *et. al.* 1991c). Because of the inaccessible nature of the Lemmon fleabane, very little is known about the ecology or population biology of this species (Warren and Reichenbacher 1991b).

Status and Date of Listing

Lemmon fleabane is a candidate for federal listing (FR 45:242, 1980), a USFS sensitive plant, and a "highly safeguarded" species under the Arizona Native Plant Law of 1993. It is an extremely rare species known from only a single location in southeastern Arizona, on Fort Huachuca.

Low-intensity monitoring of the population has been recommended for this species (Warren and Reichenbacher 1991).

Distribution and Abundance in the Region and at Fort Huachuca

Historically Lemmon fleabane range was thought to include a wider area of Arizona. However, recent taxonomic analysis has indicated that Lemmon fleabane is endemic only to Scheelite Canyon of the South Range of Fort Huachuca in the Huachuca Mountains (Warren *et. al.* 1991c). Surveys in 1991 for the Lemmon fleabane located 441 individual plants in Scheelite Canyon on two separate cliff faces between 1,920 and 2,012m (6,300 and 6,600 ft) in elevation. While no plants were found outside of Scheelite Canyon in surveys conducted in 1997, potential habitat may occur in other areas within Fort Huachuca (Warren *et. al.* 1991c; Tandy 1997).

Unlike many other plant species, Lemmon fleabane may not be susceptible to human disturbance due to its relatively inaccessible cliff habitat. Potential threats to its continued success may include extended drought, falling rocks, and illegal rock climbing (Warren *et. al.* 1991c).

3.9.5 HUACHUCA SPRINGSNAIL

Description

The Huachuca springsnail, *Pyrgulopsis thompsoni,* is a small 0.05 to 0.15 inch invertebrate mollusk belonging to the class Gastropoda. The shell of this snail is conical in shape with three to five convex whorls on the shell. However, species identification must be accomplished by examining characteristics of the reproductive organ.

General Ecology

This species occupies the shallow areas of cienegas, often at the rocky seep of a springs source, between 4,500 to 7,200 feet in elevation. These springs contain vegetation, have a slow to moderate flow, with firm substrates such as roots, wood, and rocks. Springs and cienegas inhabited by the snail are typically marshy areas with various aquatic and emergent plant species that occur within plains grassland, oak and pine-oak woodlands, and coniferous forest vegetation communities. Populations are locally abundant, but habitat within cienegas is typically very limited.

Status and Date of Listing

The Huachuca springsnail was listed as a candidate species for federal listing in February 1996. Arizona has no state protection status for this snail.

Management concerns and threats to the species are related to habitat destruction by residential development, water diversions, spring development, recreational use, timber harvesting, altered fire regimes and livestock grazing (USFWS 1995f).

Distribution and Abundance in the Region and at Fort Huachuca

The springsnail is found in springs of southern Santa Cruz and Cochise counties as well as northern Sonora, Mexico. It has been collected from nine sites in the upper San Pedro River drainage (Huachuca Mountains, Canelo Hills, and San Rafael Valley) and four sites in the upper Santa Cruz River drainage (Sonoita Creek drainage, San Rafael Valley, Santa Cruz River drainage). In 1992, 16 areas with potential habitat were surveyed and nine populations were located within the higher elevations of Fort Huachuca in Garden, Sawmill, McClure, Huachuca and Blacktail Canyons (USFWS 1997; AGFD 1993). Potential habitat for the snail on Fort Huachuca exists in the limited aquatic areas of cienegas with a spring source (USFWS 1997).

3.9.6 BALD EAGLE

Description

The bald eagle, *Haliaeetus leucocephalus,* is a large raptor with a wingspan of 1.78 to 2.29 m (5.8 to 7.5 ft; NGS 1987). Females are typically larger than males. It has a large, brownish black body with snowy white head and tail and bright yellow bill, feet, and eye (Brown and Amadon

1989). Immature bald eagles can easily be distinguished from the golden eagle, *Aquila chrysaetos*, by the large head, heavier bill, and unfeathered yellow legs (Brown and Amadon 1989).

General Ecology

The bald eagle inhabits estuaries, large lakes, reservoirs, major rivers, and some seacoast habitats. While this eagle breeds throughout most of North America, sizable breeding populations occur near sparsely human populated coasts, rivers and large lakes. Bald eagles generally nest in forest stands near water that contain a mixture of tall, old, and dead and dying trees. Nest trees must be structurally suitable to hold a large stick nest.

Eagles feed primarily on fish and waterbirds, but also on small mammals and mammal carcasses. In addition to food, another important component of eagle winter ecology is the availability of roosting habitat. Roosting habitat consists of trees that extend above the forest canopy and provides a protected microclimate for resting eagles (Stalmaster 1987). Some eagle populations are migratory where as others remain near their breeding areas year round. During the autumn and winter months large concentrations of eagles can be found where food sources are abundant (Stalmaster 1987).

Status and Date of Listing

Previously listed as federally endangered in most states, the bald eagle was reclassified as threatened, 11 August 1995 (64 FR 36454), because of significant increases in the number of breeding pairs. There is an approved Recovery Plan for the Southwest Recovery Region. No critical habitat has been designated for this species. AGFD has designated this species a Wildlife of Special Concern. Primary threats today include illegal shooting and disturbance and/or loss of habitat.

Distribution and Abundance in the Region and at Fort Huachuca

While the bald eagle declined in recent decades from historic distributions, it is still found throughout North America into Aleutian Islands and Greenland (Brown and Amadon 1989). In Arizona, nesting populations are found only along the Colorado, Salt, and Verde Rivers in the northern and central portions of the state, and one nest just upstream of the San Pedro / Gila River confluence (Beatty 1997b). Regional bald eagle populations are now repopulating areas throughout much of the species historic range. In 2002, 46 breeding areas were identified in Arizona including the reoccupied historical Needle Rock Breeding Area (AGFD 2002). The bald eagle does not nest in southern Arizona, and is generally not present during summer months. Wintering areas include the Colorado River and various reservoirs in northern and central Arizona. Approximately 200 to 300 birds winter in Arizona. Consistent wintering areas have not been documented in southeastern Arizona during statewide, yearly winter surveys (Beatty 1997b). However, in southeastern Arizona, the species is known to winter in the Sulphur Springs Valley and have been observed at Parker Canyon Lake. Although transient bald eagles have occasionally been recorded along the San Pedro River, since winter surveys were initiated in 1993, only 12 bald eagles have been recorded in this area (Beatty 1997b). While no official

winter surveys have been conducted on the Fort, a bald eagle was observed flying over the West Range in February 1998. However, suitable nesting habitat or habitat for congregations of wintering birds does not exist on Fort Huachuca. Small numbers of eagles may winter intermittently in large cottonwood or sycamore trees in the San Pedro NCA adjacent to Fort Huachuca (Beatty 1997a).

3.9.7 MEXICAN SPOTTED OWL

Description

The Mexican spotted owl, *Strix occidentalis lucida* is a medium-sized owl that averages 16-19 inches long, weighs between 19.5-23 ounces, and is among the largest of owls that inhabit North America. The Mexican spotted owl is mottled in appearance with irregular white and brown spots on its abdomen, back, and head. Mexican spotted owls typically have larger and more numerous spots than the other two subspecies *S.o. occidentalis* (Northern) and *S.o. caurina* (California), and this gives it an overall lighter appearance. Several thin white bands mark an otherwise brown tail. These morphological characteristics also distinguish Mexican spotted owl from the similar barred owl, *Strix varia,* which has streaks of white on a brown body. Unlike most owls, all spotted owl subspecies have dark eyes (USFWS 1995c). The female Mexican spotted owl is generally larger than the male; however, adult male and female Mexican spotted owls are identical in plumage characteristics. The sexes are often distinguished by voice. Spotted owls vocalize using a variety of hoots, “barks”, and whistles depending on the situation. Females often vocalize using a clear whistle as well as a series of sharp barks while males have a deeper voice and vocalize using a series of four unevenly spaced hoots to announce occupancy and delivery of prey to the female as well as in territorial disputes (USFWS 1995c, Gutierrez *et al*, 1995). Juveniles can be distinguished from adults and subadults by plumage characteristics.

The Mexican spotted owl is distinguished from the California and Northern subspecies chiefly by geographic distribution and plumage. The Mexican spotted owl has the largest geographic range of the three subspecies. The range extends from the southern Rocky Mountains in Colorado and the Colorado Plateau in southern Utah southward through Arizona and New Mexico and, discontinuously through the Sierra Madre Occidental and Oriental to the mountains at the southern end of the Mexican Plateau.

Using starch-gel electrophoresis to examine genetic variability among the three subspecies of spotted owls, Barrowclough and Gutierrez (1990) found the Mexican spotted owl to be distinguishable from the other two subspecies by a significant variation, which suggests prolonged geographic isolation of the Mexican subspecies and indicates that the Mexican spotted owl may represent a species distinct from the California and Northern spotted owls.

General Ecology

The habitat characteristics of Mexican spotted owl nesting and roosting sites generally consist of multi-layered, uneven-aged forests with high canopy closure or rocky, shaded canyons (USFWS 1995c). In the Huachuca Mountains, many spotted owl nest sites were described as Madrean

pine-oak woodland with montane conifer species and some broadleaf riparian component (Duncan 1991). Cliffs are present at some sites and used for nesting.

Within the Basin and Range-West Recover Unit (RU), spotted owls have been located in rocky canyons or in several forest types at elevations ranging from 3,690 to 9,610 feet. Below 4,264 feet, spotted owls were found in steep canyons containing cliffs and stands of live oak, Mexican pine, and broad-leaved riparian vegetation (Ganey and Balda 1989). Above 5,904 feet, spotted owls were found in mixed conifer and pine-oak forests. Mid-elevation observations included sites with Arizona cypress and the other forest types previously mentioned (USFWS 1995c).

Little is known about the reproductive output for the spotted owl. It varies both spatially and temporally (White *et. al.* 1995), but the subspecies demonstrates an average annual rate of 1.001 young per pair. There is inadequate data at this time to estimate population trend. Little confidence in initial estimates has been expressed, and is due to its reliance on juvenile survival rates which are believed to be biased low, and due to the insufficient time period over which studies have been conducted.

Status and Date of Listing

The Mexican spotted owl, *Strix occidentalis lucida*, was listed as a federally threatened species on 16 March 1993 (58 FR 14248) and is designated by AGFD as a Wildlife Species of Concern in Arizona. On 18 January 2001, USFWS designated 4.6 million acres on Federal lands in four southwestern states as critical habitat for this species. The designation includes 830,000 acres in Arizona, 525,000 acres in Colorado, 54,000 acres in New Mexico, and 3.2 million acres in Utah (50 CFR 17). No private, state, or tribal lands are included in this designation. Of this federally designated critical habitat in Arizona, 21,996 acres occur on Fort Huachuca.

The Mexican spotted owl was originally described from a specimen collected at Mount Tancitaro, Michoacan, Mexico, and named *Syrnium occidentale lucidum*. The spotted owl was later assigned to the genus *Strix* and specific and subspecific names were changed to conform to taxonomic standards. The Mexican spotted owl subspecies was named *S.o.lucida*.

Historic and continued loss and modification of habitat were the primary reasons for listing this subspecies as threatened. USFWS cited recreational developments in riparian habitat along with the USFS managed timber harvest regime as main contributors to habitat loss and modification.

Distribution and Abundance in the Region and at Fort Huachuca

The current known range of the Mexican spotted owl extends north from Aguascalientes, Mexico through the mountains of Arizona, New Mexico, and western Texas, to the canyons of southern Utah and southwestern Colorado, and the Front Range of central Colorado. Although this range covers a broad area of the southwestern United States and Mexico, much remains unknown about the species' distribution within this range. This is especially true in Mexico where much of the owl's range has not been surveyed. Information gaps also appear for the species' distribution within the United States. It is apparent that the owl occupies a fragmented distribution

throughout its United States range corresponding to the availability of forested mountains and canyons, and in some cases, rocky canyon lands.

Federal agencies overseeing lands supporting owls in the USFS, BLM, NPS, DoD, and BOR. According to the 1995 Recovery Plan, 91% of owls known to exist in the United States between 1990 and 1993 occur on land administered by the USFS (USFWS 1995c). Although the revised Recovery Plan is not yet available for review, the USFS is still the primary land manager for lands that support owls. The majority of known owls have been found within Region 3 of the USFS, which includes six national forests in Arizona, five national forests and a national grassland in New Mexico. USFS Regions 2 and 4, including two national forests in Colorado and three in Utah, support fewer owls.

The range of the Mexican spotted owl in the United States has been divided into six recovery units (RUs) as discussed (part II.B.) of the Recovery Plan for the Mexican Spotted Owl (USFWS 1995c). An additional five RUs were designated in Mexico. While the Recovery Plan provides distribution, abundance, and density estimates by RU, a reliable estimate of the numbers of owls throughout its entire range is not currently available due limited information. Owl surveys conducted from 1990 through 1993 indicate that the species persists in most locations reported prior to 1989, with the exception of riparian habitats in the lowlands of Arizona and New Mexico, and all previously occupied areas in the southern states of Mexico. Increased survey efforts have resulted in additional sightings for all RUs.

The Huachuca Mountains are included in the Basin and Range -West RU, which is characterized by mountain ranges isolated by desert basins. This RU along with the Upper Gila Mountains and the Basin and Range - East RUs are believed to be important habitat because of the high number of spotted owls relative to the other RUs (USFWS 1995c).

Fort Huachuca lies within the Basin and Range-West RU, as described in the Recovery Plan. This RU includes most of southern Arizona and a small portion of southwestern New Mexico. Owl territories occur in both heavily forested terrain and in areas with hardwood and conifer stringers dominated by Madrean Evergreen woodland. The subpopulation occurs in widely distributed territory clusters of varying sizes. The Sky Island Division (includes the Huachuca Mountains) may represent an important demographic link between the Mogollon Province demes and those in the Sierra Madre Occidental. Demographic persistence and connectivity within the Division and between divisions may be hindered by the compounding factors of naturally disjunct habitat and long dispersal distances.

Fletcher (1990) calculated that 2,074 owls existed in Arizona and New Mexico in 1990 using information gathered by Region 3 of the USFS. Fletcher's calculations were modified by McDonald *et. al.* (1991), who estimated that there were 2,160 owls in the United States. Ganey (1998) estimates 600-1,200 Mexican spotted owls inhabit Arizona. However, these numbers are not reliable estimates of current population size for a variety of statistical reasons. While the number of owls throughout its range is currently not available, the Recovery Plan reports an estimate of owl sites based on 1990 - 1993 data. Due to limited human and financial resources, population estimates are still based on information provided in the Recovery Plan. An owl "site" is defined as a visual sighting of at least one adult owl or a minimum of two auditory detections

in the same vicinity in the same year. Surveys from 1990 through 1993 indicate one or more owls have been observed at a minimum of 758 sites in the United States and 19 sites in Mexico. Previously, the greatest concentration of known owl sites in the United States occurred in the Upper Gila Mountain (55.9%), followed by the Basin and Range-East (16.0%), Basin and Range-West (13.6%), Colorado Plateau (8.2%), Southern Rocky Mountain-New Mexico (4.5%), and southern Rocky Mountain-Colorado (1.8%) RUs. New data is compiled and in the processes of being published for the revision of the Mexican spotted owl Recovery Plan (Spangle, pers. com. 2002). Spangle indicated there appears to be increases in estimated population numbers compared with those figures quoted in the 1995 Recovery Plan, especially in the Colorado Plateau.

Past, current, and future timber-harvest practices in Region 3 of the USFS, in addition to catastrophic wildfire, were cited as the primary factors leading to listing of the spotted owl as a threatened species. Fletcher (1990) estimates that 1,037,000 acres of habitat were converted from suitable (providing all requirements of the owl, e.g., nesting, roosting, and foraging) to capable (once suitable, but no longer so). Of this, about 78.7%, or 816,000 acres, was a result of human management activities, whereas the remainder was converted more or less naturally, primarily by wildfire. Other factors that have or may lead to the decline of this species include a lack of adequate regulatory mechanisms. In addition, the Recovery Plan notes that forest management has created ecotones favored by great horned owls, and there is, consequently, an increased likelihood of contact between spotted owls and great horned owls (a potential competitor and predator). Increases in scientific research, birding, educational field trips, and agency trips are also likely to occur. Finally, there is a potential for increasing malicious and accidental anthropogenic harm. Based on short-term population and radio-tracking studies, and longer-term monitoring studies, the probability of an adult Mexican spotted owl surviving from one year to the next is 0.8 to 0.9. Juvenile survival is considerably lower at 0.06 to 0.29, although it is believed these estimates may be artificially low due to the high likelihood of permanent dispersal from the study area and a period of several years before marked juveniles reappear as territory holders and are detected as survivors through recapture efforts (White *et. al.* 1995). Little research has been conducted on the causes of mortality of the spotted owl, but predation by great horned owls, northern goshawks, red-tailed hawks, and golden eagles; starvation; and accidents or collisions may all be contributing factors.

Twenty-seven Mexican spotted owl management territories, also called Protected Activity Centers (PACs) are known from the Huachuca Mountains, including eight within Fort Huachuca boundaries and nineteen on CNF lands to the south of the Fort (Tom Skinner, pers. comm., 2002). There are 21 PACs known for the Santa Catalina Mountains, 60 miles north-northwest of Fort Huachuca and 20 territories in the Santa Rita Mountains, 40 miles northwest of Fort Huachuca. Russell Duncan monitored, banded, and collected blood samples from Mexican spotted owls on Fort Huachuca from 1990 to 1999. Since 2000, the Fort has contracted with EEC for annual monitoring and inventory efforts on the installation. Results of all known Mexican spotted owl surveys on Fort Huachuca are reported in Table 11. In 1996, SAIC conducted surveys of all suitable habitats on the South Range that did not contain previously identified spotted owl territories. These surveys, which followed the Mexican Spotted Owl Inventory Protocol published by the USFS Southwest Region (USFS 1996), did not identify any new breeding territories within the South Range. Potential spotted owl habitat (pine-oak woodlands

and deciduous riparian woodlands) on the South Range comprised approximately 15.7% of the total area of the range.

TABLE 11 MSO OCCUPANCY AND REPRODUCTION IN PACS ON FORT HUACHUCA, 1990-2001

PAC	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Rock Springs Canyon Trail 5001001	ND	O, 1Y	O, 2Y	0, NN	O, NN	O, NN	O, 1Y	A	A	A	A	A
McClure Canyon 5001002	ND	O, 1Y	O, 3Y	O, NN	O, NN	O, NN	O, NF	O, 2Y	O, NN	O, NN	O, NU	1M, 1F
Huachuca Canyon - Upper 5001003	ND	O, NU	O, 1Y	O, NN	O, NN	O, NN	O, NN	O, 2Y	O, 1Y	O, NN	O, 1Y	O, 2Y
Woodcutter Canyon 5001004 [1]	O, NN	A	O, NU	A	A	A	A	A	A	A	ND	ND
Scheelite Canyon 5001005	O, NN	O, 2Y	O, NN	O, NN	O, NN	O, 1M	O, NN+M	O, NN	O, NN	O, NN	O, NU	O, 2Y
Split Rock Canyon 5001006	ND	O, NF	O, NN	O, NN	O, NN	O, NN	M	A	A	A	A	A
Blacktail Canyon 5001007	ND	A	A	A	A	A	M	A	A	A	A	A
Huachuca Canyon - Lower 5001008	ND	A	A	A	A	A	A	A	O, NU	A	0,2Y	O, NN

[1] Woodcutters Canyon designated as unsuitable habitat for MSO (S. Stone, pers. com., 2001)
[2] This table has been adapted from previous MSO annual reports provided to Fort Huachuca

LEGEND Tables 1 and 2: (From USDA Forest Service, Southwestern Regional Office Report Direction, 1992)

O - Pair Occupancy inferred or confirmed
M - Male inferred or confirmed
F - Female inferred or confirmed
P - Presence of lone inferred or confirmed, sex unknown
Y - Number of young fledged
YD - Number of young found dead
NU - Nesting status undetermined
NN - Non-nesting
NA - Nest Abandoned
NF - Nest failed
A - Absent or unoccupied
ND - No Data

Over the past 11 years of monitoring efforts, total occupancy for eight PACs ranged from as low as 25 % to as high as 75%. Occupancy percentage was determined by dividing total number of subject areas by the total number of subject areas with confirmed or inferred occupancy. Reproductive output has ranged from as low as 0% to as high as 66 % over the same period (EEC 2001d). Reproductive output was determined by dividing the total number of pairs inferred or confirmed by the total number of pairs confirmed with successful reproduction.

Seven PACs and two Inventory Areas (IAs) were monitored during Year 2001 efforts on FH with a 66% overall occupancy. There was successful reproduction of two out of the six confirmed or inferred pairs for a total of 33% reproductive output. One pair of Mexican spotted owl were observed nesting on CNF lands adjacent to the installation and foraging on installation land while a second pair is believed to foraging and protecting territory in Upper Scheelite Canyon but are a resident pair found in Brown Canyon on CNF land (EEC 2001d).

The Service's policy is that potential nest/roost habitat is considered inadequately surveyed if more than one breeding season has elapsed since the last year of survey to protocol. The Service considers inadequately surveyed habitat to be occupied by Mexican spotted owl. Follow-up surveys consisting of an additional year of survey (four visits) must occur prior to actions that may affect the owl or its habitat. Spotted owls have been detected at Fort Huachuca during winter in Tinker Canyon (Duncan *et. al.* 1993). However, no Mexican spotted owls were detected during the 2000 inventory efforts in this canyon. Owls may be found at lower elevation sites in the Huachuca Mountains when not nesting.

There are three (IAs) on Fort Huachuca in addition to the eight designated PACs (Table 12). IAs are potential foraging, nesting or roosting habitats. In the Basin and Range-West RU, owl management is based on PACs to ensure that all Mexican spotted owl sites known from 1989 through the life of the Recovery Plan are protected. PACs are areas of no less than 600 acres that enclose the best owl habitat in the area, with the nest or activity center near the center. There are 4,270 acres delineated as Mexican spotted owl PACs currently on Fort Huachuca. All eight PACs occur in the higher elevations of the Fort in the Huachuca Mountains. The Fort is currently outlining an Endangered Species Management Plan (ESMP) for this species and its habitat.

No potential spotted owl nesting, foraging, or wintering habitat is present on the East Range.

TABLE 12 MSO OCCUPANCY AND REPRODUCTION IN INVENTORY AREAS ON FORT HUACHUCA, 2000-2001

Inventory Area	2000	2001
Sawmill Canyon	0, + 1M	O, (?)Y
Upper Scheelite Canyon	1M	O, NN
Upper Tinker Canyon	A	ND

[1] Upper Tinker Canyon IA designated as unsuitable habitat for MSO (S. Stone, pers. comm., 2001)

3.9.8 SOUTHWESTERN WILLOW FLYCATCHER

Description

The southwestern willow flycatcher, *Empidonax traillii extimus,* is a small passerine bird (Order Passeriformes; Family Tyrannidae) measuring approximately 15cm (5.75 inches) in length from the tip of the bill to the tip of the tail and weighing only 0.4 ounces. It has a grayish-green back and wings, whitish throat, light gray-olive breast, and pale yellowish belly. Two white wingbars are visible (juveniles have buffy wingbars). The eye ring is faint or absent. The upper mandible is dark, the lower is light yellow grading to black at the tip. The southwestern willow flycatcher is best identified by its vocalization: a liquid, sharply whistled “whit” or a dry “sprit”, with a sneezy “witch-pew” or “fitz-bew” song (Johnson 1997).

General Ecology

One of four currently-recognized willow flycatcher subspecies (Phillips 1948, Unitt 1987, Browning 1993), the southwestern willow flycatcher is a neo-tropical migratory species that breeds in the southwestern US from approximately April 1 to September 1 and migrates to Mexico, Central America, and possibly northern South America during the non-breeding season (Phillips 1948, Stiles and Skutch 1989, Peterson 1990, Ridgely and Tudor 1994, Howell and Webb 1995). The flycatcher is a riparian obligate, nesting along rivers, streams, and other wetlands where dense growths of willow, *Salix* sp., seepwillow, *Baccharis* sp., buttonbush, *Cephalanthus* sp., boxelder, *Acer negundo*, saltcedar, *Tamarix chinensis*, or other plants are present, often with a scattered overstory of cottonwood and/or willow. Flying insects, particularly Hymenoptera (ants, bees, and wasps), Diptera (flies), and Hemiptera (true bugs), are the most important prey of the southwestern willow flycatchers; however, they will also glean larvae of non-flying insects, such as Lepidoptera (butterflies and moths), from vegetation (Drost *et. al.* 1998).

Unitt (1987) reviewed historical and contemporary records of *E.t. extimus* throughout its range, determining that it had "declined precipitously..." and that although the data reveal no trend in the past few years, the population is clearly much smaller now than 50 years ago, and no change in factors responsible for the decline seem likely. In Arizona in 2001, six hundred and thirty-five resident willow flycatchers were documented within 346 flycatcher territories. Breeding by 311 paired flycatchers was documented at 42 sites (Smith *et. al.* 2002). Habitat loss and degradation is caused by a variety of factors, including urban, recreational, and agricultural development, water diversion and groundwater pumping, channelization, and livestock grazing. Fire is an increasing threat to willow flycatcher habitat (Paxton *et. al.* 1996). Fire frequency in riparian vegetation increases with dominance by saltcedar (DeLoach 1991), and water diversions or groundwater pumping that result in desiccation of riparian vegetation (Sogge *et. al.* 1997).

The presence of livestock, range improvements such as waters and corrals, and agriculture provide feeding areas for cowbirds. These feeding areas, if near riparian habitats, coupled with habitat fragmentation, facilitate cowbird parasitism of flycatcher nests (Tibbitts *et. al.* 1994, Hanna 1928, Mayfield 1977). After five years of cowbird trapping on the South Fork of the Kern River, California, nest parasitism rates dropped from 65 to 22%, nest success increased from 28 to 43%, and mean number of young fledged per female flycatcher increased from 1.04 to 1.72 (Whitfield *et. al.* 1998, Uyehara *et. al.* 2000).

For further information on the ecology, range, status, and threats to this subspecies, refer to Brown (1988), Harris (1991), Harris *et. al.* (1987a&b), McCarthey *et. al.* (1988), Paradzick *et. al.* (1999,2000), Paxton *et. al.* (1996), Sferra *et. al.* (1997), Smith *et. al.* 2002, Sogge *et. al.* (1997), Stoleson and Finch (1998), Tibbitts *et. al.* (1994), Unitt (1987), and Uyehara et a. (1998).

Status and Date of Listing

The southwestern willow flycatcher, *Empidonax traillii extimus,* was listed as a federally endangered species on February 27,1995 and is designated as a Wildlife Species of Concern in Arizona. Critical habitat was designated on July 22, 1997, and included 18 critical habitat units totaling 964 km (599 river miles) in Arizona, California, and New Mexico (Federal Register V62, July 22, 1997). In Arizona, critical habitat was designated along portions of the San Pedro River, Verde River, Wet Beaver Creek, West Clear Creek, Colorado River in the Grand Canyon, and Little Colorado River (USFWS 1997b). However, in a 10th District Court ruling on May 11, 2001, the court ruled that the Service improperly failed to consider all economic impacts of the designation. Previous to this Court ruling, critical habitat within Cochise County included:

1. The San Pedro River in Cochise County from the Hereford Bridge (T23S, R22E, Section 9), downstream to eastbound Interstate 10 bridge at Benson (T17S R20E, Section 11). Approximately 87 km (54 miles). The boundaries include areas within the 100-year floodplain where thickets of riparian trees and shrubs occur or may become established as a result of natural floodplain processes or rehabilitation.

2. The San Pedro River in Cochise, Pima and Pinal Counties from the gauging Station near Aguaja Canyon (T12S, R18E, Section 19), downstream to the confluence with the Gila River (T5S, R15E, Section 23). Approximately 106 km (66 miles). The

boundaries include areas within the 100-year floodplain where thickets of riparian trees and shrubs occur or may become established as a result of natural floodplain processes or rehabilitation.

The principal factor in the decline of the southwestern willow flycatcher has been the extensive loss, modification, and fragmentation of its riparian breeding habitat. These losses and modifications have resulted from river flow management and diversions, agricultural clearing, sand and gravel extraction, urban development, recreation, grazing, groundwater pumping, pollution, fire, flooding, erosion, and exotic plant invasion (Krueper 1993). Brood parasitism by brown-headed cowbirds has reduced songbird reproductive success in forest habitat near open habitat (Brittingham and Temple 1993) and is "another significant and widespread threat to the southwestern willow flycatcher" (Sogge *et. al.* 1997).

Distribution and Abundance in the Region and at Fort Huachuca

The historical range of the southwestern willow flycatcher included southern California, Arizona, New Mexico, western Texas, southwestern Colorado, southern Utah, extreme southern Nevada, and extreme northwestern Mexico (Sonora and Baja) (Unitt 1987).

Four hundred and twenty-six nesting attempts were documented statewide in Arizona at 40 sites in 2001. Nest success for all monitored sites was 65% combined. Thirty-two of the thirty-eight nesting sites were characterized as mixed native/exotic association with approximately 80% of nests located in saltcedar (Smith *et. al.* 2002).

The lower San Pedro River is one of the most important sites for the southwestern willow flycatcher. In 2001, the major concentration of southwestern willow flycatchers was documented in the Winkleman Study Area, near the confluence of the Gila and San Pedro Rivers. A total of 254 flycatchers were known to fledge from nests on the lower San Pedro River in 2001 (Smith *et al* 2002). In 1997, flycatchers nested primarily in saltcedar on the lower San Pedro River, but a few nests were found in buttonbush and willow (McCarthey *et. al.* 1998). Nests were observed in riparian habitat, which varied from monotypic saltcedar stands to native Goodding willow and Fremont cottonwood. A reasonable and prudent alternative in the Services BO to the Bureau of Reclamation on proposed modifications to Roosevelt Dam required Reclamation to acquire and protect habitat for the flycatcher. In response, Reclamation provided a grant to TNC to acquire and manage an 820-acre site encompassing riparian habitat near Dudleyville, downstream of the Aravaipa confluence. This site, known as the San Pedro River Preserve, is part of a larger reach of the San Pedro, 11.3 miles in length - from the Gila River confluence to about 1.5 miles south of the Aravaipa confluence - that supports a rich and diverse riparian community and includes all of the important flycatcher sites on the lower river.

The few southwestern willow flycatchers on the upper San Pedro River as compared to the lower San Pedro is probably a result of the relatively narrow corridor of riparian forest; a lack of understory in most areas, and a history of grazing that probably reduced understory foliage density on the upper San Pedro River. In addition, saltcedar, which is an important nesting substrate on the lower San Pedro, is relatively scarce on the upper San Pedro River. Since removal of most cattle after establishment of the SPRNCA, apparent foliage density in the

understory has been increasing, with resulting increasing quality of flycatcher habitat. Nesting by riparian bird species has increased in a relatively short time (EEC 2001c). If this trend continues, more flycatchers will likely be found in the SPRNCA. The upper San Pedro River may serve as a migration corridor for some birds moving between wintering grounds in Latin America and the lower San Pedro or other sites to the north; however, Skagen (1995) recorded no willow flycatchers on the upper San Pedro River during April and early May 1989-1994, although flycatchers have been detected during surveys from 1996 to the present.

In 1996, flycatchers were found on the upper San Pedro River near St. David, and in 1997, one flycatcher nest was found near Kingfisher (or Young-Block) ponds in the SPRNCA near the Highway 90 crossing (McCarthey *et. al*. 1998), however it was abandoned in July. A dead cowbird chick was found in the abandoned nest (SAIC 1998a). Early in the season, two territorial males were found upstream, and one was downstream of Kingfisher Pond (T. McCarthey, AGFD, pers. comm. 1997). SAIC (1998b) conducted flycatcher surveys along 17.1 miles in six reaches of the upper San Pedro River in May-July 1997. Surveys were conducted according to Service protocol in five of the six reaches. No flycatchers were detected during these surveys. In 1998, one flycatcher was detected at Kingfisher ponds on June 8, but it is unknown if this bird was a migrant or a breeding bird. An apparent migrant was seen on June 4, 1998 at Hereford Bridge, but was not observed in subsequent surveys (Paradzick *et. al.* 1999). Also in 1998, three territorial males were found on the San Pedro River at Apache Powder Road, just north of the SPRNCA, but it is not known if these birds were paired or if nests were present (T. McCarthey, pers. comm. 1998). In 1999, two willow flycatchers, probably migrants, were detected in late May and early June at Kingfisher Ponds (T. McCarthey, pers. comm. 1999). EEC, contracted by the Fort in 2000 and 2001, conducted comprehensive surveys for the species on the upper SPRNCA. No southwestern willow flycatchers were detected along the SPRNCA during 2000 and 2001 surveys. However, an incidental sighting was observed by Jack Whetstone (BLM) while conducting weekly Monitoring Avian Productivity and Survivorship (MAPS) at the Banding Station near Kingfisher pond both in August 2000 and 2001 (Whetstone, pers. comm. 2000 2001).

The Babocomari River has not been well surveyed for southwestern willow flycatchers; however, most of the habitat on the river is probably unsuitable due to intermittent flows and lack of sufficient riparian vegetation cover (Dave Krueper, BLM, Sierra Vista, AZ, pers. comm. 1998). The Babocomari Cienega, located on the Babocomari River upstream of Huachuca City at the Babocomari Ranch, may have potential to support nesting southwestern willow flycatchers (D. Krueper, pers. comm. 1998). The area consists of an impoundment, possibly an impounded spring, surrounded by a healthy stand of cottonwoods, and farther upstream, a thick stand of short willows (Susan Skagen, USGS, Biological Resources Division, pers. comm. 1998). Avian surveys from April 3 to May 14 over a four year period (1989, 1991, 1993, 1994) resulted in no observations of willow flycatchers (Skagen 1995), but southwestern willow flycatchers do not begin building nests until late May. Riparian woodlands above and below the cienega consist mostly of decadent, old cottonwoods and a relatively low proportion of foliage density in the understory. This may reflect a lack of recruitment possibly due to heavy grazing that occurs in the area (Skagen 1995; S. Skagen, pers. comm. 1998). However, a decline in groundwater elevation could have the same effect on cottonwood demographics.

Riparian habitat suitable for nesting southwestern willow flycatchers is generally lacking at Fort Huachuca. R.B. Duncan (in SAIC 1998a) reported a small patch of marginal habitat (no more than 10 acres of cottonwoods and wetland vegetation) near Highway 90 just north of the main gate; however, this habitat no longer exists as a result of a fire in May of 1999 (EEC 2000b). The riparian vegetation is likely to recover and may develop into potential habitat in future years. Marginal habitat for flycatchers may also occur on-post at Gravel Pit Pond and Middle Garden Canyon Pond. These sites, previously classified as potential breeding habitat, were re-evaluated in May 2000. These areas were classified as unsuitable nesting habitat through an on-sight evaluation based on current described and classified plant species composition and habitat structure used by the southwestern willow flycatcher for nesting (EEC 2000b).

The establishment of the SPRNCA has greatly reduced the level of livestock grazing from an estimated 9,000 head to occasional trespass cattle after the SPRNCA was fenced. Other land uses potentially damaging to riparian plant communities such as gravel mining and off-road vehicle use have also been eliminated in the SPRNCA (BLM 1989). The result has been a substantial recovery of the riparian vegetation, a large increase in breeding bird species diversity and abundance (Krueper 1993), and, in 1997, one pair of nesting southwestern willow flycatchers. However, cowbirds are common along all sections surveyed in the SPRNCA and it is expected that this species will continue to be common given that the SPRNCA is surrounded by open habitat that is grazed by livestock. Brown-headed cowbirds were common at the Babocomari Cienega and on the upper San Pedro River in April and May 1989-1994 (Skagen 1995) and on the upper San Pedro River in May and June 1997 (SAIC 1998b). McCarthey *et. al*. (1998) report that brown-headed cowbirds were present at the flycatcher localities on the upper San Pedro River in 1997; and the one nest in 1997 was parasitized by cowbirds (SAIC 1998a). Therefore, the potential for continued cowbird brood parasitism of the southwestern willow flycatcher and other nesting birds in the SPRNCA is high. The only livestock grazed in Fort Huachuca are horses at the Buffalo Corral; eight surveys for cowbirds at this site in 1997 resulted in the observation of one transient bird (Chase 1997; SAIC 1997a). Therefore, horse grazing at Buffalo Corral on Fort Huachuca does not appear to be contributing to the local cowbird population.

3.9.9 CACTUS FERRUGINOUS PYGMY-OWL

Description

The cactus ferruginous pygmy-owl, *Glaucidium brasilianum cactorum*, is the most northern subspecies of the ferruginous pygmy-owl, *G. brasilianum* (Lesh and Corman 1995) and is herein referred to as the pygmy-owl. The pygmy-owl is a small, secretive owl with a gray-red upper body, white underparts with red-brown streaks, a long rufous-colored tail with dark barring, yellow eyes, conspicuous black and white “eye spots” on the back of the head, and lacking eartufts (Lesh and Corman 1995; Proudfoot and Beasom 1996). Like many other birds of prey, *G. brasilianum* displays reversed sexual size dimorphism, with females slightly larger (75.1 gm or 1.7 lbs) than males (61.4 gm or 1.4 lbs; Earhart and Johnson 1970; Johnsgard 1988). The pygmy-owl can be distinguished from two other subspecies of *G. brasilianum ridgwayi* and *G. brasilianum brasilianun*, by its grayer, lighter plumage, shorter wings, and longer tail (Lesh and Corman 1995).

General Ecology

The cactus ferruginous pygmy-owl inhabits lowland riparian forests, forest edges, second growth forests, and thickets from sea level to 1,500 m (4,890 ft) in elevation with dense overall cover with high diversity of vertical structure (Enriquez-Rocha *et. al.* 1993; Richardson 1997). In Texas, the pygmy-owl occupies mature, mixed oak-mesquite woodlands and is never found in open pastures, prairie habitats, or in low-growing oak mottes (Wauer *et. al.* 1993). In Arizona, the pygmy-owl occurs in an elevations range between 397 – 1,220 meters (1,300 – 4000 feet) in Sonoran riparian deciduous woodlands, dense Sonoran desertscrub areas, and xeroriparian paloverde-mesquite-saguro habitat rather than the historical habitats of hydroriparian cottonwood-mesquite (Lesh and Corman 1995). Cavities for nesting and roosting may be an important component of pygmy-owl habitat. In Arizona, and in Sonoran desertscrub areas where these owls occur, saguaros may provide the majority of potential cavities (Lesh and Corman 1995).

The pygmy-owl is diurnal (Lesh and Corman 1995). Insects and reptiles compose the majority of the prey items, but anthropods, small birds, and small mammals are also preyed upon by the pygmy-owl (Lesh and Corman 1995). In addition, there are accounts of *G. brasilianum* attacking and killing prey larger than itself (i.e.; young domestic fowl, *Gallus gallus*, and captive guans, *Penelope*; Johnsgard 1988).

Pygmy-owls nest in cavities and breed in late winter to early spring (NWR 1997). In Arizona, pygmy-owls have been documented breeding in abandoned woodpecker cavities in cottonwood, palo verde, and mesquite trees (Gilman 1909). Up to five eggs are laid in mid to late April and are incubated for approximately 22 to 28 days. The nestling period lasts approximately 30 days (Gilman 1909; Johnsgard 1988; Lesh and Corman 1995). Generally, male pygmy-owls display territorial and mate-attraction vocalizations more frequently from September through March (Lesh and Corman 1995). The pygmy-owl is non-migratory throughout its range (NWR 1997).

Status and Date of Listing

The pygmy-owl was designated an endangered species in Arizona by the USFWS on March 10, effective April 9, 1997 (USFWS 1997e), but notice of the potential listing dates back to 1989. The Service proposed critical habitat in 1994 but determined it not to be prudent in a final rule in March of 1997. The Service was sued for failure to designate critical habitat for the owl in 1997 and was court ordered to designated critical habitat in 1998. Approximately 296,115 hectares (731,712 acres) of riverine riparian and upland habitat in Pima, Cochise, Pinal and Maricopa Counties was designated critical habitat for the owl in a final rule dated July 12, 1999. On September 24, 2001, a US district court vacated all critical habitat designated for the Arizona population of the owl stating that the USFWS failed to fully evaluate the economic and other impacts of designating critical habitat in southern Arizona. The pygmy-owl is a USFS sensitive species, in Arizona it is a Wildlife Species of Concern, and proposed as a threatened species in Texas (Federal Register 14 April 1995, Vol. 60, No. 72).

The pygmy owls decline is believed be due to mainly loss of riparian habitat (Lesh and Corman 1995). Urban and agricultural development, channelization, water diversion, groundwater

pumping, livestock overgrazing, and timber harvesting account for the various causes of riparian habitat destruction (Lesh and Corman 1995). Additionally, threats to this avian species include potential vulnerability to extinction due to environmental, demographic and genetic threats as well as the absence of effective conservation measures (SDCP 1999).

Distribution and Abundance in the Region and at Fort Huachuca

Total range for this subspecies includes southern Arizona and southern Texas south to Guerrero, Nuevo Leon, and Tamaulipas, Mexico. This species was once "fairly common" in mesquite bosques throughout central and southern Arizona along the Gila, Salt, Verde, San Pedro, and Santa Cruz rivers and drainages (Gilman 1909; Lesh and Corman 1995, AGFD 2001b). The San Pedro River near Dudleyville is considered historical habitat for this species. AGFD conducted breeding surveys in 1997 and located nine owls near Tucson in addition to two birds in Organ Pipe National Monument, Arizona (Richardson 1997). While this is a decrease from the 12 birds located in 1996, surveys were terminated on 31 May 1997 due to the new status of pygmy owls. All of the owls located in the Tucson area, during the 1996 surveys, were found in Sonora desert shrub with fairly diverse structure (similar to studies by Lesh and Corman 1995) and nested in cavities of saguaro cactus (Richardson 1997). In 2000, 34 known adults were documented with seven nest sites and 23 young in which the majority were located in Pima County. In 2001, 47 birds were found in southern Arizona. In 2001, two University of Arizona researchers found 280 pygmy owls in the northern half of Sonora, Mexico within 150 miles of the US/Mexico border, which may be a potential source for birds to disperse north into Arizona.

No potential habitat for cactus ferruginous pygmy-owls is present on the South, West, or East Ranges of Fort Huachuca and subspecies in not known to occur on the installation. Habitat outside of the East Range along the Babocomari and San Pedro Rivers may be suitable for this subspecies, although this area is at a slightly higher elevation than most occupied cactus ferruginous pygmy-owl areas (Richardson 1997).

3.9.10 NORTHERN APLOMADO FALCON

Description

The northern aplomado falcon, *Falco femoralis septentrionalis,* is one of three aplomado falcon (*Falco femoralis*) subspecies. Unless otherwise stated, the term aplomado falcon or falcon will refer to the northern subspecies *F.f. septentrionalis*, which is larger and paler than the aplomado subspecies of Central American and eastern South America (USFWS 1990c).

When perched, the aplomado falcon is easily distinguished by its distinct black and white facial pattern, long barred tail (dark with 8 white bars and white tip), dark “cummerbund”, bluish-black beak, bright yellow legs and feet, black talons, and white trailing edge on the wings (Palmer 1988). In flight, the aplomado falcon has a longer tail, narrower wings, and shallower wingbeat than the peregrine falcon (*Falco peregrinus*) and the prairie falcon (*Falco mexicanus*; Palmer 1988). The aplomado falcons vocalization is similar to the peregrine and prairie falcon, but with a higher pitch and a more rapid call (Palmer 1988). Females are larger (407 gm or 0.9 lb) than

males (260 gm or 0.6 lb; Palmer 1988). Juvenile aplomado falcons are more difficult to identify, but still have the facial patterns, tail coloration, and proportions of adults (Palmer 1988).

General Ecology

Throughout its range, the northern aplomado falcon is associated with savannas. The aplomado falcon inhabits neotropical savannas and desert grasslands from southwestern US to Tierra del Fuego (Hector 1985). In the US, the northern aplomado falcon historically occupied yucca-covered sand ridges in coastal prairies, riparian woodlands in open grasslands, and scattered mesquite and yucca in desert grasslands (USFWS 1990c). Montoya *et. al.* (1997) found that aplomado falcons in north-central Mexico occupied the few relict desert grasslands with dense ground cover of grasses interspersed with tall yuccas. In Arizona, the aplomado falcon has been reported in only two biotic communities; timbered riparian areas that meander through grasslands and open grasslands with scattered yucca (Corman 1992). According to the USFWS (1990c), suitable habitat should consist predominately of grasslands with scattered trees or shrubs and patches of plant communities that could provide nesting and feeding habitat. However, small bird abundance is probably the most important determinant of potential breeding habitat for this species (Hector 1985; USFWS 1990c). In addition, aplomado falcons do not build nests, but use the old nests of other birds such as corvids and raptors. In south Texas in 2001, aplomado falcons were also observed nesting on the ground and on artificial structures like high-tension power poles and microwave towers (Burnham et al 2002).

The northern aplomado falcon diet consists of small birds, insects, rodents, and reptiles. In similar studies of aplomado falcons (*Falco femoralis*) in eastern Mexico (Hector 1985), northcentral Chile (Jimenez 1993), and northcentral Mexico (Montoya *et. al.* 1997) the falcons diet consisted primarily of birds such as doves, cuckoos, woodpeckers, blackbirds, flycatchers, and thrushes (USFWS 1990c). These species were also identified as common prey species in recent falcon release studies in Texas, along with bats, lizards, dragonflies and grasshoppers (Burnham et al 2002). Aplomado falcons typically hunt by perching in a tree and chasing small birds in a horizontal flight pattern. However, mated pairs will hunt cooperatively when chasing avian prey (Palmer 1988). These falcons will also glide or slowly flap in the air while hunting for insects. Hunting typically occurs during the morning or late afternoon within 1 km (0.62 miles) of the nest (USFWS 1990c).

Little information is available on the reproductive behavior of northern aplomado falcons within the United States. Within eastern Mexico, the falcon breeds during the dry season of January through June (Palmer 1988). Because the breeding season is so long (181-242 days), northern aplomado falcons could potentially raise more than one brood per year (USFWS 1990c). Typically, the falcons use the of nests of corvids and raptors as platforms to lay 2 to 4 eggs (2.58 mean clutch size ; Palmer 1988). A study in north-central Mexico by Montoya *et. al.* (1997) located 6 nests in yucca and 4 in honey mesquite, *Prosopis glandulosa*. Incubation lasts 31 to 32 days, nestlings fledge at 32 to 40 days, and the post-fledgling period lasts approximately 4 weeks (USFWS 1990c). Siblings remain and hunt together for an extended period after independence (Palmer 1988).

Little information is available on the migratory behavior of this species. In eastern Mexico, aplomado falcons can be found on their territories throughout the year. It is assumed this subspecies moves further south during the winter months, however, most northern aplomado falcons collected within the US were taken during the winter months (Palmer 1988).

Status and Date of Listing

The northern aplomado falcon was described in 1916 by Todd. The type specimen was an adult male collected by H.C. Benson on May 6, 1887 near Fort Huachuca Military Reservation, Cochise County, Arizona.

In response to extirpation within the U S and declines in population numbers within eastern Mexico, the northern aplomado falcon was listed as a federally endangered species on February 25, 1986, but critical habitat was not designated. The aplomado falcon recovery plan was established in 1990 with the goal of achieving 60 breeding pairs within the US (USFWS 1990c). Within Arizona it is a Wildlife Species of Concern.

The northern aplomado falcon declined from various human-caused disturbances such as agricultural development, fire suppression, channelization of once permanent desert streams, recreational activities by humans, direct persecution by humans, and pesticide contamination (USFWS 1990c; Corman 1992; Ward and Ingraldi 1994). However, overgrazing by livestock appears to be the primary factor responsible for the decline of this falcon (Montoya *et. al.* 1997). In addition, this species was exposed to contamination by (DDT) in the 1950s and 1960s due to its diet which consists primarily of avian prey and insects. Aplomado falcon eggs during this period had 25.4% thinner eggs than eggs prior to this period (Palmer 1988).

Distribution and Abundance in the Region and at Fort Huachuca

Historically, the northern aplomado falcon was fairly common from southeastern Arizona and southwestern Texas through Guatemala and Nicaragua (Palmer 1988; USFWS 1990c). Most breeding records within the US occurred near Brownsville, Texas. However, there have been some reports of breeding in the Animas and Rio Mimbres Valleys and Jornada del Muerto of New Mexico and near Fort Huachuca, Arizona (Palmer 1988). While the northern aplomado falcon was still breeding within the US in 1952, it disappeared from most of its US range by 1940 (USFWS 1990c).

Occasional sightings of individual aplomado falcons have been confirmed in western Texas and eastern New Mexico, but no confirmed sightings have been reported for Arizona (Ward and Ingraldi 1994). The nearest known breeding population to Fort Huachuca is in northern Chihuahua, Mexico, approximately 210 km (350 miles) from Fort Huachuca (TPF 1994). Released Aplomado falcons have been shown to travel up to 190 km (316 miles) (Burnham *et. al.* 2002). In 2001, 26 occupied Aplomado falcon territories were located in two breeding areas, El Sueco and Tinaja Verde, in Chihuahua. General trends show a decline in occupied sites and average number of young per occupied territory. These trends are associated with drought conditions in the region (Burnham *et. al.* 2002).

Reintroduction of aplomado falcons in Texas by The Peregrine Fund, Inc. began in 1985 and continues today, with 104 falcons released through 1995 (TPFund 1994). In 1995, the first active aplomado falcon nest since 1941 was observed near Brownsville, Texas. This pair was captive-bred, released by the Peregrine Fund, and successfully fledged one young. In 1994, the AGFD initiated a survey within southeastern Arizona, but no aplomado falcons were located during this survey.

The aplomado falcon recovery plan recommended reintroducing this species to its historic range. This recovery plan proposed several potential release areas within Arizona including Fort Huachuca, Buenos Aires National Wildlife Refuge (NWR), Elgin Research Ranch, SPRNCA, San Simon Valley, Santa Rita Experimental Range, and the Willcox Playa Wildlife Area (USFWS 1990c).

In a 1992 AGFD evaluation of potential release sites in southeastern Arizona, a site on the San Pedro River near Hereford, approximately 12 km (8 miles) from Fort Huachuca, was ranked second of 10 potential reintroduction sites evaluated (Corman 1992). Rankings were based on relative density and diversity of potential prey species; habitat characteristics most closely resembling those of historical use by aplomados in Arizona; and vegetation structure unlikely to hinder the hunting success of released falcons. The San Pedro sites were characterized by a diversity of habitats, primarily consisting of semidesert grasslands and Sonora riparian deciduous forest.

Based on the AGFD evaluations in 1992, semidesert grassland and riparian communities on Fort Huachuca have a strong potential to support released or re-colonizing aplomado falcons. The proximity of these habitat types on the East and South Ranges to abundant songbird populations in the SPRNCA suggests that foraging or nesting falcons may occur through much of these areas as aplomado falcon populations recover in the future. Presently, the northern aplomado falcon is not known to occur on Fort Huachuca and has been extirpated from Arizona. However, with areas of suitable, vacant habitat, it is conceivable that future natural recolonization by wild aplomado falcons could occur especially with recovery and stabilization of the mesquite-grass savanna and shrub-grassland ecosystems on the East Range.

3.9.11 YELLOW-BILLED CUCKOO

Description

Three genera of the Family Cuculidae are found in the United States including, *Crotophaga*, *Geococcyx,* and *Coccyzus*. The population of *Coccyzus americanus* that occurs west of the Pecos River, Texas, is *C. a. occidentalis*. In 1887, it was distinguished from its eastern counterpart, *C.a. americanus*, by its morphological differences. In 1993, Franzreb and Layman reported a small but statistically significant size difference between the eastern and western populations in support for the recognition that the western population is a distinct subspecies. Currently the subspecies issue stands unresolved pending further research and information (USFWS 2000a). The population of *Coccyzus americanus* that occurs in Arizona is *C.a. occidentalis* (YBCU).

The Yellow-Billed Cuckoo (YBCU) is 10-12 inch (26-30cm) long, slender with relatively short, dark legs. The plumage is grayish-brown above, white below with rufous primaries. The lower mandible is yellow while the under tail exhibits a bold black and white pattern. Adult female and male YBCUs are identical in plumage characteristics. Juveniles can be distinguished from adults and sub-adults by plumage characteristics. Juvenile tail plumage, held well into fall, has a much paler pattern and the mandible will show little or no yellow. YBCU is most often identified by its distinctive song that is a hollow and wooden rapid staccato kuk-kuk-kuk that usually descends to a kakakowlp-kowlp ending (AFGD 1998).

General Ecology

In Arizona, YBCUs have been found in mature Sonoran riparian deciduous forest, cottonwood-willow series, Sonoran riparian scrub, and in well developed mesquite bosques (Corman and Magill 2000). YBCUs will use streamside cottonwood, willow groves and large mesquite bosques for migrating and breeding between an elevational range of 0 to1600 meters.

The peak nesting activity period for this species in Arizona is between 15 June and 10 August. The species nests primarily in the central and southern parts of Arizona. Breeding often coincides with outbreaks of cicadas, tent caterpillars and other prey species. The YBCU breeds in willow or mesquite thickets where the nest will be concealed in surrounding foliage (AGFD 1998).

The cuckoo is sill relatively common east of the crest of the Rocky Mountains but biologists estimate that more than 90% of the bird's streamside habitat in the West has been lost or degraded (USFWS 2001). Populations of the western subspecies have decreased throughout their range and populations appear to be extremely reduced from historic numbers, and a general decline in all areas seems to be occurring (AGFD 1998, Corman and Magill 2000).

Status and Date of Listing

The YBCU is listed as a migratory bird under the Migratory Bird Treaty Act, and petitioned for listing as endangered on 8 February 1998. USFWS issued a finding to maintain this species as candidate for listing (USFWS 2001). An immediate publication of a proposed rule to list this species is precluded by higher priority listing actions. It is designated by AGFD as a Wildlife Species of Concern in Arizona (1996) and listed as a Sensitive Species by the USFS, Region 3 (AGFD 1998). The primary threat to this avian species is the continued loss, degradation, and fragmentation of mature cottonwood-willow riparian habitat. Major threats to the habitat include stream diversion, water management, agriculture, urbanization, overgrazing, recreation, and invasion of non-native invasive species to the riparian areas.

Distribution and Abundance in the Region and at Fort Huachuca

Historically the YBCU was believed to be locally widespread and common in California and Arizona. In Arizona the species was a common resident in the lower Sonoran zones of the southern, central and western portions of Arizona. The YBCU occurs in the Apache- Sitgreaves, Coconino, Coronado, Prescott, and Tonto National Forests of Arizona. The species have been

found at Cienega Creek, Arivaca Creek, the San Pedro River, the Tanque Verde Wash, Rincon Creek, and Green Valley, Sahurarit, Bill Williams River, Havasu, Buenos Aires and Imperial NWRs of Arizona. They have been recorded as rare transients in Saguaro National Park and documented at Picacho State Recreation Area. YBCU has been extirpated from most lower elevation localities and most of the Santa Cruz River in Pima County (Corman and Magill 2000). In 2001, thirty-six individuals, paired and single, were detected while surveyors were conducting southwestern willow flycatcher surveys on the San Pedro River within the SPRNCA (EEC 2001c). The SPRNCA has previously been documented as having the highest concentration of breeding YBCU in the state of Arizona, and throughout the southwestern United States (EEC 2001c). In September 2001, a single male YBCU was detected calling while an EEC biologist was conducting habitat evaluation for Huachuca water umbel at Middle Garden Canyon Pond on Fort Huachuca (Kirchner, personal observation 2001).

3.9.12 MOUNTAIN PLOVER

Description

The mountain plover, *Charadrius montanus,* is a long legged, sandy-brown shorebird in the Family Charadriidae measuring between 20-24cm (8-9.5 inches.) in length. Male and female mountain plovers are similar in plumage characteristics. The mountain plover has a black cap, black loral stripe extending from a black bill to the eye, white supercilium, and whitish forehead, foreneck, breast and belly. This species has a whitish wing stripe, whitish wing linings, and black band near the tail tip. In breeding plumage, unbanded white underparts distinguish this plover from all other brown-back plovers. On its breeding grounds, this bird can be heard calling with low, drawn out whistles and harsh notes. During migration and winter, it vocalizes using a harsh, single krrp note.

General Ecology

This bird species inhabits short-grass prairie and shrub-steppe landscapes and is not found in the mountains. They are strongly associated with sites of heaviest grazing pressure and are attracted to man made landscapes, such as cultivated fields and agricultural lands, that mimic their natural habitat associations. The mountain plover nests primarily in short-grass prairie areas with bare ground, often with manure piles or rocks nearby (BISON 2002).

Status and Date of Listing

The mountain plover was declared a Federal Candidate Category 2 species on November 21,1991.

This listing was in error and in January 1995 correcting the former listing, the mountain plover was listed as a Federal Candidate Category 1 (Jahrsdoerfer 1995). A notice to list the mountain plover as a proposed species threatened species without critical habitat was published on February 16, 1999 (64 CFR 17).

Three of five factors, that are used to determine whether a species can be listed as endangered or threatened, can be applied to the mountain plover. These factors (threats) include present destruction, modification, or curtailment of its habitat or range, ineffectiveness or inability of existing Federal agency policies and regulations to sufficiently reverse the species decline, and natural or manmade disturbances during the nesting period (BISON 2002). This species is also listed as a Sensitive Species by the USFS, Region 3 (1990).

Distribution and Abundance in the Region and at Fort Huachuca

The mountain plover is a migratory species that occupy breeding and wintering locales. Breeding occurs in the Rocky Mountain states from Canada south to Mexico. Most breeding occurs in Montana and Colorado. Most wintering occurs in California with fewer birds found in Arizona, Texas, and Mexico. The mountain plover is known to occur locally over a large area of Arizona during the winter. They are consistently reported from the Sulphur Springs Valley during the winter (Davis and Russell 1995, Taylor 1995). These birds are often observed as small flocks in short grass field, fallow fields and recently plowed fields. The potential exists for individual birds to occur anywhere within the valley where appropriate habitat is available, to include the Wilcox Playa. Potential habitat may exist on Fort Huachuca, but this species is not known to occur on the installation.

3.9.13 WHOOPING CRANE

Description

The whooping crane, *Grus americana,* is the tallest North American bird. The male, which is larger than the female can reach up to1.5 meters (~5 feet) in height. The adult male and female are identical in plumage characteristics. Adults are snowy white except for black primary feathers on the wings and a red face and crown. The bill is a dark olive gray. The eyes are yellow and the legs and feet are gray-black. Juveniles can be distinguished from the adults by plumage. Juveniles are a reddish cinnamon color with white feather bases that gradually are replaced through the winter months, when by the following spring, yearlings become predominantly white.

General Ecology

Whooping cranes inhabit marshes, river bottoms, potholes, prairies, and croplands. Foraging areas include agricultural fields and valley pastures. They typically roost on sandbars and are often found roosting with sandhill cranes. Whooping cranes are monogamous and form life-long pair bonds. They arrive on breeding grounds in April and autumn migration begins in mid-September. They arrive on wintering grounds by late October to mid-November (USFWS 1995d). Whooping cranes migrate singly, in pairs, in family units, or in small flocks.

Status and Date of Listing

The whooping crane was federally listed as endangered on March 11,1967 (32 FR 4001), was listed as a “state accidental” species in Arizona in 1995 and is listed as a Sensitive Species by the

USFS Region 3. Critical habitat for the whooping crane was designated on 15 May 1978 (43 FR 20938 20942). USFWS announced a notice to withdraw critical habitat on 6 March 1978 (44 FR 12382 12384) and presently the whooping crane is listed as endangered without critical habitat (BISON 2002). The recovery plan for this species was first approved in 1980. It has gone through two revisions since then with the current plan revision accepted 11 February 1994. Primary threats that led to the species being listed as endangered include conversion of wetlands and prairies to croplands, specimen collection, and collisions with power line, fences, and human disturbance (Bison 2002).

Distribution and Abundance in the Region and at Fort Huachuca

Historically this species ranged throughout North America but has declined over time to three wild populations and four captive populations (BISON 2002) The current nesting range of the natural wild population is restricted to Wood Buffalo National Park in Canada. In the Rocky Mountains, the whooping crane population includes middle Rio Grande Valley of New Mexico, the lower San Luis Valley of Colorado, and summering areas in southeastern Idaho and western Wyoming. Since, 1975, the range of the Rocky Mountain experimental population of the whooping crane has extended into Idaho, northern New Mexico, northwestern Colorado, southwestern Montana, northeastern Utah, with occasional strays appearing in Arizona and Mexico (Pratt 1996).

This species is known as an “Accidental” in Arizona which means a rare occurrence, and it is unlikely to occur on Fort Huachuca or in the region again.

3.9.14 LESSER LONG-NOSED BAT

Description

The lesser long-nosed bat, *Leptonycteris curasoae yerbabuenae*, is a medium to large sized leaf-nosed bat of the family Phyllostomidae (Hoffmeister 1986). It has a long muzzle and a long tongue, and is capable of hover flight. These features are adaptations to feed on nectar from the flowers of columnar cactus, such as the saguaro and organ pipe cactus and from paniculate agaves, such as Palmer's agave, *Agave palmeri*, and Parry's agave, *A. parryi* (Hoffmeister 1986).

Leptonycteris curasoae has short dense fur and the pelage, in adults, is a reddish brown, washed with brown or cinnamon ventrally (Nowak 1991). Juveniles are grayish. Though appearing to be tailless, three caudal vertebrae are present. Adult weigh from 18 to 25 gm (0.63 to 0.88 oz) with a forearm length of 51 to 56 mm (2 to 2.2 in)(USFWS 1994c).

General Ecology

The lesser long-nosed bat is migratory, found throughout its historic range, from southern Arizona and extreme southwestern New Mexico, through western Mexico, and south to El Salvador. Roosts in Arizona are typically occupied from April to November (Cockrum and Petryszyn 1991, Sidner 2000); the bat has only rarely been recorded outside of this time period in Arizona (Fleming 1995, Hoffmeister 1986). In spring, adult females, most of which are

pregnant, arrive in Arizona gathering into maternity colonies. These roosts are typically at low elevations near concentrations of flowering columnar cacti. After the young are weaned, these colonies disband in July and August; some females and young move to higher elevations, primarily in the southeastern parts of Arizona near concentrations of blooming paniculate agaves. Adult males typically occupy separate roosts forming bachelor colonies. Males are known mostly from the Chiricahua Mountains but also occur with adult females and young of the year at maternity sites (Fleming 1995). Throughout the night between foraging bouts, both sexes will rest in temporary night roosts (Hoffmeister 1986). These bat populations occupy the northern portion of their range from spring to autumn then migrate south for the winter. Seasonal movements of bats apparently coincide with the blooming of appropriate food plant species, namely agave and columnar cacti such as organ pipe.

The lesser long-nosed bat consumes nectar and pollen of paniculate agave flowers and the nectar, pollen, and fruit produced by a variety of columnar cacti. These bats often forage in flocks. Nectar of these cacti and agaves are high-energy foods. Concentrations of some food resources appear to be patchily distributed on the landscape and the nectar of each plant species utilized is only seasonally available. Cacti flowers and fruit are available during the spring and early summer; blooming agaves are available primarily from July through October. Columnar cacti occur in lower elevation areas of the Sonoran Desert region, and paniculate agaves are found primarily in higher elevation desert scrub areas, desert grasslands and shrubland, and into the oak woodland (Gentry 1982). Palmer's agave exhibit many characteristics of chiropterophily, such as nocturnal pollen dehiscence and nectar production, light colored and erect flowers, strong floral order, and high levels of pollen protein with relatively low levels of nectar sugar concentrations (Slauson 1996). Parry's agave demonstrates many (though not all) of these morphological features (Gentry 1982). In the Huachuca Mountains, Parry's agave is generally found at higher elevations than Palmer's agave; the former is common in forest openings to the crest of the Huachuca Mountains.

Lesser long-nosed bats appear to be opportunistic foragers and efficient fliers. Seasonally available food resources may account for the seasonal movement patterns of the bat. The lesser long-nosed bat is known to fly long distances from roost sites to foraging sites. Night flights from maternity colonies to flowering columnar cacti have previously been documented in Arizona at 15 miles and in Mexico at 25 miles and 38 miles (one way)(Dalton *et al.*1994, Yar Petryszyn, University of Arizona, Tucson, pers. comm. 1997). Fleming (1995) suggests that a substantial portion of the lesser long-nosed bats at the Pinacate Cave in Sonora fly 25 to 31 miles each night to foraging areas in Organ Pipe Cactus National Monument. Horner *et al*. (1990) found that lesser long-nosed bats commuted 15.5 miles between an island maternity roost and the mainland in Sonora. The authors suggested that bats regularly flew at least 47 miles each night. Lesser long-nosed bats have been recorded visiting individual blooming Palmer's agaves in excess of 1,000 visits per night (Ronnie Sidner, Tucson, Arizona, pers.comm. 1997), while other agaves may not be visited at all (Liz Slauson, Desert Botanical Gardens, Phoenix, Arizona, pers. comm. 1997). Lesser long-nosed bats have been observed feeding at hummingbird feeders many miles from the closest known potential roost site (Yar Petryszyn, pers. comm. 1997).

Status and Date of Listing

The lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*) was federally listed (originally as *Leptonycteris sanborni*; Sanborn's long-nose bat) as endangered on 30 September 1988 (53 FR 38456), is designated by AGFD as a Wildlife of Special Concern and is listed as a Sensitive Species by the U.S. Forest Service, Region 3 (USFS 2000). The USFWS has not designated critical habitat for the lesser long-nosed bat. A recovery plan for this species was approved on 4 March 1997 (USFWS 1994c). Disturbance and loss of roost and foraging habitat, as well as direct taking of individual bats during animal control programs, particularly in Mexico, have contributed to the current endangered status of the species. Suitable day roosts and suitable concentrations of food plants are the two resources that are crucial for the lesser long-nosed bat (Fleming 1995).

Distribution and Abundance in the Region and at Fort Huachuca

This species is found in arid regions ranging from Central America to a small portion of the southwestern United States. In the southwestern United States, lesser long-nosed bat roosts are known to occur in six counties in southern Arizona and one county in New Mexico.

It has been recorded in southern Arizona from the Picacho Mountains (Pinal County) southwest to the Agua Dulce Mountains (Pima County), southeast to the Chiricahua Mountains (Cochise County), and south to the international boundary. Additional locations have been located for this species as a result of intensive investigation associated with the endangered species listing.

The greatest densities of lesser long-nosed bats are located in northern Mexico and in southern Arizona (USFWS 1994c). Known major roost sites include 16 large roosts in Arizona and Mexico (Fleming 1995). According to surveys conducted in 1992 and 1993, the number of bats estimated to occupy these sites was greater than 200,000. Twelve major maternity roost sites are known from Arizona and Mexico. According to the same surveys, the maternity roosts are occupied by over 150,000 lesser long-nosed bats. The numbers above indicate that although a relatively large number of these bats are known to exist, the relative number of known large roosts is small. Disturbance of these roosts and the food plants associated with them could lead to the loss of the roosts. Limited numbers of maternity roosts may be the critical factor in the survival of this species. Of the three maternity roosts in Arizona, the largest, located approximately 150 miles from Fort Huachuca in Organ Pipe Cactus National Monument, has contained an estimated 20,000 adult bats (USFWS 1994c).

Records of the lesser long-nosed bat at Fort Huachuca and areas within foraging distance of the Fort (~40 miles) include at least two large post-maternity roosts; observers have recorded over 15,000 lesser long-nosed bats at a mine in the Coronado National Memorial, approximately 10 miles from Fort Huachuca, and over 30,000 bats at Patagonia Cave, at a distance of approximately 20 miles from the Fort (Sidner 1996). Other records include: 1) Panama Mine near Pyeatt Ranch on the western boundary of Fort Huachuca; 2) Pyeatt Cave, Fort Huachuca; 3) Manila Mine, Fort Huachuca; 4) Woodcutters Canyon, Fort Huachuca; 5) Wren Bridge, Fort Huachuca; 6) Brown Canyon, Huachuca Mountains; 7) Canelo Mine eight miles west of Fort Huachuca; 8) Miller Canyon, Huachuca Mountains; 9) SPRNCA at Fairbank; 10) Ramsey

Canyon, Huachuca Mountains; 11) State of Texas Mine, Coronado National Memorial, Huachuca Mountains; 12) Cave of the Bells, Santa Rita Mountains; 13) Helvetia, Santa Rita Mountains; 14) Madera Canyon, Santa Rita Mountains; 15) Empire Ranch north of Sonoita; 16) several localities near Patagonia; and 17) Colossal Cave, Pima County (Cockrum and Petryszyn 1991, Fleming 1995, Sidner 1993, 1994). Of the above sites, Fleming (1995) considered the Patagonia Bat Cave, Manila Mine, State of Texas Mine, and the Cave of Bells to be major post-maternity roosts of the lesser long-nosed bat. Three major maternity roosts and five major post-maternity roosts are known in Arizona. Post-maternity roosts are typically transitory roosts used by adults and/or young bats in summer or fall (Fleming 1995). Of the sites at Fort Huachuca, lesser long-nosed bats have been found day roosting at Pyeatt Cave and Manila Mine (some night roosting occurs at these sites as well). Wren Bridge is a night roost, and lesser long-nosed bats were mist-netted in Woodcutters Canyon (Sidner 1999, 1996, 1994). Upper Pyeatt Cave and Indecision Cave are considered potential day roosts, but the species has yet to be documented at these sites (Sidner 2000, 1999, 1996). A lesser long-nosed bat banded at Wren Bridge was found the next night at the Patagonia Bat Cave, demonstrating that individuals of this species move relatively long distances and bats at Fort Huachuca are part of a larger regional population (Sidner 1996, Howell 1996).

Fort Huachuca is located within a portion of this species' range utilized as a migratory corridor during the southward seasonal movement. Semidesert grasslands and lower oak woodlands provide summer and early fall foraging habitat of paniculate agave. There are no records of parturient or lactating lesser long-nosed bats from the installation. Rather, occurrence coincides with post-maternity disbursal of juveniles and adult females. Feeding and mass gain is critical at this time for survival during migration (Sidner 1996). Prior to listing, little work was done on Fort Huachuca resulting in a paucity of historical occurrence data. Recent work, beginning in 1989 and continuing through 2002 resulted in the discovery and consistent monitoring of numerous day roosts, night roosts and potential roosts. Monitored sites include Manila Mine, Pyeatt Cave, Upper Pyeatt Cave, Indecision Cave and Wren Bridge (Sidner 2000). Manila Mine and Wren Bridge are important night roosts for varying numbers of lesser long-nosed bats and Pyeatt Cave has been found to be used as a night roost as well.

Since 1990, Sidner has conducted surveys of six potential roost sites on Fort Huachuca and found that Manila Mine and Pyeatt Cave were used primarily as day roosts by lesser long-nosed bats as well as other bat species, that roost sites have been inhabited by bat colonies at least six months of the year, that there is variation in bat population numbers throughout this period, and that the population numbers have increased following the use of protective measures. These roosts are located on the West Range.

Annual peak numbers of lesser long-nosed bats counted at roosts on Fort Huachuca between 1990 and 2000 have varied from 24 in 1990 to approximately 3900 in 2000 (Sidner 2000). Lesser long-nosed bats have been recorded at Fort Huachuca from late July through October and as late as November 26 (Sidner 2000), with numbers of bats typically peaking in early September (Sidner 1996). Howell (1996) suggests that there are many potential roost sites in the Huachuca Mountains where hundreds of nectar feeding bats could roost without being detected.

Sensitivity of roosting lesser long-nosed bats to human disturbance lead the Fort to close Manila Mine, Pyeatt Cave, and Upper Pyeatt Cave to entry from April 15 through October 31 of each year. Entrances to these caves/mine are fenced with chain link in a way that inhibits illegal human entry but does not interfere with bats entering or exiting the roosts. The caves/mine are also posted. The access roads to Manila Mine and Pyeatt Cave are gated and locked.

Lesser long-nosed bats require suitable forage plants. At and near Fort Huachuca, forage plants include Palmers agave and possibly Parrys agave (the two are known to hybridize, as well.) Populations of Palmer agave found on the South and West Ranges represent the primary food source for lesser long-nosed bats on Fort Huachuca (Howell and Robinett 1995). Several areas of agave stands on the South and West Ranges are protected and are known as agave management areas (Figure 23, page 104). These stands have relatively high densities of agave as compared with other populations across the installation.

There are no known mines or caves on the South Range with suitable roosting habitat for lesser long-nosed bats. Nighttime netting efforts conducted on the South Range (Lower Garden, Middle Garden, Upper Garden, Huachuca, Tinker and Woodcutters Canyons) by Sidner in 1993 and 1994 were successful in trapping one lesser long-nosed bat in Woodcutters Canyon in nine nights of trapping.

There is no known roosting habitat for lesser long-nosed bats on the East Range. Only a few agaves are present in the grasslands located in the northwestern corner of this range.

3.9.15 JAGUAR

Description

The jaguar, *Felis onca,* is the largest endemic cat in the western hemisphere, measuring 170 to 240 cm (6 to 8 ft) in length. Adult male jaguars average 90 to 120 kg (198 to 265 lbs, rarely exceeding 135 kg or 300 lbs) while adult females average 60 to 90 kg (132 to 199 lbs)(Nowak 1991). This large, muscular cat is occasionally melanistic in color (black) in its southern range, but typically appear to be tawny-yellow in color, profusely speckled with black spots. These black spots may form broken circles or rosettes with one or more black spots in the center (Hoffmeister 1986). In addition, a row of black elongated black spots merges into a solid line along the midline of the back (Nowak 1991). All underparts are white, and except for a series of black bars on the chest, are marked with black splotches (Brown and Gonzalez 2001). The lower region of the tail is ringed in black and the tips of the ears have black edges. The tails of jaguars are typically 40 to 45% of the head-body length (Hoffmeister 1986).

General Ecology

Jaguars use a variety of habitats. In South and Central America, they inhabit all forest types including evergreen rain forest, evergreen riparian forest, semi-evergreen forest and dry deciduous forest. In southern Mexico, jaguars inhabit evergreen and semi-evergreen rain and montane forests. 30% of the jaguars killed in the borderland regions are known from Madrean evergreen woodlands biotic community (Brown and Gonzalez 2001). In the arid southwest,

jaguars inhabit pine-oak woodland as well as Madrean woodland and Sinaloan thornscrub. Den sites vary but often consist of a natural cave, abandoned mine, an overhang or copse of dense vegetation (Brown and Gonzalez 2001).

Individual jaguars use 26 to 52 square km (10 to 20 square miles), depending upon the available prey base (Hoffmeister 1986). The jaguar preys on more than 85 species, including javelina (*Pecari tajacu*), capybaras, armadillos (*Dasypus*), deer (*Odocoileus*) and various fish and birds (USFWS 1997d). Along the US / Mexico border, deer and javelina are its primary prey base. The dietary overlap between the jaguar and the mountain lion (*Felis concolor*) is about 70%, however, jaguars consume larger prey (Hoffmeister 1986; Johnson and Van Pelt 1997). Unlike most felids which kill with a throat or neck bite, the jaguar kills its prey by biting through the temporal bones of the skull.

Jaguars breed year round. However, in the more northern regions of its range, there is evidence of a spring breeding season (USFWS 1997d). The female provides all parenting to the 1 to 4 cubs born after a 95 to 105 day gestation period. The cubs are weaned at 3 months of age but remain in the birthing den for up to 6 months and associate with the mother for up to 24 months. In the wild, few jaguars live greater than 11 years (USFWS 1997d).

Status and Date of Listing

The jaguar was extended endangered status within the US on 22 July 1997, effective 21 August 1997 (USFWS 1997d). With this ruling, the jaguar is now considered endangered within the US, Mexico, and South America. In addition, the jaguar is a Wildlife of Special Concern in the state of Arizona. Critical habitat was found "not be prudent" by the USFWS and therefore was not designated (USFWS 1997d). Until further information is available on the present distribution in the US, recovery plans for this cat are consistent with the Listed Cats of Texas and Arizona Recovery Plan (USFWS 1997d).

In March 1997, the AGFD released a Conservation Assessment and Strategy (Johnson and Van Pelt 1997) for the jaguar in Arizona and New Mexico along with a Memorandum of Agreement (MOA) to unite 17 agencies in order to identify and assess the risks and to promote the expansion of the jaguar.

The primary threats to the jaguar population are loss and modification of habitat and poaching. A minimum of 64 jaguars have been killed within Arizona since 1900 (USFWS 1997d). An illegally poached jaguar pelt can sell for as much as $8,000.

Distribution and Abundance in the Region and at Fort Huachuca

Historically, this species range extended from Argentina north into Louisiana, Texas, New Mexico, Arizona, and possibly southern California (Johnson and Van Pelt 1997; USFWS 1997d). There may have been a resident population in southwestern Arizona (USFWS 1997c); however, there is no evidence they are breeding here now or is there consensus that they have bred here historically (Brown and Gonzalez 2001). The current range of the jaguar has been reduced to more southern areas of central Mexico, central America, and northern Argentina

(USFWS 1997d). In areas of Mexico such as the arid Sierra del Bacatete, jaguars are common and are still hunted (Hoffmeister 1986). Since 1848, there have only been 84 recorded jaguar occurrences in Arizona; most were assumed to be transients (Johnson and Van Pelt 1997). Girmendonk reported that between 1961 and 1994 there were seven confirmed observations of jaguars. Four of these observations occurred in Cochise and Santa Cruz Counties (Girmendonk 1994). Currently, there is no known resident populations of jaguars in the US (USFWS 1997d). In Arizona, transient jaguars are occasionally observed; in 1996 two sightings occurred in Pima County and in Cochise County, both documented by photographs. The latest confirmed sighting occurred on December 6, 2001 when a young male jaguar was photographed by a motion-activated camera along the US/Mexican border south of Tucson. These observations may be evidence that the jaguar is becoming more abundant within its historical range. Because jaguars use a wide variety of habitat types and regional jaguar sightings are rare, the probability of jaguars occurring within Fort Huachuca is low.

The likelihood of jaguars occurring on within the proposed action area is low. However, if jaguar populations recover on a regional basis, the probability of jaguars occurring in the action area may increase in the future.

3.9.16 OCELOT

Description

The ocelot, *Felis paralis*, is a medium sized cat weighing 7 to 16 kg (15 to 35 lbs) and 122 cm (48 in) in total length. The dark-ringed tail of the ocelot is about one half the length of the head-body (Nowak 1991). The coat is creamy gray to yellow-red in color with black streaks and stripes running horizontally down the body (Hoffmeister 1986). In addition, there are two black stripes on each cheek and one to two black transverse bars on the inside of each leg (Nowak 1991).

General Ecology

In tropical America, the ocelot is found more often in forested habitats (Hoffmeister 1986). However, in Texas and Arizona (the northern part of their range), the ocelot usually inhabits dense, chaparral thickets or shrubby vegetation along streams. A study conducted in Texas by Tewes (1982) revealed that ocelots occur in habitats with very dense brush. In that study, brush canopy cover was a better indicator of potential habitat than the brush species composition and canopy coverage of habitat known to contain ocelots was typically greater than 99% (Tewes 1982). The Tewes study utilized a 95% canopy coverage to identify optimal habitat where a contiguous dense brush stand of 40 ha (100 acres) or two proximate 30 ha (75 acre) stands were located. Tewes considered several small acres of typical brush to be good habitat if they totaled a minimum of 40 ha (100 acres) and were in close proximity to one another with brush between patches as a corridor. Narrow, riparian strips were also considered good corridors, however they have minimal value if not within a larger patch network.

Ocelots are generally crepuscular and nocturnal, spending the day within heavy brush areas. They typically hunt alone and prey primarily on small mammals and birds but will occasionally

consume snakes, lizard, insects, and fish (USFWS 1990d). Males typically have larger home ranges than females, with a single male's home range overlapping more than one female's home range (USFWS 1990d).

Mating can occur throughout the year and captive females are polyestrous year round. After a 70 to 89 day gestation, 1 to 4 (typically 1 or 2) kittens are born in a secluded den typically found in a dense thicket or fallen tree. At 8 weeks of age the kittens join the mother on foraging excursions and by 4 months of age reach independence. However, they may remain within the mother's home range for up to 2 years of age. Sexual maturity can be reached by 8 months of age, but 2 years is the usual age of first conception (USFWS 1990d).

Status and Date of Listing

The ocelot is listed as federally endangered and a recovery plan has been approved. In addition, this species is listed as sensitive by the USFS and endangered in Mexico. Formerly considered endangered in Arizona, this species is now considered a Wildlife Species of Concern (AGFD 1996). No critical habitat has been designated.

Poaching and fur trade in the mid 1800s is thought to be the major cause for the decline of the ocelot. The USFWS (1990d) ocelot recovery plan recommends implementing hunter and trapper surveys to obtain information on current ocelot distribution within Arizona. When a sighting is reported, the recovery plan recommends a trained biologist respond in a timely manner to obtain sighting information and to determine the reliability of the sighting.

Distribution and Abundance in the Region and at Fort Huachuca

The ocelot ranges from northern Argentina to the extreme southern portions of Arizona and Texas (Hoffmeister 1986). The last confirmed ocelot observation in Arizona was in 1964 in the Huachuca Mountains (Girmendonk 1994). Since 1966, there have been three reliable reports of ocelots greater than 483 km (300 miles) south of Fort Huachuca in Sonora, Mexico. In addition, there have been unconfirmed and unreliable ocelot sightings since 1980: two from the San Pedro Valley; one from the Holbrook-Concho area; and one from the Sasabe area (USFWS 1990d). Because ocelots are rare and sightings within the area are unconfirmed, the occurrence of ocelots on Fort Huachuca is unlikely. In addition, potential habitat in the area is limited to mesquite woodland vegetation along the Babocomari and San Pedro Rivers, but the density of the vegetation in these areas may be too low to support ocelots.

3.9.17 MEXICAN GRAY WOLF

Description

The Mexican gray wolf, *Canis lupus baileyi,* is the smallest and the southernmost subspecies of the gray wolf, *Canis lupus* in North America (Bednarz 1988). Adult Mexican wolves weigh from 27 to 41 kg (60 to 90 lbs) and are 134 to 198 cm (53 to 78 in) in length. Males are typically larger than females in this species. Mexican wolves are reddish-gray in color with black on the

face, sides, and back; reddish between the ears and underside of belly; with white on the throat and foreleg area; and a distinct white lip line around the mouth.

General Ecology

The Mexican wolf historically occupied oak woodlands, pine/oak woodlands, or pine forests with adjacent grasslands of mountainous terrain, dense cover, and accessible water from 4,000 – 12,000 feet (Bednarz 1988). Historic observations of this species in New Mexico indicate that they were primarily found in the upper Sonoran and transition zones associated with densely forested terrain composed of ponderosa pine (*Pinus ponderosa*), pinyon pine (*Pinus edulis*), and oak (*Quercus* spp.). The Mexican wolf tends to avoid desert habitats, although they have been known to cross the desert floor to suitable habitat (Bednarz 1988, Hoffmeister 1986; Groebner *et. al.* 1995). According to McBride (1980), while it appears wolves prefer certain vegetative associations, their presence or absence is generally a response to prey availability.

The primary prey item of the Mexican wolf is mule deer and white-tailed deer, but their diet also includes elk, javelina and occasionally pronghorn, bighorn sheep, rabbits, hares, turkeys and small rodents (USFWS 1995e). It is estimated that a Mexican wolf consumes 2.8 kg (6.1 lbs) of meat a day compared to the northern subspecies that consumes 4.1 kg (9.0 lbs) per wolf per day (USFWS 1995e). The heavy livestock depredation by Mexican wolves in the late 1800s and early 1900s may have been due to new settlers who greatly reduced the natural prey base through over-hunting and habitat degradation (USFWS 1995e). If adequate, natural prey populations exist, the Mexican wolf should coexist with livestock in a similar manner as wolves in the northern Rocky Mountain regions. No accounts exist of Mexican wolves attacking humans (USFWS 1995e).

The Mexican wolf typically breeds in February, producing five to six pups after a 63 week gestation period (USFWS 1995e). The entire pack of two to eight individuals (typically five) provides food for the pups after they are weaned at five to six weeks of age. In the wild, Mexican wolves reach sexual maturity at 2 years of age and live eight to sixteen years (USFWS 1995e).

Status and Date of Listing

The Mexican gray wolf was listed as a federally endangered species on April 28, 1976 (41 FR 17742) and a federal recovery plan was approved in 1982. Critical habitat was not designated for the experimental, non-essential population of this canid. In Arizona the wolf is considered a Wildlife Species of Concern.

A portion of the population's decline has been attributed to the increase of agriculture and roads in their habitats, as well as a decrease in the deer population from human hunting. However, the dominant cause of the Mexican wolf's extirpation in Arizona was persecution by humans (USFWS 1995e). Federal wolf eradication efforts were begun in 1915 and by 1930, very few Mexican wolves remained.

Distribution and Abundance in the Region and at Fort Huachuca

Historically, the Mexican wolf inhabited areas from southern Arizona (including the Huachuca Mountains) and Texas down to southern Mexico (Groebner and Johnson 1995). Wolves were present in southeastern Arizona until the 1950s. Despite numerous reports of sightings in Arizona, New Mexico, Chihuahua, and Durango, Mexico by the public, survey efforts by the AGFD failed to detect any evidence of the Mexican wolf in either Arizona or the northern reaches of Sonora, Mexico (Groebner and Johnson 1995). Currently, the Mexican wolf is believed to be extirpated from the US (Sevilleta LTER 1996).

Because of the broad habitat requirements of the Mexican gray wolf, most of the upland habitats of Fort Huachuca may be suitable for wolves. There have been no recent wolf reports from Fort Huachuca; however, several unconfirmed reports have come from the Parker Canyon Lake region south of the Fort (USFWS 1995e). Mixed woodland, montane conifer forest, and savanna communities on the South and West Ranges have the potential to support the species and its prey base (Coue's white-tailed deer, desert mule deer, javelina, and pronghorn), if it recovers in the future, either naturally or through reintroduction. The USFWS (1995e), predicted that if natural re-colonization was to occur on Fort Huachuca, it would not pose a conflict with the Fort's activities nor with the regional economy.

The USFWS proposed reintroducing this endangered species within its historic range in the southwestern US. The proposed release sites were in the Blue Range Primitive Area of east-central Arizona and the White Sands Missile Range of south-central New Mexico (USFWS 1995e). In March 1997, Secretary of Interior Bruce Babbit approved Alternative A for reintroduction of the Mexican wolf. This alternative classifies the wolf as an experimental, non-essential population and does not allow for dispersal outside of an 18,200 sq. km (7,000 sq. mile) recovery area. The recovery area is referred to as the Blue Range Wolf Recovery Area (BRWRA) and is comprised of portions of the Apache-Sitgreaves National Forest in eastern Arizona and the adjacent Gila National Forest in western New Mexico. On March 29, 1998, 11 Mexican Gray wolves were released on the Apache-Sitgreaves Nations Forest with the objective of reestablishing a wild population of at least 100 wolves. This goal is expected to be achieved by 2006. Sixty-nine wolves have been released since March of 1998 and as of July 2001, approximately 35 wolves inhabited the BRWRA.

Suitable habitat for this species does exist on Fort Huachuca and it is possible that introduced wolves could relocate to those habitats. However, per Alternative A, dispersing wolves will be relocated if they move out of the recovery area surrounding the Blue Range Primitive Area (Parsons 1997).

3.9.18 BLACK-TAILED PRAIRIE DOG

Description

The black-tailed prairie dog, *Cynomys ludovicianus,* is a diurnal, burrowing rodent, almost 15 inches in length, including a 2½-inch, black-tipped tail. It is yellowish buff in color and weighs up to three pounds (AGFD 1999).

General Ecology

The black-tail prairie dog is found in burrows in plains and grassland habitats. They live in colonies or towns, which cover from one acre to tens of thousands of acres of grassland habitat. They are active throughout the year. However, in extremely cold weather, the black-tailed prairie dog will remain underground for several consecutive days, but they do not hibernate. When unsuitable habitat such as a hill, tall vegetation, or a stream divides a prairie dog colony, the resulting sub-colonies are called wards (King 1955). Within colonies, prairie dogs live in territorial, harem-polygamous family groups called coteries. Groups of colonies comprise a complex. The colonial nature of prairie dogs, especially the black-tailed prairie dog, is a significant characteristic of the species (AGFD 1999).

Breeding season varies with locale. In the southern parts of its range, breeding begins in January whereas in the northern portion of it range, breeding continues into April. Longevity for this species has been documented up to eight years in the wild (AGFD 1999).

This species feeds on a variety of grasses and forbs and to a lesser degree on seeds and insects. Commonly associated grasses include buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*).

Status and Date of Listing

On July 30, 1998, the USFWS received a petition to list the black-tailed prairie dog as threatened throughout its range. On March 23, 1999, the USFWS announced a positive 90-day finding which resulted in a nine-month review process for the petition. On 4 February 2000, USFWS announced a 12-month petition notice that listing the species is warranted but precluded by other higher priority actions. This finding remained unchanged when the 12-month review notice was announced on 31 October 2001 (USFWS 2001).

Distribution and Abundance in the Region and at Fort Huachuca

The following distribution account is excerpted from the Black-tailed Prairie Dog Conservation Assessment and Strategy Draft dated 9 September 1999, referenced herein as AGFD 1999.

Historically, this species is known from Canada to Mexico throughout the Great Plains states and west to southeastern Arizona. The historic range of the black-tailed prairie dog included portions of 11 States, Canada, and Mexico. Today it occurs from extreme south-central Canada to northeastern Mexico and from approximately the 98th meridian west to the Rocky Mountains. The species is currently present in 10 States including—Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming. It has been extirpated in Arizona circa 1960. Early accounts about prairie dogs, although anecdotal at times, indicate they occurred in large numbers. Naturalist Ernest Thompson Seton estimated that five billion black-tailed prairie dogs inhabited the North America prairies in the early 1900s. However, since that time prairie dog numbers and distribution have been greatly reduced across their range. This reduction resulted from a number of factors including intensive control

programs, conversion of habitat to croplands, disease epizootic, and urbanization. The historic and current distributions of black-tailed prairie dogs in Arizona is as follows:

In the 1800s, black-tailed prairie dogs were considered quite abundant throughout their range in southeastern Arizona. In 1907, Mearns (cited in Hoffmeister 1986) reported that "For miles the burrows of these animals are thickly scattered over the plains south of the Pinaleno range or Sierra Bonito, where the soil is clayey and better suited to the habits of this animal than the loose sand of most of Arizona." Black-tails ranged from the Sulphur Springs Valley north of Bonito, south to the Mexican border, and west to the Sonoita grasslands, on the west side of the Huachuca Mountains. Although Alexander considered black-tailed prairie dogs extirpated by 1932, Charles Vorhies collected two animals six miles southeast of Fort Huachuca in 1938 (Hoffmeister 1986). In 1962, in a memorandum to the Bureau of Sports Fisheries and Wildlife Regional Director, Everett M. Mercer documents the persistence of a small black-tailed prairie dog colony near Apache, Arizona until 1959-1960. The black-tailed prairie dog was considered extirpated from Arizona in 1960 and the species is still considered extirpated by the AGFD (AGFD 1999).

As stated above, the black-tail prairie dog is considered extirpated from Arizona. Therefore it is not known or likely to occur on Fort Huachuca. However, suitable habitat is present on the installation and Fort Huachuca is being considered as a potential reintroduction area for southeastern Arizona.

3.9.19 SONORA TIGER SALAMANDER

Description

The Sonora tiger salamander, *Ambystoma tigrinum stebbinsi*, is a large salamander with a dark venter and light-colored blotches, bars, or reticulation on a dark background. Snout-vent lengths of metamorphosed terrestrial salamanders vary from approximately 2.6-4.9 inches (Jones *et. al.* 1988, Lowe 1954). Larval salamanders are aquatic with plume-like gills and well-developed tail fins (Behler and King 1980). Larvae hatched in the spring are large enough to metamorphose into terrestrial salamanders from late July to early September, but only an estimated 17 to 40% metamorphose annually. Remaining larvae mature into branchiates (aquatic and larval-like, but sexually mature salamanders that remain in the breeding pond) or over-winter as larvae (Collins and Jones 1987; James Collins, Arizona State University, pers. comm. 1993).

This subspecies was described by Lowe in 1954, subsequent field surveys, and genetic analysis in the 1980's and 1990's reinforced the status of the Sonora tiger salamander as a distinct subspecies (USFWS 1999c). It is one of three subspecies found in Arizona. The other two are Arizona tiger salamander, *A.t. nebulosum,* and barred tiger salamander, *A.t. mavortium*.

General Ecology

Larval salamanders are aquatic and hatch in the spring with approximately 30% of larvae metamorphosing into terrestrial adults in late summer and early fall. The remaining larvae either

overwinter as larvae or mature into branchiates. The Sonora tiger salamander inhabits springs, cienegas, and livestock tanks (USFWS 1997a).

Historically, the Sonora tiger salamander probably inhabited springs, cienegas, and possibly backwater pools that were extant long enough to support breeding and metamorphosis (at least two months), but ideally were permanent or nearly permanent, allowing survival of mature branchiates. The grassland community of the San Rafael Valley and adjacent montane slopes, where all extant populations of Sonora tiger salamander occur, may represent a relictual grassland and a refugium for grassland species. Tiger salamanders in this area became isolated and, over time, genetically distinct from ancestral *A. t. mavortium* and *A. t. nebulosum* (Jones *et. al.* 1995). Contrary to the statement in SAIC (1998a) that these salamanders in Arizona were introduced into stock tanks by humans, genetic work by Jones *et. al.* (1995) suggests the subspecies known as the Sonora tiger salamander originated in the San Rafael Valley, and was not introduced by humans. This subspecies has opportunistically taken advantage of available stock tank habitats as natural habitats disappeared (Hendrickson and Minckley 1984) or were invaded by nonnative predators with which the salamander can not coexist (USFWS1997a). The habitat requirements for the genus include lakes, ponds, and stock tanks with surrounding vegetation types ranging from arid sagebrush plains and rolling grassland to mountain meadows and forests with elevations of near sea level to 3660 meters (12,000 ft). Jones *et. al.* (1988) found the Sonora tiger salamander only in stock tanks and believes that these salamanders in Arizona were introduced into stock tanks by humans.

Status and Date of Listing

The Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*) was federally listed as endangered on 6 January 1997 (50 CFR 17). No critical habitat was designated for this species and a recovery plan drafted in 1999 has not yet been approved. Arizona considers this amphibian a Wildlife Species of Special Concern.

Primary threats to the salamander include predation by nonnative fish and bullfrogs, a disease, catastrophic floods and drought, illegal collecting, introduction of other subspecies of salamanders that could genetically swamp *A.t. stebbinsi* populations, and stochastic extirpations or extinction characteristic of small populations with low genetic variability. Predation by catfish, bass, mosquito fish, and sunfish can eliminate stock tank populations of Sonora tiger salamander (Jonathan Snyder, Arizona State University, pers. comm. 1996; Collins *et. al.* 1988). The salamanders can apparently coexist with bullfrogs, but bullfrogs prey on salamanders (J, Snyder, pers. comm. 1996) and perhaps if they are present in sufficient densities could reduce or eliminate salamander populations. Tadpoles of wood frogs, *Rana sylvatica*, are known to feed on spotted salamander, *Ambystoma maculatum*, eggs (Petranka *et. al.* 1998), but under experimental conditions bullfrog tadpoles do not feed on viable salamander eggs or hatchlings (Collins 1996, J. Collins, pers. comm. 1996). A disease, recently identified as an iridovirus, has been documented at numerous tanks in the San Rafael Valley (Jancovich *et. al.* 1998). Once introduced to a stock tank, most or all aquatic salamanders die (Collins *et. al.* 1988, Jancovich *et. al.* 1998). The disease may be spread by birds, cattle, or other animals that move among tanks (Jancovich *et. al.* 1998). The disease could also be spread by researchers if equipment such as waders and nets used at a salamander tank are not disinfected or allowed to thoroughly dry

before use at another tank. Diseased salamanders were found at two tanks in 1997 (Abbate 1998).

Ambystoma tigrinum mavortium or *stebbinsi mavortium* crosses have recently been confirmed for the first time at two stock tanks in the San Rafael Valley (Ziemba *et. al.* 1998). Thus, genetic swamping of stebbinsi populations may be underway. With the exception of Bog Hole in the San Rafael Valley and a site on Fort Huachuca, cattle grazing occurs throughout the range of the Sonora tiger salamander. Cattle can trample salamanders and their eggs, and can degrade habitat at stock tank breeding sites. Overgrazing can cause loss of cover and erosion that can threaten the integrity of stock tanks used by the salamander. Genetic analysis suggests very little genetic variability in Sonora tiger salamanders (Jones *et. al.* 1988, Jones *et. al.* 1995, Ziemba *et. al.* 1998). In populations with low genetic variability lethal alleles are more likely to be expressed, disease resistance may be low, and evolution and adaptation to a changing environment is relatively slow.

Threats to Sonora tiger salamander in the project area include erosion, sedimentation, and smoke or ash toxicity due to wildfire, prescribed fire, or managed natural fire, and suppression activities; death or injury of salamanders due to off-road vehicles illegally driving through upper Garden Canyon Pond; illegal collection of salamanders for bait or other purposes; introduction of nonnative fish, bullfrogs, or other subspecies of salamanders to Sonora tiger salamander habitat that may prey upon or spread disease to Sonora tiger salamanders; and in the case of other subspecies, interbreed with and cause genetic swamping of the Sonora tiger salamander population. Crayfish are present in upper Garden Canyon Pond and likely prey on salamander larvae and eggs, but such predation has not been documented.

Distribution and Abundance in the Region and at Fort Huachuca

All sites where Sonora tiger salamanders have been confirmed are located in the San Rafael Valley and adjacent portions of the Patagonia and Huachuca mountains in Santa Cruz and Cochise counties, Arizona.

In Arizona, currently known populations are located in San Raphael Valley, Harshaw and Cooper Canyons, Coronado Memorial, and on Fort Huachuca. Salamanders suspected of being Sonora tiger salamanders were found in the Los Fresnos cienega in Mexico (USFWS 1999c).

The Sonora tiger salamander is known from approximately 53 breeding localities (Collins and Jones 1987, Collins 1996, USFWS 1997a, Abbate 1998, Ziemba *et. al.* 1998, Jon Snyder, Arizona State University, pers. comm., 1999; Mike Pruss, AGFD, pers. comm. 1999); although at any one time not all of these sites are occupied. During intensive surveys in 1997, from one to 150 Sonora tiger salamanders were found at 25 stock tanks (Abbate 1998). Populations and habitats are dynamic, thus the number and location of extant aquatic populations changes over time, as exhibited by the differences between survey results in 1985 and 1993-1997 (Collins and Jones 1987, Collins 1996, James Collins, pers. comm., 1996, Ziemba *et. al.* 1998, Abbatte 1998). Some sites that once supported salamanders are now inhabited by nonnative predators that preclude re-colonization.

Three populations of Sonora tiger salamanders are known to exist in the Huachuca Mountains. These salamanders occur in Scotia and Copper Canyons off-post, and in Upper Garden Canyon on post. Tiger salamanders suspected of being Sonora tiger salamanders occurred in recent years at the lower Peterson Ranch tank in Scotia Canyon, which is within approximately one mile of Gate No. 7 and upper Garden Canyon Pond. The upper reaches of Scotia Canyon supports perennial surface water and the canyon may be a movement corridor for salamanders to access higher elevation sites in the Huachuca Mountains from localities in and near the lower reaches of Scotia and Sunnyside canyons. Salamanders have not been observed at the lower Peterson Ranch tank in the last few years; this population may be extirpated.

On Fort Huachuca, tiger salamanders are known from upper Garden Canyon Pond near the crest of the Huachuca Mountains and the junction of Sawmill and Garden canyons, and also from the wastewater treatment ponds and the golf course. The Upper Garden Canyon Pond nearly went dry in the spring of 1996. Drought conditions in early 1996 severely diminished the volume of the tank, and surveys of this population in April 1996 detected only one branchiate salamander. The pond dried again in June 1997 (J. Collins pers. comm. 1998) and June 1999 (J. Rorabaugh, Fish and Wildlife Service, pers. obs. 1999). Periodic drying results in the elimination or metamorphosis of aquatic larval and branchiate salamanders. Reduced water levels stimulates metamorphosis, and many salamanders simply walk away from drying ponds and return to breed when the pond refills. However, if the pond remained dry for several seasons or for years, or water was not present long enough to allow breeding and metamorphosis, the number of surviving terrestrial salamanders might not be sufficient to re-colonize the pond. Re-colonization would then have to occur as a result of immigration from another pond.

In 1998, salamanders were collected from the upper Garden Canyon Pond and from the wastewater treatment ponds. Mitochondrial DNA sequencing and allozyme analysis of salamanders from the wastewater treatment plant suggests that these salamanders are *Ambystoma tigrinum mavortium*. Analysis of salamanders from upper Garden Canyon pond was less clear. These animals showed a high level of heterozygosity, which is uncharacteristic of *A. t. stebbinsi*, but the mitochondrial DNA sequencing suggested these animals are identical to the majority of *stebbinsi* populations in the San Rafael Valley. A cannibalistic morph was also found at upper Garden Canyon pond, which is highly unusual for *stebbinsi* populations, but a common occurrence in populations of *A. t. mavortium*. These salamanders could be hybrids between the two subspecies, but available data are inadequate to make this determination (Storfer *et. al.* 1999.) Additional genetic work, using micro-satellite analysis, is underway to clarify the taxonomy of this population.

3.9.20 RAMSEY CANYON LEOPARD FROG

Description

Platz (1993) was the first to describe a new, distinct species of frog, the Ramsey Canyon leopard frog, *Rana subaquavocalis,*. Previously, it was thought only one species of leopard frog, *Rana pipiens* existed. Recent evaluations of behavior and genetic analyses have resulted in the description of six species in the genus *Rana* in the US, including the Ramsey Canyon leopard frog (Platz 1993).

The Ramsey Canyon leopard frog is a large frog that is typically green and spotted. It also has cream-colored spots on the caudal portion of the dark thigh. This species is distinguished by its call which is given underwater.

General Ecology

The Ramsey Canyon leopard frog ranges in elevation of 1,645 to 1,737 m (5,400 to 5,700 ft) only within the Huachuca Mountains. It inhabits stock ponds and natural or plunge pools that are 30.5 to 131.1 cm (1.0 to 4.3 ft) deep. Plant communities that surround these sites are typically oak woodland or semidesert grassland.

The Ramsey Canyon leopard frog feeds primarily on arthropods and other invertebrates, and on small vertebrates as well (AGFD 1995). In addition, it is known to exhibit lekking behavior (a courting behavior where the males gather at the center of a pond and vocalize to attract females) during the breeding season (ESWR 1996).

Status and Date of Listing

The Ramsey Canyon leopard frog was recently removed as a candidate for federal listing but is on Arizona's list of Wildlife Species of Concern. The Ramsey canyon leopard frog declined from 96 frogs in 1990 to 26 frogs in 1995 (ESWR 1996). Therefore, the USFWS, TNC, AGFD, USFS, a private land owner, and Fort Huachuca developed a 5 year conservation agreement for the Ramsey canyon leopard frog on 16 July 1996. This agreement was implemented in order to reduce threats to the species, stabilize the species population, and maintain its habitat.

The primary threats to Ramsey Canyon leopard frog are population fragmentation, low population sizes, and habitat loss due to water diversion and groundwater pumping. In addition, adequate water flows, pond depth, oxygen levels, pH levels, and reduction of predation by crayfish, bullfrogs, and non-native fishes are thought to be critical to the species preservation. The most studied population (the Ramsey Canyon Preserve) has had low recruitment in recent years.

Distribution and Abundance in the Region and at Fort Huachuca

The Ramsey Canyon leopard frog is limited to artificial ponds in Brown, Ramsey, Miller and Tinker Canyons within a 6 km (3.7 miles) radius on the east slope of the Huachuca Mountains near Fort Huachuca (AGFD 2001b). The Tinker Canyon population on Fort Huachuca appears to be doing well and is reproducing (Wallace 1998). In addition, this amphibian was introduced into the Lower Garden Canyon pond in September 1996. The Garden Canyon pond population has been extirpated due to limited water and exotic bullfrogs and mosquitofish. Surveys conducted in from 1994 through 1997 by AGFD did not find any additional populations of the Ramsey Canyon leopard frog outside of Tinker pond (Wallace 1998).

3.9.21 CHIRICAHUA LEOPARD FROG

Description

The Chiricahua leopard frog, *Rana chiricahuensis,* is a distinct species, formerly considered *Rana pipens* (Platz and Mecham 1979). The Chiricahua leopard frog is a relatively stocky frog with cream colored spots on the dark, caudal portion of the thighs. This frog has dorso-lateral folds (on the top and sides) that are interrupted and deflected medially (toward the middle). This frog is distinguished from other *Rana* sp. by its vocalization that is given out of water (Platz and Mecham 1979).

General Ecology

This species is highly aquatic and will utilize a variety of water sources such as rocky streams with deep rock bound pools, river overflow ponds, oxbows, permanent springs, earthen stock tanks and ponds. This species appears to require permanent or nearly permanent water sources. There is evidence to support that Chiricahua leopard frog larvae will adapt morphologically (change shape and color) to various habitats for camouflage (Jennings and Scott 1993).

Vegetation surrounding populations is usually oak and mixed oak/pine woodlands, but will occasionally be found in chaparral, grasslands, and even desert. In southeastern Arizona, the elevation range of known populations is 372 to 1,226m (1,219 to 4,023 ft). Adults feed on arthropods and other invertebrates, while larvae eat algae, organic debris, plant tissue, and minute organisms in the water (AGFD 2001a).

Status and Date of Listing

The Chiricahua leopard frog was proposed for listing as a federally threatened species on June 14, 2000 (65 FR 37343). Within Arizona, this frog is a Wildlife Species of Concern.

The Chiricahua leopard frog is declining in Arizona, and it is suspected that introduced bullfrogs and fish are to blame (AGFD 2001b). While there are no management strategies in place, this frog is currently being studied by the AGFD and research has been conducted by area universities.

Distribution and Abundance in the Region and at Fort Huachuca

The Chiricahua leopard frog has two separate ranges: the montane portions of the Mogollon Rim extending into New Mexico; and the southeast montane regions of Arizona and adjacent Sonora, Mexico (Platz and Mecham 1979). Potential habitat exists on the South and West Ranges for this frog. However, this frog was not located on Fort Huachuca during surveys conducted by AGFD in 1996 and is not known to presently occur on the installation.

3.9.22 NEW MEXICAN RIDGE-NOSED RATTLESNAKE

Description

The New Mexican ridge-nosed rattlesnake, *Crotalus willardi obscurus*, is one of five species of willardi that occur in Arizona. It is a small mountain rattlesnake up to 26.3 inches in total length. This subspecies is generally grayish-brown with a distinct ridge on the end of its snout. The upper surface has irregularly spaced white cross bars edged with brown in a dull pattern. The young can be distinguished from the adults by color. The young are dark brown, have yellow-orange pigment on the labial scales, and may have yellow or black tails (AGFD 2001e). *C.w. obscurus* lacks the vertical white stripe on the rostral and mental scales and the lateral facial stripes are faded or absent, compared to *C.w. willardi* which is recognized as the most common subspecies in Arizona (AFGD 2001e, BISON 2000).

General Ecology

The ridge-nose rattlesnake is a montane species throughout its range and is described as a montane generalist (AGFD 2001e, BISON 2000). C.w. obscurus is found in habitat composed of various oaks (*Quercus* spp.), Apache and Chihuahua pines (*Pinus engelmannii* and *P. leiophylla*), Arizona madrone (*Arbutus arizonica*), alligator juniper (*Juniperus deppena*), Arizona cypress (*Cupressus arizonia*), manzanita (*Arctostaphylos* spp.) and various grasses (AGFD 2001e). *C.w. obscurus* is restricted to rocky hillsides, canyon bottoms, and talus slopes (BISON 2000).

Status and Date of Listing

The Mexican ridge-nosed rattlesnake was listed as federally threatened on 4 August 1978 (43 CFR 34479) and is listed as a Sensitive Species by USFS, Region 3. Critical habitat was designated in 1996 in New Mexico, Hidalgo County between the elevations of 6,200 feet and 8,532 feet in Bear, Indian, and Spring Canyons in the Animas Mountains (50 CFR 17.95 [c]) (BISON 2000). A recovery plan was completed in 1985. Primary threats that lead to the listing of the subspecies include habitat alteration, loss or degradation from grazing, wood cutting, and stand–replacing fires. Snake collecting has also had an impact on the decline of this subspecies (BISON 2000). This subspecies may not be collected from the wild in Arizona by Order 43 of Arizona Game and Fish Commission (AFGD 2001e).

Distribution and Abundance in the Region and at Fort Huachuca

The New Mexican ridge-nose snake is only known from the Animas mountains of New Mexico, the Peloncillo Mountains of Arizona, the Sierra de San Luis of extreme northeastern Sonoran and Western Chihuahua, Mexico (AGFD 2001e). It is endemic to New Mexico and the San Luis Mts. of adjacent Chihuahua (BISON 2000). Although *C.w obscurus* had been reported from the Chiricahua Mountains since 1988, no confirmed specimens, details, or photographs support these observations. One specimen was collected in the Peloncillo Mountains in Cochise County, Arizona in 1996 (BISON 2000). *C.w. obscurus* is not known or likely to occur on Fort Huachuca or in the action area.

3.9.23 GILA TOPMINNOW

Description

The Gila topminnow, *Poeciliopsis occidentalis occidentalis*, is a small sexually dimorphic, guppy-like fish. Males reach a length of approximately 25 mm (1 inch) and the larger females reach a length of 30 to 35 mm (1.2 to 1.8 inches)(NMDGF 1996). Coloration is tan to olivaceous with a whitish-yellow belly. Females have a dark band on each side while breeding males turn black with some golden/yellow fins. A dark spot occurs at the base of the dorsal fin, and the body has some dark edges or speckling (NMDGF 1996). The Gila topminnow has a short snout, with a sub-superior (lower portion is larger) mouth, and a dark lateral line from the opercle to the base of the caudal fin on the females.

General Ecology

The Gila topminnow inhabits springs, marshes, permanent streams, intermittent streams, and cienegas at elevation below 1500 meters. This species prefers areas with dense mattings of algae, debris, and emergent or aquatic vegetation. True to its name, the topminnow tends to congregate in shallower waters or near the surface of deeper waters in areas of moderate current, below riffles, and along the margins (NMDGF 1996). The topminnow is omnivorous, foraging on organic detritus, algae and other plants, and invertebrates such as crustaceans, insects, and mosquito larvae (NMDGF 1996).

During reproduction, males vigorously pursue females and frequent copulations occur. Once sperm has been transferred, females are capable of storing it for their entire lives, thus eliminating the need for additional copulation. Sperm is transferred internally, and the topminnow gives birth to live young; as many as 15 at one time. In waters that do not freeze in winter, this species is capable of reproducing throughout the year.

Status and Date of Listing

The Gila topminnow was listed as federally endangered in 1967. Critical habitat has not been designated for this species, but a recovery plan has been developed. In Arizona, the Gila topminnow is a Wildlife Species of Concern.

The demise of this fish is attributed to habitat destruction and competition with and predation by the non-native mosquitofish, *Gambusia affinis* (NMDGF 1996).

Distribution and Abundance in the Region and at Fort Huachuca

In Arizona, the Gila topminnow was once common and abundant in the RioYaqui basin and the Gila River basin, including the San Pedro River until the mid to late 1970s (BLM 1989). Reintroduction of the Gila topminnow in Arizona has been successful in restoring populations and establishing new ones in some areas (NMDGF 1996). Since the 1960s, 180 reintroduction of the Gila topminnow have occurred throughout its historic range. Thirty-seven of these reintroductions have occurred on Fort Huachuca, Aravaipa Creek, and Babocomari Creek; all of

these reintroduced population have since disappeared (SFB 1996a). However, the Gila topminnow now occurs in 11 indigenous localities in southern Arizona. All but a few populations are considered to be in danger of extirpation (SFB 1996a).

3.9.24 DESERT PUPFISH

Description

The desert pupfish, *Cyprinodon macularius*, is a small cyprinodontid (50 mm or 2 in) with a compact body and a rounded dorsal profile. Female and juvenile pupfish are silver in color with dark, with vertical bars on each side, colorless fins except for a dark ocellus on the dorsal and occasionally anal fin. Males are larger and during the breeding season and are an iridescent light-blue color with bright orange caudal dorsal and caudal peduncle fins (USFWS 1993).

General Ecology

Pupfish were first described in the literature in 1853 from collections taken from the San Pedro River. The pupfish has since been the subject of considerable study because of its remarkable ability to survive under conditions of high water temperatures (38° C or 100° F), low dissolved oxygen concentrations, high salinity, and abrupt changes in salinity and temperature. The desert pupfish typically occupy cienegas, springs, small streams, and the edges of larger bodies of water with shallow, clear water and soft substrates (USFWS 1993).

Desert pupfish are opportunistic, diurnal omnivores, that eat a wide variety of food items such as detritus, algae, ostracods, copepods, insects, worms, and mollusks (USFWS Young, larval pupfish appear to consume tiny invertebrates and become more opportunistic with age.

Desert pupfish may become sexually mature at six weeks of age under ideal conditions, however, most do not begin to breed until their second summer (USFWS 1993). Male pupfish actively defend territories during the breeding season while awaiting a female to chose their site for spawning. Young pupfish growth is dependent upon age, habitat and environmental conditions, and population density (USFWS 1993). The life span of desert pupfish in the wild varies from one to three years of age.

Status and Date of Listing

The desert pupfish was listed as a federally endangered species in 1995. This species is also listed as a USFS sensitive species and endangered in Mexico. A federal recovery plan was approved in 1993. Critical habitat was designated at Quitobaquito Springs, in Pima County, Arizona (SFB 1996a). In Arizona this fish is a Wildlife Species of Special Concern.

Reasons for decline in pupfish numbers include groundwater pumping, dewatering of springs, stream impoundment, channelization, livestock grazing, timber harvest, mining, road construction, pesticide application, and interactions with non-native species (USFWS 1993a). Exotic fishes, such as the western mosquitofish, sailfin molly (*Poecilia latipinna*), largemouth bass (*Micropterus salmoides*), and juvenile cichlids (*Oreochromis* ssp. and *Tilapia* spp.) pose the

greatest threat to extant desert pupfish populations (USFWS 1993). In addition, non-native bullfrogs (*Rana catebeiana*) may also prove to a serious management concern for future reintroduction efforts.

Distribution and Abundance in the Region and at Fort Huachuca

Despite its hardy nature, the pupfish has suffered severe population decline. Historically, the desert pupfish was once common, but not continuous, below 1,500 m (5,000 ft) in southern Arizona, southeastern California, and Mexico. In Arizona, the desert pupfish was once found within the Gila River basin, and probably in lower Colorado, Agua Fria, Hassayampa, and Verde Rivers (USFWS 1993).

Only one indigenous population of desert pupfish exists in Arizona at the Quitobaquito Spring (SFB 1996a). Reintroduction endeavors have been made in a number of locations throughout Arizona, including three unsuccessful reintroductions on Fort Huachuca: at Boston Water Catchment and Kino Springs in 1982, and Buffalo Corral Spring in 1988 (SFB 1996a). No reintroduction efforts have been made within the San Pedro River due to lack of suitable habitat and exotic fish predators (SFB 1996a).

In Arizona, future reintroduction endeavors will be located within the Gila, Hassayampa, Agua Frio, San Pedro, Santa Cruz, Salt, and Verde River drainages (USFWS 1993).

3.9.25 LOACH MINNOW

Description

The loach minnow, *Rhinichthys cobitis,* is a member of the minnow family, *Cyprinidae*. The loach minnow is an elongated (approximately 60 mm ro 2.4 inch) ventrally flattened fish that may be identified by its lower lip which is thick and creased in a way as to appear lobed when viewed laterally (NMDGF 1996). Distinctive creamy-white spots are located anterior and posterior to the dorsal fin and near the caudal peduncle. During the breeding season, males are bright reddish-orange in coloration, while the females become yellowish on their fins and lower body (USFWS 1990b).

General Ecology

The loach minnow is a small fish inhabiting shallow areas of rapidly flowing, turbulent streams with moderate to high gradients at elevations below approximately 2,200 meters (7,000 ft; USFWS 1990b). A reduced gas bladder has allowed the loach minnow to become a highly specialized bottom-dwelling fish. The loach minnow inhabits shallow, swift water over gravel, cobble, and rubble substrates (Rinne 1989, Propst and Bestgen 1991). The loach minnow uses the spaces between, and in the lee of, larger substrate for resting and spawning (Propst *et. al.* 1988, Rinne 1989). It is rare or absent from habitats where fine sediments fill the interstitial spaces (Propst and Bestgen 1991). Some studies have indicated that the presence of filamentous algae may be an important component of loach minnow habitat (Barber and Minckley 1966). The life span of a loach minnow is about two years (Britt 1982, Propst and Bestgen 1991). Loach

minnow feeds exclusively on aquatic insects (Schreiber 1978). Spawning occurs primarily in March through May (Britt 1982, Propst *et. al.* 1988); however, under certain circumstances loach minnow also spawn in the autumn (Vives and Minckley 1990). The eggs of the loach minnow are attached to the underside of a rock that forms the roof of a small cavity in the substrate on the downstream side. Limited data indicate that the male loach minnow may guard the nest during incubation (Propst *et. al.* 1988, Vives and Minckley 1990).

Status and Date of Listing

The loach minnow was listed as a threatened species on October 28, 1986. Although the loach minnow is currently listed as threatened, the Service has found that it warrants uplisting to endangered status. Reclassification is pending; however, work on it is precluded due to work on other higher priority listing actions (USFWS1994b). The need for reclassification is not due to data on declines in the species itself, but is based upon increases in serious threats to a large portion of its habitat.

Critical habitat was designated for loach minnow on March 8, 1994, including portions of the San Francisco, Tularosa, Blue, and upper Gila rivers, and Aravaipa Creek. In Arizona, part of the designated critical habitat consists of Aravaipa Creek, a tributary of the San Pedro River that enters the mainstream about 100 km (63 miles) north of Fort Huachuca. However, as recognized in a recent Federal Register notice (63 FR 14378), the critical habitat designation was set aside by court order in Catron County, New Mexico. In Arizona this fish is a Wildlife of Special Concern.

Competition and predation by nonnative fish and habitat destruction have reduced the range of the species by about 85% (Miller 1961, Williams *et. al.* 1985, Marsh *et. al.* 1989).

Human activities, such as groundwater pumping, stream channelization, water diversion, damming, livestock grazing, poor timber harvest practices, mining, agriculture, and development have all contributed to the decline of loach minnow populations (NMDGF 1996).

Recent biochemical genetic work on loach minnow indicates there are substantial differences in genetic makeup among remnant loach minnow populations. Remnant populations occupy reaches of the Gila basin that are isolated from each other. Tibbets (1992) recommended that the genetically distinctive units of loach minnow should be managed as separate units to preserve the existing genetic variation.

Distribution and Abundance in the Region and at Fort Huachuca

Historic range of the loach minnow included the basins of the Verde, Salt, San Pedro, San Francisco, and Gila rivers (Minckley 1973, Sublette *et. al.* 1990). In Arizona, loach minnow were known to occur in the Salt River, White River, East Fork White River, Verde River, Gila River, Aravaipa Creek, San Francisco River, Blue River, Eagle Creek, the San Pedro River, and other major tributaries of large streams (Minckley 1973, 1980; University of Michigan Museum of Zoology, unpublished records). The loach minnow was last recorded from the San Pedro River in the 1950s (BLM 1989).

Loach minnows remain in limited portions of the upper Gila, San Francisco, Blue, Black, Tularosa, and White rivers; and Aravaipa, Eagle, Campbell Blue, and Dry Blue creeks in Arizona and New Mexico (Barber and Minckley 1966, Silvey and Thompson 1978, Propst *et. al.* 1985, Propst *et. al.* 1988, Marsh *et. al.* 1990, Knowles 1995).

Loach minnow are not currently known from Fort Huachuca or the upper San Pedro River basin (Sally Stefferud, pers. comm. 1998); however, the species occurred in the river historically (BLM 1998). Within the San Pedro River watershed, the loach minnow is found in Aravaipa Creek and two tributaries to Aravaipa Creek: Deer Creek (Hell Hole) and Turkey Creek. In Aravaipa Creek, the loach minnow is presently found in suitable habitat throughout the area of perennial flow, which is a reach approximately 15 to 20 miles in length in Aravaipa Canyon (Barber and Minckley 1966, Minckley 1973, Velasco 1994). The population in Turkey Creek is small and limited to an area near the confluence (BLM 1996). The BLM (1996) considers the loach minnow population in Deer Creek to be large and self-sustaining.

It is possible that unknown populations may still exist in unsurveyed stretches of river systems within portions of Mexico, and on some Indian Reservation and National Forest lands (USFWS 1990b).

Although the loach minnow is not present within the proposed action area, the USFWS recovery plan for the loach minnow (1990b) recommends reintroducing this species within its historical range, including perennial reaches of the San Pedro River, Babocomari River, and Eagle Creek.

3.9.26 SPIKEDACE

Description

The spikedace, *Meda fulgida*, belongs to the monotypic genus *Meda*, and is a member of the minnow family *Cyprinidae*. The spikedace is a small silvery fish whose common name alludes to the well-developed spine in the dorsal fin (Minckley 1973). Their sides are metallic silver in color, flecked dorsally with brown or black splotches over an olive or brownish background and their abdomen is yellowish white. Males exhibit a brassy color on their head and fins during breeding season, while females retain their silver coloring year-round (NMDGF 1996). Adults reach a length of approximately 63 to 75 mm (2.5 to 3 inches)(USFWS 1990a).

General Ecology

Spikedace live in flowing water with slow to moderate water velocities over sand, gravel, and cobble substrate (Propst *et. al.* 1986, Rinne and Kroeger 1988). Specific habitat for this species consists of shear zones where rapid flow borders slower flow, areas of sheet flow at the upper ends of mid-channel sand/gravel bars, and eddies at downstream riffle edges (Propst *et. al.* 1986). Spikedace spawn from March through May with some yearly and geographic variation (Barber *et. al.* 1970, Anderson 1978, Propst *et. al.* 1986). Spawning has not been observed, but spawning behavior indicates eggs are laid over gravel and cobble where they adhere to the substrate.

Spikedace live about two years with reproduction occurring primarily in one-year old fish. It feeds primarily on aquatic and terrestrial insects (Schreiber 1978, Barber and Minckley 1983, Marsh *et. al.* 1989).

Status and Date of Listing

The spikedace was listed as a threatened species on July 1, 1986 (Service 1986). Critical habitat was designated for spikedace on March 8, 1994, including Aravaipa Creek, portions of the Gila River in New Mexico, and the upper Verde River (Service 1994a); however, as recognized in the Federal Register notice (63 FR 14378), the critical habitat designation was set aside by court order in Catron County, New Mexico.

Although the spikedace is currently listed as threatened, the Service has found that it warrants uplisting to endangered status. Reclassification is pending; however, work on it is precluded due to work on other higher priority listing actions (USFWS 1994a). The need for reclassification is not due to data on declines in the species itself, but is based upon increases in serious threats to a large portion of its habitat.

Habitat destruction, and competition and predation from introduced nonnative fish species are the primary causes of the species decline (Miller 1961, Williams *et. al.* 1985, Douglas *et. al.* 1994). Activities contributing to habitat loss include alteration of natural flow regimes, livestock grazing, mining, agriculture, timber harvest, and other developments. Introduction of non-native fishes has resulted in increased predation upon the spikedace and increased competition with other fishes, particularly the red shiner, for suitable habitat (USFWS 1990a; SFB 1996a).

The effects of historic and present perturbations in the Gila River basin have resulted in fragmentation of spikedace range and isolation of remnant spikedace populations. Recent taxonomic and genetic work on spikedace indicates there are substantial differences in morphology and genetic makeup among remnant spikedace populations. Anderson and Hendrickson (1994) found that spikedace from Aravaipa Creek are morphologically distinguishable from spikedace from the Verde River, while spikedace from the upper Gila River and Eagle Creek populations have intermediate measurements and partially overlap the Aravaipa and Verde populations. Mitochondrial DNA and allozyme analyses have found similar patterns of geographic variation within the species (Tibbets 1992).

Distribution and Abundance in the Region and at Fort Huachuca

Historically, the spikedace is endemic to the Gila River basin of New Mexico, Arizona, and Sonora, Mexico below 1,828m (6,000 ft)(SFB 1996a). In Arizona, this species was once widespread (occupied up to 2575 km or 1600 miles of streams) throughout the larger river systems including the Gila, Salt, Verde, San Francisco, and San Pedro River systems (AGFD 1996; SFB 1996a). Reports of spikedace in the San Pedro River exist from as early as 1846 up through the 1950's and 1960's (SFB 1996a; BLM 1989).

Spikedace are currently known only from Aravaipa Creek (Graham and Pinal Counties, Arizona), the upper Gila River (Grant and Catron Counties, New Mexico), the middle Gila River (Pinal County, Arizona), Eagle Creek (Greenlee County, Arizona), and the Verde River (Yavapai County, Arizona) (Barber and Minckley 1966, Minckley 1973, Anderson 1978, Barrett *et. al.* 1985, Bestgen 1985, Marsh *et. al.* 1990, Sublette *et. al.* 1990, Jakle 1992, Knowles 1994). The Aravaipa Creek population is the only extant population in the San Pedro River basin (NMDGF 1996). This fish has otherwise been extirpated from the mainstream of the San Pedro River and its tributaries (SFB 1996a; BLM 1989).

Spikedace are not currently known from Fort Huachuca or the upper San Pedro River basin (Sally Stefferud, Service, Phoenix, pers. comm. 1998); however, the species occurred in the upper San Pedro River historically (BLM 1998).

Although the species is currently thought to be extirpated, the upper San Pedro River is considered important recovery habitat for the spikedace. A number of agencies have been working towards native fish recovery in the San Pedro River. The BLM management plan for the SPRNCA calls for "reintroduction of native wildlife species, including threatened and endangered species, as well as for consideration of "removal of exotic fish from existing ponds" (BLM 1989). BLM habitat management plan for the area contains specific objectives for reintroducing spikedace. The USFWS recovery plan proposes reintroducing the spikedace within its historical range. The San Pedro River system in Arizona, including the Babocomari River, north of Fort Huachuca, represents the most amenable historical areas in which to reestablish the spikedace (USFWS 1990a).

3.9.27 RAZORBACK SUCKER

Description

The razorback sucker, *Xyrauchen texanum*, is one of the largest suckers in North America, weighing up to 6.5 kg (14 lbs) and 1 m (38 in) length (SFB 1996). These fish have a dark head and keel, are olivaceous in color on the back, brown-red on the sides, yellow-white on the underside, with a dark dorsal fin, and a yellow anal fin (NMDGF 1996). Female razorback suckers have smaller tubercles on the anal and caudal fins. Breeding males have a bright yellow abdomen and large conical breeding tubercles on the anal and caudal fins (NMDGF 1996).

General Ecology

The razorback sucker is a long-lived fish that inhabits large rivers, backwaters, and reservoirs with strong currents, deep pools, and eddies approximately 2.0 m (6.6 ft) deep (NMDGF 1996). This fish prefers temperature ranges of 22.9 to 24.8° C (70 to 75° F) and appears to prefer gravel bottoms. The razorback sucker is benthic level omnivore. This species diet consists primarily of algae, dipteran larvae, and occasionally plant debris; *Ephemerptera* ssp. and *Trichoptera* ssp. (NMDGF 1996).

Razorback suckers spawn from late winter to early summer. Fertilized eggs mature and hatch along stream bottoms. In this species, several males attend each female, no nest is built, and no

parental care is given to the 75,000 to 144,000 eggs laid. Therefore, mortality for young larvae and juvenile razorback suckers is very high, due to predation from introduced species (NMDGF 1996). Sexual maturity is reached at four years of age with adults living 40 years or more.

Status and Date of Listing

The razorback sucker was listed as federally endangered in 1991. In addition, this species is listed as a sensitive species by the USFS. In 1994, the USFWS designated critical habitat for this fish that included 15 reaches of the Colorado River as well as portions of the Gila River (above the confluence with the San Pedro River), Salt River, and Verde River. A recovery plan has not been prepared for the razorback sucker. In Arizona this fish is a Wildlife Species of Concern.

Survival, successful reproduction, and recruitment of this species has declined from interactions with non-native fish, high winter flows, reduced high spring flows, seasonal changes in river temperatures, and lack of inundated shorelines and bottom lands.

Distribution and Abundance in the Region and at Fort Huachuca

Razorback suckers were once abundant and widely distributed in the rivers of the Colorado and Gila River Basins (AGFD 1996; SFB 1996a). However, there are few published accounts of this fish within the San Pedro River. Today, the razorback sucker appears to have disappeared from the Gila River Basin (SFB 1996a). The populations of razorback suckers that do remain are in the Colorado River lower basin (between the Grand Canyon and the border with Mexico) are small, with very little recruitment. The largest extant population exists at Lake Mohave, Arizona-Nevada, but this population has not shown recruitment for many years (NMDGF 1996). In 1981, large-scale reintroduction began in the Gila, Verde, and Salt Rivers, but the long-term success of these populations is not known (NMDGF 1996). No reintroduction efforts have been reported in the San Pedro River Basin (SFB 1996a). This fish did not historically occur on Fort Huachuca.

The razorback sucker has not been reported to occur on Fort Huachuca, and aquatic habitat on post is not suitable for this species (SFB 1996a).

3.9.28 GILA CHUB

Description

The Gila chub, *Gila intermedia,* is one of eight species of chub known from Arizona (Minckley 1973). This small-finned, deep-bodied chunky and dark colored minnow can reach up to lengths of 10 inches. Females are generally larger than males. Females may grow up to 9.8 inches while males seldom reach 5.9 inches in length (AGFD 2001f). As described by Minckley in 1973: scales are large, thick and broadly imbricated, and basal radii usually present; lateral line scales usually are fewer than 80 and dorsal and anal fin-rays are usually eight or fewer. The length of head divided by depth of caudal peduncle is usually 3.0 or less and total vertebrae 38-45, and usually number fewer than 42. Breeding males with red or orange on lower cheek, posterior parts of lips, paired fin bases, and on ventro-lateral surfaces (including caudal peduncle) (AGFD 2001f).

General Ecology

Gila chub are normally found in smaller headwater streams, cienegas, and springs marshes of the Gila River basin. Based on season and age, the Gila chubs utilize diverse habitat types. Adults have been collected from deep pools with heavily vegetated margins and undercut banks while juveniles have been collected from riffles, pools and undercut banks of runs. In larger stream systems they utilize heavily vegetated backwaters for cover and feeding. In Arizona, this species occurs between 2,720 and 5,240 feet (AGFD 2001f).

Status and Date of Listing

Since 1997, the Gila chub has been a candidate for listing under the ESA. USFWS recently entered a settlement agreement on October 2, 2001 that requires the Service to deliver a proposed rule to the Federal Register for publication by July 31, 2002 (USFWS 2001). In 1996, AGFD designated the Gila chub a Wildlife Species of Special Concern and it is listed as a Sensitive Species by USFS, Region 3 (AGFD 1996).

Threats to this species include aquifer pumping, stream diversion, habitat alteration and competition by non-native crayfishes as well as predation by and competition with non-native fishes.

Distribution and Abundance in the Region and at Fort Huachuca

It is likely that the Gila chub's historic range included suitable habitat throughout the entire Gila River basin except the Salt River drainage above Roosevelt Lake. It is known from rivers, streams, and stream-fed tributaries in Arizona, New Mexico, and likely in the San Pedro and Santa Cruz River systems in Sonora Mexico.

The Gila chub is currently known from the following drainages: Santa Cruz River (Cienega Creek, Sabino Canyon, Sheehy Spring, Middle Gila River (Eagle, Bonita and Harden Cienega Creeks and San Carlos and Blue Rivers), San Pedro River (Bass, O'Donnell, and Redfield Canyons, Babocomari River, and Turkey Creek), Agua Fria River (Silver and Sycamore [rare] Creeks) Verde River (Spring and Walker Creeks). The Gila chub is thought to be extirpated from New Mexico, Monkey Spring (Santa Cruz River, Arizona) and Fish and Cave Creeks (Salt River, Arizona) (AGFD 2001f). Potential habitat may be present on Fort Huachuca and the SPRNCA, but the species is not known to occur in these areas.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 4
POTENTIAL EFFECTS OF PROPOSED ACTION ON FEDERALLY LISTED, PROPOSED, AND CANDIDATE SPECIES

This section evaluates the potential effects of ongoing and programmed future military operations and activities at and near Fort Huachuca on federally listed, proposed and candidate species and designated critical habitat.

This BA is a programmatic BA in that the effects of the Fort's activities are evaluated broadly over a large range of programs and actions into the foreseeable future. This BA is designed so that all aspects for the Fort's activities discussed herein are addressed to the project level. In other words, most or all activities described in the proposed action require no further consultation unless re-initiation criteria are met. Re-initiation of formal consultation is required when: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may adversely affect listed species or critical habitat in a manner or to an extent not considered previously; 3) the agency action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered previously; or 4) a new species is listed or critical habitat designated that may be affected by the proposed action. In any case, the Army has the responsibility under Section 1(a)(2) of the Endangered Species Act and 50 CFR 402.14(a) to review its actions to determine whether any action may adversely affect a listed species or critical habitat, and if such a determination is made, to enter into formal consultation with the Service.

Some components of the proposed action (e.g., the Fort Huachuca Fire Management Plan and Endangered Species Management Plans) may require additional consultation because effects to listed species and critical habitat are difficult to determine with precision at this time. As the details of these plans are developed, the Fort and the Service have established a process to evaluate their effects of future projects and develop and implement conservation measures under the umbrella of this BA. No further consultation on these projects is required as long as no re-initiation criteria are triggered and the Service approves mitigation plans for these projects. In considering whether or not to approve mitigation plans, the Service will determine if the type of project proposed and the nature of impacts anticipated fall within the scope of activities and impacts described herein. In making this determination, the Service will carefully evaluate the additive effects (number and impacts of all such projects) to ensure that the sum of such projects does not exceed the extent or nature of that evaluated here, and that impacts do not exceed that anticipated. If the anticipated effects of the proposed projects exceed that described herein, the project type is not included in the proposed action, or anticipated take would be met or exceeded, the Service would not approve the mitigation plan and, in accordance with 50 CFR 402.14(a), the project would be subject to additional Section 7 consultation.

This BA evaluates all effects of the proposed action, including direct, indirect, interrelated, interdependent and cumulative effects, some of which occur off of Fort Huachuca. Direct effects are those that are caused by the proposed action and occur at the same time and place of the proposed action. Indirect effects are those effects that are caused or will result from the proposed

action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification.

Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02). The Service's March 1998 Section 7 Handbook provides further guidance on the definition of "interrelated and interdependent actions" by establishing the following rule: "...the analysis of whether other activities are interrelated to, or interdependent with, the proposed action under consultation should be conducted by applying the "but for" test. The biologist should ask whether the activity in question would occur "but for" the proposed action. If the answer is no, that the activity in question would not occur but for the proposed action, then the activity is interrelated and interdependent..." Cumulative effects are "those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area"" (50 CFR 402.02).

The primary purpose of a BA is to determine, based on analysis of all effects, whether a proposed action is likely to adversely affect a listed species or designated critical habitat, jeopardize the continued existence of a proposed species or adversely modify proposed critical habitat. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Destruction or adverse modification of critical habitat means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining habitat to be critical" (50 CFR 402.02).

4.1 GENERAL EFFECTS ANALYSIS

Potential direct effects on federally listed threatened and endangered and candidate species and habitats include habitat loss, wildfire, noise, direct mortality, human disturbance, and erosion. Indirect effects include potential effects from Fort Huachuca groundwater usage and erosion resulting from fire or human disturbance.

Many Fort Huachuca activities listed in Section 2 of this BA are infrequent, occur in the cantonment area, use existing facilities, or involve small numbers of personnel and vehicles on existing roads and trails. These activities are unlikely to have direct effects on species or habitat of concern and are not evaluated in great detail as separate direct effects. However, the potential effects of these activities are considered as part of the indirect and cumulative impact analysis. Activities with minimal direct effects include most administrative activities, activities confined to the cantonment or buildings, and some testing missions as described in Section 2.2.

4.2 HABITAT LOSS

Minimal habitat loss will result from programmed facilities development at Fort Huachuca (Table 3, page 36). Most proposed construction projects will occur within the cantonment area in already disturbed habitat. One proposed construction project will occur in the cantonment area,

but in habitat that is relatively unaltered. This project, the proposed RV park expansion, will remove approximately five acres of semi-desert grassland vegetation consisting primarily of mesquite and grasses adjacent to the existing RV complex. No known listed species or designated critical habitat occurs in this area. This project will result in a negligible loss of grassland habitat which is abundant across the installation. Another proposed project, a new ammunition supply point (ASP), is scheduled for construction in fiscal year 2011 and will affect approximately 25 acres of grassland with scattered mesquite in Training Area Victor. Although the removal of vegetation will result in the loss of habitat for numerous small wildlife species, this land is not within a protected agave management area and no listed, proposed or candidate species or designated critical habitat is known to occur in the area.

Training activities include weapons training on the South and East Ranges (see Section 2.2 for details). Weapons training include mortar and small ammo training. Mortar firing would continue to occur on the East Range at current levels. These mortars are fired from firing pads across the East Range into Impact Area Zulu, which has been used as an impact area since World War II. Small arms firing would occur on the South Range with existing targets, roads, and firing locations. Vehicle travel within ranges is limited to existing roads and trails between firing areas and target areas. These ranges have been in use for many years and no ground-disturbing activities would occur in previously undisturbed areas. Therefore, additional habitat loss would not occur as a result of continued weapons training.

Troop marches and vehicle convoys would continue to take place on existing roads and trails across the installation. Roads and trails are already devoid of vegetation; however, vegetation along the edges may be further impacted as these areas are used. Cross-country foot travel should not result in any habitat loss. The use of bivouacs across the installation should not result in additional habitat loss because bivouacs are typically scheduled in previous bivouac areas to minimize soil and vegetation disturbance. No vegetation clearing is authorized during the establishment of a bivouac.

Other proposed activities at Fort Huachuca that could potentially cause habitat loss include the construction of retention/detention basins for stormwater management and recharge, fire management activities to include firebreak maintenance, fuel load reduction and prescribed fire activities, recreational use and the further development of wind turbines to harness a renewal source of energy. Although these projects could potentially cause habitat loss, none of them would occur in areas with listed species or designated critical habitat. Many of these projects would cause only a temporary loss of habitat, and some could actually decrease the potential for future habitat loss or improve habitat for some species, such as some fire management activities. In addition, Fort Huachuca would implement appropriate conservation measures as specified in Section 5 to minimize any potential adverse effects that might be associated with these projects.

4.3 FIRE

4.3.1 FORT HUACHUCA

Accidental wildfires associated with on-going and future operational activities could result in impacts to federally listed, proposed and candidate species and critical habitat including direct

mortality, direct habitat destruction or degradation, and indirect destruction or degradation of habitat through post-fire flooding, erosion, and sedimentation. Fire risk would be associated primarily with weapons training (small arms, machine guns, and mortars), with exhaust systems of trucks and other vehicles and with recreational use. Tracer rounds are often used with machine gun fire, and these contribute to increased fire danger during training operations. The use of tracer rounds may be prohibited by Range Control during extremely dry periods. Vehicle traffic is limited to existing roads and trails at all times, where fuel load is relatively low. The Range Control Officer and Fort Huachuca Fire Chief are responsible for determining fire risk based on climatic conditions and trends, using the National Fire Danger Rating System. Recreational use of camp sites or the discarding of cigarettes by recreational users could lead to a wildfire. The Fort has taken many precautions to help reduce the potential for accidental fires by recreational activities. Some of these include restricting camping areas, smoking, canyon access and vehicle use as well as educating recreational users of fire danger and reducing fuel loads in high use recreational areas.

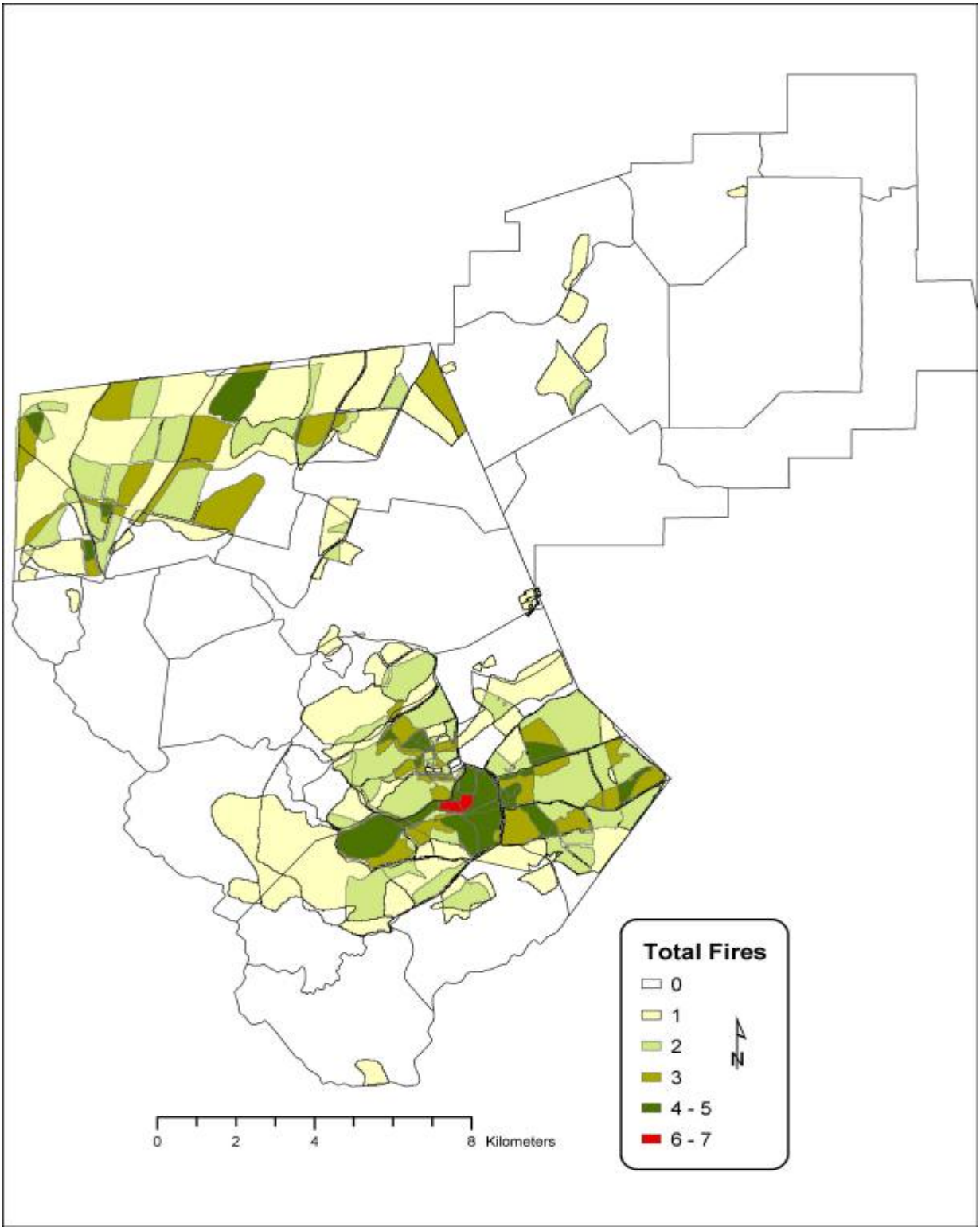
Fire history data have been collected at Fort Huachuca since 1973 with a gap from 1975 – 1977. These data have been mapped and are shown in Figure 24. Most areas of Fort Huachuca have experienced no more than one fire greater than one acre in size every ten years. Higher incidences of wildfires occur in Training Area Tango in portions of the area used for live ammunition fire. These areas consist predominantly of open grassland, mesquite-grass savanna, oak-grass savanna, and oak woodland vegetation.

Fire effects, particularly in grasslands, are generally short-term. In addition, it is estimated that fires in grasslands in the Fort Huachuca area historically occurred every 7 to 10 years. Grass cover is substantially reduced during the first year after a fire. Various studies have shown that grasslands will recover from fires in 2 to 4 years (Finberg 1994, Bock and Bock 1992, Martin 1983).

The effect of fire varies depending on fire frequency and intensity, vegetation type, fuel load, and duration. For example, velvet mesquite is very fire tolerant and most mature plants sprout after a fire (Bock and Bock 1992, Cable 1965, DeBano *et. al*. 1996, Martin 1983, Robinett and Baker 1996, White 1969). Palmer agave seedlings are easily killed by fire but adult plants appear to be fire tolerant (Robinett and Baker 1996). The effects of fire from the Peak Burn on the Madrean oak woodlands in Arizona showed that oak mortality was high (over 95%) in severely burned areas and that reduced oak cover would persist over the long-term. In the lightly burned areas, mortality of oak was lower (about 35%) (Folliott and Bennett 1996). Many of the larger alligator junipers burned in the Peak Burn died while manzanita sprouted vigorously after the fire (Folliott and Bennett 1996).

Fires have been rare to non-existent in the upper elevation plant communities (pine woodlands, pinyon/juniper and mixed woodlands) in the South Range from 1973 to the present (Figure 24). Fires on the West Range during this same time period have occurred in the open grassland and mesquite-grass savanna. Fires on the east range have occurred in the western half of the range in the open grassland and shrubland (Chihuahuan Desert shrublands) plant community types (Figure 24). Velvet mesquite and creosotebush are the most common shrubs in the Chihuahuan

FIGURE 24 FORT HUACHUCA FIRE FREQUENCY 1973 - 2002



Desert shrublands; while mesquite is fire-tolerant as indicated above, creosotebush does not respond well to fire. This species suffered almost 100% mortality from fire in the Sonoran Desert and only 3% of the plants sprouted in California while 37% sprouted in Arizona (Brown and Minnich 1986, McLaughlin and Bowers 1982). In general, fires are infrequent in the Sonoran and Chihuahuan deserts due to limited plant bio-mass (Brown and Minnich 1986, Buffington and Herbel 1965).

Fire suppression measures have the potential to have negative effects on listed, proposed and candidate species through the establishment of fire lanes, staging areas, and other activities. These activities have the potential to affect species directly or affect their habitat.

Prescribed burns have the potential to have negative effects on listed, proposed and candidate species. Although every reasonable precaution will be taken, prescribed burns could become more intense than planned or burn more area or vegetation than anticipated. This could cause mortality or habitat loss or indirectly affect species and habitat by increasing erosion. Every reasonable precaution will be taken to minimize adverse effects of prescribed burns to listed and candidate species and their habitat. For a more thorough list of Fort Huachuca conservation measures pertaining to fire, see Section 5.

4.3.2 US FOREST SERVICE LAND

Data regarding fires from Fort Huachuca entering USFS land (CNF) is not available. However, the fire frequency map for the period 1973 to 2002, shows that there have been very few fires along the Fort Huachuca-CNF boundary (see Figure 24, page 167). Two fires occurred at this boundary in the area of Scheelite and McClure Canyons during this time period and it is not known if they spread on to USFS land. Information from the CNF indicates that there have been over 2200 fires on the national forest from 1980 through 1997 or an average of 122 fires per year (Kerrigan 1998). Of the fires on the CNF, 1325 (61%) were started by lightning, 443 (20%) by camp fires, and the remainder from various causes such as smokers, equipment, arson and other miscellaneous causes (Kerrigan 1998).

4.3.3 SAN PEDRO RIVER

Much of the eastern boundary of the East Range is in close proximity to the SPRNCA (Figure 1, page 2). Fire data from 1973 through 2002 indicate that very few fires have occurred on the East Range with the closest fire to the SPRNCA being approximately five kilometers away (Figure 24, page 167). There are no records of fires spreading into the SPRNCA from the East Range. In addition, the Chihuahuan Desert shrublands and shrub-grassland plant communities cover the land which borders the SPRNCA, and fires are rare in these communities because of low fuel loads. Information from the BLM indicates there have been 36 fires in the SPRNCA from 1980 through 1996. The number of fires each year varied from zero to seven and the size varied from one to 323 acres in size. Most fires (24) occurred from May through August. Nineteen (53%) of these fires were caused by lightning, six (17%) were caused by human fire use in the SPRNCA, four (11%) were caused by equipment, and the rest from miscellaneous causes. From this information, it appears that the probability of fire spreading from the East Range into the

SPRNCA is remote. If a fire did start on the East Range, it would not likely travel far due to low fuel loads and fire suppression activities. In addition as discussed above, an average of two fires per year occur in the SPRNCA due to lightning and human causes unrelated to military or other activities at Fort Huachuca.

4.3.4 BABOCOMARI RIVER

The northern boundaries of the East and West Range parallel the Babocomari River (Figure 1, page 2). Fire data from 1973 through 2002 indicate that fewer than four wildfires have occurred on the West Range along the installation boundary. The Babocomari river is approximately 2 to 3 km from the installation along the West Range. There are no records of fires spreading into the Babocomari River area from the West Range although a fire in 2002 passed through the West Range. If a fire did start on the West Range, it would not likely travel far due to low to moderate fuel loads and fire suppression actions. Fires on the East Range are infrequent and none have been reported along the installation boundary (Figure 24, page 167). The Babocomari River is within 0.25 km from the installation along portions of the East Range. Chihuahuan desert shrubland and shrub-grassland plant communities cover the land that borders the Babocomari River along the East Range. The probability of fire spreading from these communities into the Babocomari River area is remote because of low fuel loads.

4.4 NOISE

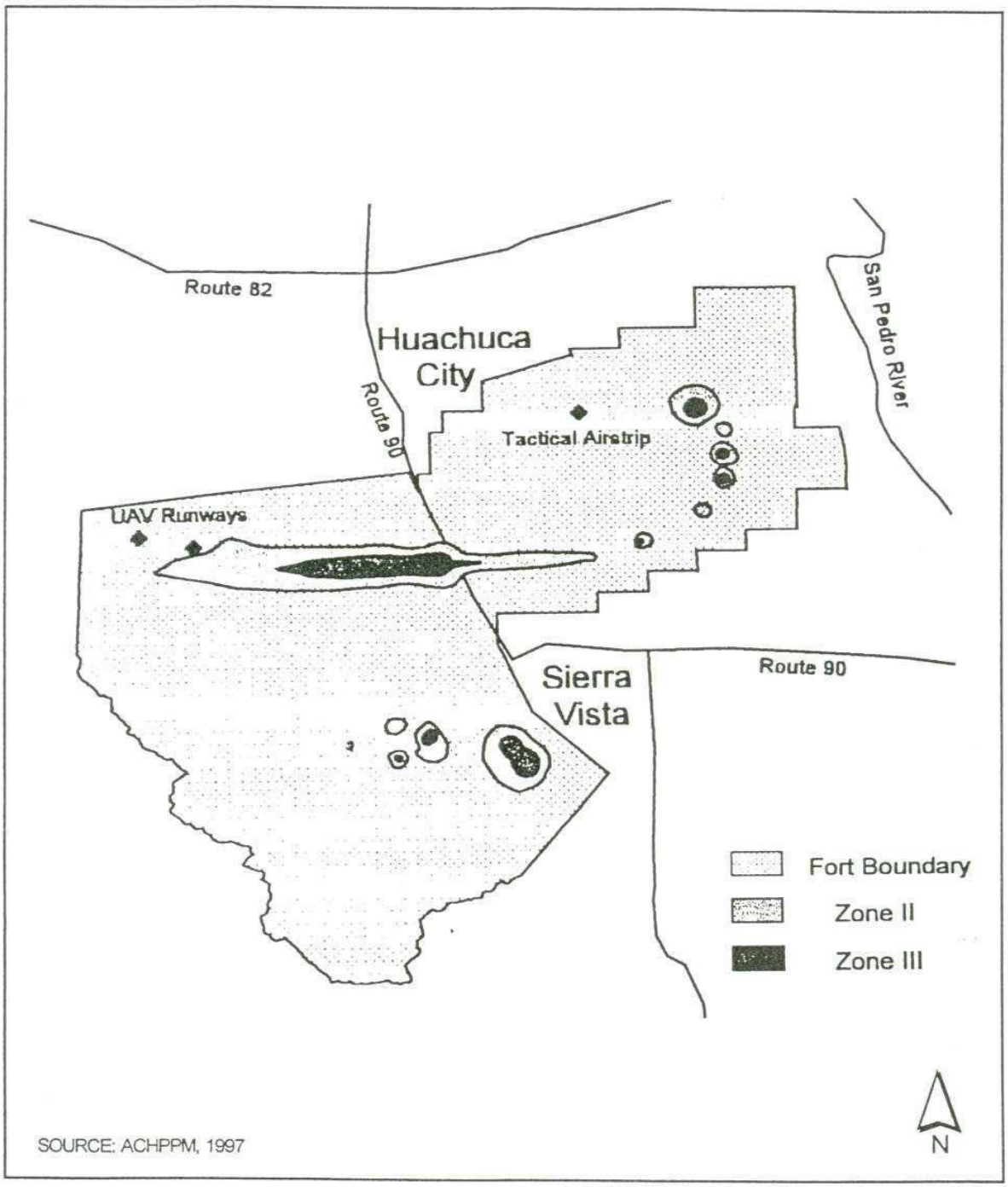
Noise sources at Fort Huachuca would include construction; wheeled vehicle convoys; UAV testing and operation; recreation; aircraft operations; emergency ordnance detonation; and mortar, machine gun, and small arms firing. Aircraft operations, UAV operations, and mortar firing would be the primary noise sources of concern under continuing and proposed activities. Construction activities would be concentrated in the cantonment area, where no known listed, proposed or candidate species or critical habitat is known to occur.

Aircraft operations at LAAF include takeoffs and landings by helicopters, private and commercial planes, and military airplanes (USAF, USAFR, AZ ANG, MO ANG). For these ongoing activities, noise contours associated with LAAF follow an east-west orientation, with approximately 1157 acres of land in the vicinity of LAAF exposed to noise levels of greater than 65 dBA (USACHPM 1997) (Figure 25).

UAV operations at Pioneer and Rugge-Hamilton airstrips would generally result in low levels of noise. Operating levels of UAVs are low, because of the small size of UAV engines (USAIC&FH 1993a). RATO occur infrequently, no more than 10 times annually. RATOs may reach noise levels of 100 dB at the launch (USAIC&FH 1991) but these levels last for only 2.5 seconds (USAIC&FH 1993a). In addition, the use of RATOs is restricted to times when there would be no effect on listed species. Noise levels at the minimum operating altitude of 3000 feet agl are attenuated to negligible levels on the ground.

Potential noise impacts resulting from the ongoing and proposed activities would include vehicle traffic and limited ordnance use. Low numbers of explosive ordnance are used at Impact Area Zulu on the East Range, producing varying noise levels depending on the type of ordnance used.

FIGURE 25 FORT HUACHUCA NOISE CONTOURS



The greatest noise level produced would be attenuated to approximately 70 dB at a distance of one mile.

On the South and West Ranges, additional noise sources include vehicle training, troop movements, small arms training and recreation. Vehicle noise would attenuate to less than 55 dBA at 1000 meters. Small arms training would result in noise that would attenuate to less than 55 dBA at a distance of 1000 meters from the firing positions. Noise from recreational use has the potential to affect listed species, especially when recreational use may overlap with listed species locales. However, the Fort has implemented a number of conservation measures to alleviate potential adverse effects of noise on listed species (see Section 5).

4.5 DIRECT MORTALITY

Direct mortality of listed species may result from collisions with vehicles, wind turbines or wind data towers, training ordnance, or construction equipment. The probability of federally listed threatened and endangered and candidate species colliding with vehicles is extremely low. Wildlife-vehicle collisions could involve operational activities such as convoys, wheeled and tracked vehicle training and testing, or civilian travel including contractors and recreational visitors. Installation policy, enforced by military police, prohibits travel at speeds greater than 35 miles per hour (mph) on all roads except Whitside, Winrow, Squire, and the Canelo Roads, on which speeds are limited to 45 mph. Traffic on most roads on the South, West and East Ranges is limited to 25 mph. Convoy and tracked vehicle movements are also limited to very slow speeds, usually no greater than 15 mph. Most recreational travel outside of the cantonment area is restricted to daylight hours.

The threat of trampling, crushing, collection, or harassment on federally listed, proposed and candidate species and critical habitat would be greatest in recreational areas. Garden Canyon area has the greatest potential for these impacts to occur due to the overlap of recreational areas and species locales and critical habitat. Section 5 contains conservation measures that help alleviate direct mortality that might result from the proposed action.

4.6 HUMAN DISTURBANCE

Construction, military training operations, and recreation have potential to adversely affect protected species by increasing human presence in areas of occupied habitat. Human presence may cause species to alter foraging, breeding, or roosting behavior; if disturbance is prolonged or occurs during periods in which species are particularly sensitive, reproductive success or survival may be affected (Grubb and King 1991). Sensitivity to human disturbance varies among species and among individuals; some species or individuals may become sensitized to disturbance while others may become habituated (Knight and Gutzwiller 1995).

Since nearly all proposed construction and administrative activities would occur in the cantonment area away from areas frequented by listed species, there is very little chance that human disturbance associated with the action would affect listed species.

Training and testing operations tend to be concentrated in the lower elevations of the South and West Ranges and in the western portions of the East Range. Listed species are generally not found in these areas, with the exception of the lesser long-nosed during foraging activities. Training and testing activities may result in short-term disturbance to these species when operational and foraging activities overlap temporally and spatially, but the Fort has implemented a number of conservation measures to minimize potential effects (see Section 5).

Most recreational activities will remain concentrated in Huachuca Canyon and Garden Canyon. Developed camping and picnic areas will continue to receive the most use within these canyons. Except for a small camping area in lower Garden Canyon and rental cabins in upper Garden and Split Rock Canyons, recreation is limited to daylight hours in these areas and therefore would not affect species foraging nocturnally. Section 5 outlines a number of conservation measures the Fort has implemented to minimize human disturbance to listed species that is associated with recreational activities.

4.7 EROSION

Erosion may be a direct effect, as in the case of operational activities that cause soil loss and habitat degradation, or an indirect effect following wildfire. The potential for erosion following fire depends on many factors, including the size and intensity of the fire, and vegetation rehabilitation and erosion-prevention measures employed after the fire.

As a direct effect, operational activities may cause soil compaction and a reduction in vegetative cover. Several factors contribute to increased opportunity for soil compaction and erosion to occur:

- Improper road design and poor maintenance of roads and trails, which increases runoff and erosion.
- Dismounted foot traffic, which has the potential to affect protective plant cover and the litter layer, and may loosen surface soils.
- High moisture content of soils, which leads to increased soil compaction

Soil erosion potential is highest in areas of low vegetation cover and high topographic relief. In general, the South and West Ranges exhibit moderate erosion. Erosion on these ranges is predominantly limited to the occurrence of dirt roads and fire breaks within the Huachuca Mountains (AZ ANG 1997).

Erosion within the East Range is the highest on the installation, with sheet and rill erosion within the central portion of the range the most significant. Under training and management conditions associated with ongoing and proposed activities, sheet and rill erosion across the East Range was estimated to be approximately 0.74 to 1.33 tons per acre per year (AZ ANG 1997). Through analysis and field observation, transfer of sediment from areas within the central zone of the East Range has been found to be deposited within the respective stream channels within a distance of approximately three to four miles. These findings suggest that, while significant erosion and

sediment transfer continue to occur across the East Range, the extent of deposition is predominantly limited to areas within Fort Huachuca and not in the adjacent SPRNCA (AZ ARNG 1997). Fort Huachuca has taken a number of conservation measures to minimize erosion (see Section 5). A few of these include implementation of the East Range Watershed Improvement Plan, the use of silt fencing and other erosion control structures, stormwater pollution prevention plans, in-channel stormwater retention basins, etc.

4.8 GROUNDWATER USE

While the existence and historical cause of the cone of depression in the Sierra Vista subwatershed are generally agreed upon in the recent hydrology literature, there is considerable debate regarding the effect of groundwater use at Fort Huachuca on baseflow that sustains surface flow in the SPRNCA (see Section 3.6 and Appendix F for more details).

The following geologic and hydrologic evidence indicates that the use of groundwater by Fort Huachuca has not caused a change in groundwater discharge from the USPB to the SPRNCA and that groundwater use by the Fort will not affect perennial reaches of the River in the near future.

1. Evidence indicates that even under the assumption of one large, continuous aquifer, groundwater use at Fort Huachuca has not caused a change in groundwater discharge volumes and rates from the regional aquifer of the USPB to the San Pedro River (ADWR 1988, 1991; Putman 1996, Koehler and Ball 1998).

2. Hydrologic models indicate that no effects to surface water flows in the San Pedro River have been observed to date resulting from groundwater use at Fort Huachuca (ADWR 1991, Putman 1996).

3. "The cone of depression in the Sierra Vista/Fort Huachuca area has not intercepted the river" (ADWR 1991, p. 495) and while the report suggests that a certain amount of groundwater flow toward the river in the regional aquifer is being diverted into the cone of depression, it concludes that "fifty years into the future, the Sierra Vista/Fort Huachuca cone of depression [will still] not intercept the river" ADWR 1991, p. 495).

4. The ADWR (1991) model projects potential effects to the SPRNCA resulting from regional groundwater use occurring by the year 2038.

5. Average base flows have decreased through time from 1951 to 1980. However, there may have been an increase in average base flows for the period 1981 to 1990 (Correll *et. al.* 1996a).

Recent geophysical studies suggest that the assumption of one large, continuous regional aquifer may not be correct. Preliminary findings suggest at least some natural isolation between the Fort Huachuca recharge areas and nearby parts of the San Pedro River. If this is the case, then not only is there evidence to suggest that groundwater use by Fort Huachuca has not and is not

currently affecting surface flows in the SPRNCA, but there is evidence to suggest that there is less potential that groundwater use will affect the SPRNCA in the future.

1. Wynn and Gettings (1997) report that based on drilling and ground geophysical surveys this intermediate conductor appears to be a clay body that may influence flows near the shallow aquifer between Fort Huachuca and the San Pedro River (Wynn and Gettings 1997). They conclude that while it remains unclear from these limited data how this structure affects water movement in the aquifer. Isotopic evidence reported elsewhere, and the appearance of the intermediate conductor both suggest that there may be some natural isolation between the recharge areas west of Fort Huachuca and much of the San Pedro River in the surveyed area (Wynn and Gettings 1997). The study cites that if this natural isolation exists, then much if not most of the water in the SPRNCA must derive from the upper reaches of the San Pedro River drainage in Mexico (Wynn and Gettings 1997).

2. Moore (1993) identified a volcanic center and parts of the Tombstone Caldera that underlie the eastern margins of Fort Huachuca. Geophysical studies confirm the presence of a volcanic body at the approximate confluence of the Babocomari and San Pedro Rivers. Wynn and Gettings (1997) delineate the volcanic center and part of this caldera.

3. Pool and Coes (1999) determined, based on conductance and stable isotope sampling during March 1996 – March 1997 monitoring period, that groundwater discharge from the regional aquifer contributed a minor part of the base flow at the Charleston stream flow gauging station. It was found that groundwater from the Holocene alluvium that infiltrated near the river during surface flows was the primary source of base flow. The authors also demonstrated a decrease in wet season flow volume from more than 40,000 ac-ft before 1935 to less than 10,000 ac-ft during the early to mid 1990's at the Charleston site.

4. The direct and indirect effects of pumping in the regional aquifer, including the impact of the cone of depression in the Fort Huachuca and Sierra Vista area, on baseflow of the San Pedro River are not clear. For instance, widespread use of wells in the San Pedro Valley only began in the 1940s while baseflow has been declining steadily since 1930 (Geraghty and Miller 1995).

Not only is the presence of surface water in the SPRNCA a result of geologic and hydrologic conditions, it is also a result of historic and current land uses, and vegetative and climatic conditions. Historic land uses, changes in floodplain vegetation, and erosional processes have also been studied to determine potential correlation with surface flow variability.

1. ADWR (Correll 1996) modeled several groundwater flow scenarios of future groundwater and surface water conditions in the Sierra Vista subwatershed. The results of this model indicate that agricultural pumpage had the greatest impact on percent changes in baseflow at Charleston, followed by effluent recharge.

2. The University of Arizona San Pedro Interdisciplinary Study Team concluded that pumping from the regional aquifer is not a major factor imperiling streamflow in the San Pedro River. The team noted that drought-related reductions in surface runoff and irrigation-related pumping from the floodplain aquifer are much stronger influences (Maddock 1994).

3. The establishment of riparian vegetation in the 1930s has significantly increased the evapotranspiration rates along the San Pedro River (Geraghty and Miller 1995).Qi *et. al*. (1998) estimate total water loss from the riparian corridor along the San Pedro River to be approximately 48,270 tons per day. The daily evaporative water loss for the entire riparian corridor is estimated to be approximately 10 mg, or 30.7 ac-ft per day (Qi *et. al*. 1998).

4. Historic evidence suggests that entrenchment of the San Pedro River up to 30 feet may have occurred with a consequent lowering of the water table adjacent to the river by the same 30 feet (Geraghty and Miller 1995). They conclude that the observed long-term water level declines in wells near the river may reflect this occurrence.

Geologic and hydrologic studies indicate that the use of groundwater by Fort Huachuca has not caused a change in groundwater discharge from the USPB to the SPRNCA. Most hydrology models and studies suggest that flows will continue to diminish or be lost, and in time, riparian acreage will be reduced along the Upper San Pedro River if groundwater pumping in excess of recharge continues unmitigated. However, pumping will not go unmitigated. Since 1993, Fort Huachuca has reduced its on-post water consumption by 1,000 ac-ft. In addition Fort Huachuca has also agreed to implement many conservation measures to reduce an additional 2,784 ac-ft of water usage in the Sierra Vista subwatershed. Fort Huachuca's declining water usage, expected to have a zero net effect on the aquifer by 2011, will not affect surface flow in the SPRNCA. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

4.9 CUMULATIVE EFFECTS

Cumulative effects are “those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area” (50 CFR 402.02).

One cumulative effect to consider in the Sierra Vista subwatershed area is population growth. The best available data to project population growth and its associated water use is the 2000 Census data. There are approximately 64,655 people who live in the Sierra Vista subwatershed. The Sierra Vista subwatershed area includes the cities of Sierra Vista, Tombstone, Huachuca City, Bisbee, Whetstone, Naco and unincorporated areas southeast of Sierra Vista. Some of these municipalities have not grown or have grown very little over the past 10 years. Sierra Vista increased its population, but it was much slower than anticipated. From 1990 to 2000, the City of Sierra Vista increased its population by 14.5% (37,775) while Cochise County increased by 20.4% (117,755). Overall the growth rate was approximately 2% per year. Using Fluid Solutions USPP Report (July 2001), the annual forecast for future population growth is 2% for Sierra

Vista, 0.4% for Tombstone, 0.5% for Bisbee, 1.5% for Huachuca City, and 1.3% for unincorporated areas. Using an average of 2% this would equate to a total of approximately 77,586 people in the in the Sierra Vista subwatershed by 2010. Of the approximately 13,000 additional people, 6,500 people would be living in the City of Sierra Vista and 6,500 would be outside Sierra Vista.

Another important cumulative effect associated with population growth is the potential impact on groundwater resources. Due to Fort Huachuca's ongoing water conservation efforts (reduced water consumption by over 1,000 ac-ft since 1993) and the City's effluent recharge project, the water deficit in the Sierra Vista subwatershed is 5,144 ac-ft, instead of the 1999 CEC estimate of 7,000 ac-ft. By subtracting Fort Huachuca's conservation measures of 2,784 ac-ft, the groundwater deficit attributable to cumulative effects, not related to Fort Huachuca, is 2,360 ac-ft.

This figure of 2,360 ac-ft does not include the projected population growth in the future. The projected population increase of 12,931 people would result in a net increase of 1,239 ac-ft of additional groundwater use in the Sierra Vista subwatershed by 2011. This figure includes the correction for the associated recharge going back into the aquifer from either effluent recharge facilities or septic systems. By taking the existing cumulative groundwater deficit of 2,360 ac-ft and adding 1,239 ac-ft of projected additional water usage, the total cumulative groundwater deficit by 2011 will be approximately 3,599 ac-ft.

Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects (3,599 ac-ft) associated with groundwater usage by 2011 as well. This is a very achievable accomplishment. Bisbee alone is currently planning to begin construction of an effluent recharge plant in two years. When constructed in six years the effluent recharge plant is projected to recharge approximately 392 ac-ft which would reduce the cumulative water deficit in 2011 to 3,207 ac-ft. Therefore, not only has Fort Huachuca agreed to zero out all direct, indirect, interrelated and interdependent effects of its proposed action, but Fort Huachuca anticipates that the communities and agencies in the region will also agree to zero out all the cumulative effects associated with groundwater usage in the Sierra Vista subwatershed. The bottom line is that by the year 2011 the groundwater deficit in the Sierra Vista subwatershed will be reduced to zero and there will be no effect on threatened or endangered species or their critical habitat at that time. For a detailed discussion of on-going and proposed USPP efforts, see Section 5 and Appendix L.

Another cumulative effect to consider is recreational activities. It is likely that population growth will result in an increase in recreational activities in the Fort Huachuca/Sierra Vista region, to include Fort Huachuca, the SPRNCA and the adjacent Coronado National Forest. Recreation has been identified as a threat to Mexican spotted owl survival and reproductive success in some areas (USFWS 1995b). In addition to the human disturbance factor and the potential for habitat loss associated with recreation, increased recreation on Fort Huachuca and the SPRNCA may result in a higher risk of wildfire, with the potential to impact federally listed, proposed and candidate species and critical habitat in the project area.

4.10 EFFECTS DETERMINATIONS FOR THREATENED, ENDANGERED, PROPOSED, AND CANDIDATE SPECIES AND DESIGNATED CRITICAL HABITAT

A total of 28 species are addressed in this BA as determined by a list from the USFWS of all federally listed, proposed and candidate species that may occur in Cochise County (Table 10, page 102). In addition, critical habitat designations for four species are also addressed. Although the Army is not required by the ESA to include candidate species, AR 200-3 requires Army installations to consider candidate species when actions have the potential to affect them. Installations will avoid taking actions that result in the need to list candidate species. For this reason, Fort Huachuca has included five candidate species in this BA and effect determinations for each of the species are included below.

An effect determination was not made for five of the 28 species because they are not known or likely to occur on Fort Huachuca or in the project area due to lack of suitable habitat. As a result, they will not be discussed further in this section. These species include the Cochise pincushion cactus, New Mexican ridge-nosed rattlesnake, cactus ferruginous pygmy-owl, Mexican gray wolf, and the razorback sucker.

Effect determinations were made on the 23 remaining species (Table 13). This includes a no effect determination for the following 10 species: desert pupfish, whooping crane, Chiricahua leopard frog, northern aplomado falcon, Gila topminnow, Gila chub, mountain plover, black-tailed prairie dog, Lemmon fleabane, and ocelot.

Ongoing and proposed future activities by Fort Huachuca may affect, but are not likely to adversely affect the following five species: Canelo Hills ladies' tresses, bald eagle, jaguar, and the loach minnow and spikedace with their designated critical habitat.

Under current conditions, activities at Fort Huachuca have the potential to adversely affect the following eight species: Huachuca water umbel, Mexican spotted owl, lesser long-nosed bat, Sonora tiger salamander, southwestern willow flycatcher, Ramsey Canyon leopard frog, Huachuca springsnail, and the yellow-billed cuckoo. This includes critical habitat designated for the Huachuca water umbel and Mexican spotted owl.

Determination of effects for each species are discussed in detail below and were based upon:

- Abundance and distribution of the species in the region, and the likelihood of the species to occur in the vicinity of ongoing military operations and activities;
- Habitat requirements of the species;
- Availability of suitable habitat in the vicinity of ongoing and programmed military operations and activities, including critical habitat designated by the USFWS;
- Documented or potential sensitivities of the species to disturbances likely to result from ongoing and programmed military operations and activities;

- Ongoing and planned conservation measures associated with the proposed action as described in Section 5, and

- Analysis of potential direct, indirect, interrelated, interdependent and cumulative effects of military and non-military activities at and near Fort Huachuca.

More specifically, species determinations were based upon the following nine items:

1. Minimal loss of native vegetation would occur under existing and proposed levels of military operations at Fort Huachuca.

2. Fire prevention and suppression procedures that currently exist or that will be implemented, will reduce the risk of accidental fires.

3. The successful use of prescribed burns and fuel load reduction on Fort Huachuca would greatly reduce the probability of severe, stand-replacing fires.

4. Natural resource personnel will coordinate with fire fighters to reduce the potential for fire suppression measures that directly affect listed species or their habitats.

5. Noise levels within the vicinity of listed species and their occupied or potential habitat is generally below the decibel level range documented to result in impacts to wildlife. Exceeding these low levels would be infrequent, of short duration, and of sufficient distance away from species locales to attenuate to moderate levels.

6. The frequency of human disturbance is generally low in areas that support or have the potential to support listed, proposed and candidate species. Restrictions on recreational and operational activities in areas with these species will reduce the risk of incidental disturbance and potential adverse effects.

7. Few records exist of direct mortality of listed species on Fort Huachuca. Moreover, the probability of listed species mortality due to collisions with vehicles, wind turbines, construction equipment, or aircraft is remote.

8. Erosion rates on the South and West Ranges are generally low and are not expected to impact protected species or their habitat. Although moderate to high erosion rates on the East Range, no listed species are known to occur there and sediment from the East Range is deposited prior to reaching the Babocomari and San Pedro Rivers (ENRD 1997). Current and planned erosion conservation measures will reduce the potential for erosion to affect listed species or critical habitat.

TABLE 13 SUMMARY OF POTENTIAL EFFECTS OF FORT HUACHUCA ACTIVITIES ON 23 FEDERALLY-LISTED, PROPOSED AND CANDIDATE SPECIES AND DESIGNATED CRITICAL HABITAT

Species (Status)	Habitat Loss	Fire	Noise	Direct Mortality	Human Disturbance	Erosion	Groundwater Usage	Cumulative Effects	Effect Determination
Huachuca Water Umbel (E) w/critical habitat	No effect	May affect, likely to adversely affect	No effect	No effect	May affect, likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Southwestern Willow Flycatcher (E)	No effect	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect
Mexican Spotted Owl (T) w/critical habitat	No effect	May affect, likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect	May affect, likely to adversely Affect
Lesser Long-Nosed Bat (E)	May affect, not likely to adversely affect	May affect, likely to adversely affect	May affect, not likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect	May affect, likely to adversely Affect
Sonora Tiger Salamander (E)	No effect	May affect, likely to adversely affect	No effect	No effect	May affect, likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect	May affect, likely to adversely affect
Yellow-Billed Cuckoo (C)	No effect	May affect, not likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, likely to adversely affect	May affect, likely to adversely Affect
Huachuca Springsnail (C)	No effect	May affect, likely to adversely affect	No effect	No effect	May affect, likely to adversely affect	No effect	No effect	May affect, not likely to adversely affect	May affect, likely to adversely affect
Ramsey Canyon Leopard Frog (Conservation Agreement)	No effect	May affect, likely to adversely affect	No effect	No effect	May affect, likely to adversely affect	May affect, not likely to adversely affect	No effect	May affect, not likely to adversely affect	May affect, likely to adversely Affect
Spikedace (T) w/critical habitat	No effect	May affect, not likely to adversely affect	No effect	No effect	No effect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely Affect
Loach Minnow (T) w/critical habitat	No effect	May affect, not likely to adversely affect	No effect	No effect	No effect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Canelo Hills Ladies' Tresses (E)	No effect	May affect, not likely to adversely affect	No effect	No effect	No effect	No effect	No effect	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Bald Eagle (T)	No effect	No effect	No effect	May affect, not likely to adversely affect	No effect	No effect	No effect	No effect	May affect, not likely to adversely affect
Jaguar (E)	No effect	May affect, not likely to adversely affect	No effect	No effect	No effect	No effect	No effect	No effect	May affect, not likely to adversely affect
Chiricahua Leopard Frog (T)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Mountain Plover (P)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Ocelot (E)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Black-tailed Prairie Dog (C)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Desert Pupfish (E)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Gila Topminnow (E)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Gila Chub (C)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Whooping Crane (E)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Northern Aplomado Falcon (E)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Lemmon Fleabane (C)	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect

9. The cone of depression associated with groundwater pumping by Fort Huachuca and Sierra Vista has not, and will not, intercept the San Pedro River in the near future. Ongoing and proposed activities at Fort Huachuca are not expected to affect the perennial reaches of the San Pedro River based upon:

    a. Fort Huachuca's commitment to water conservation measures that will offset water use associated with the direct, indirect, interrelated and interdependent effects of the proposed action (2,784 ac-ft).

    b. Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well (3,599 ac-ft).

4.10.1 HUACHUCA WATER UMBEL

Possible adverse effects to the Huachuca water umbel and its critical habitat could result from the proposed action due to groundwater use, fire, human disturbance and erosion. However, with respect to groundwater usage, Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with its proposed action by 2011. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

Current Baseline Conditions and Potential Unmitigated Effects of Groundwater Use in the Sierra Vista subwatershed

The purpose of this subsection is to discuss the current baseline conditions and the potential effects of unmitigated groundwater use in the Sierra Vista subwatershed. As detailed throughout this BA, the proposed action is to implement conservation measures which will completely mitigate or offset all direct, indirect, interrelated and interdependent effects of water usage associated with the presence of Fort Huachuca in the Sierra Vista subwatershed. In addition, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

Groundwater pumping in the Fort Huachuca-Sierra Vista area has created a large cone or cones of depression in the groundwater aquifer that extend from approximately the Babocomari River southeast for at least 15 miles (see Section 3). In 1998, ADWR determined that groundwater elevation has recently declined by an average of about two feet per year. If the cone of depression reaches the San Pedro River, it could reverse the flow of groundwater, cause gaining reaches to become losing reaches, and result in declines or loss of base flow. Before actually reaching the river, base flow is expected to decline due to reduced hydraulic head between the cone of depression and the river.

Several changes in riparian and wetland vegetation are expected in response to declining groundwater elevation (Stromberg *et. al.* 1996) and are apparently ongoing in certain reaches of the upper San Pedro River (ADWR 1994). Herbaceous aquatic and semi-aquatic plants found in cienegas or marshes, such as the Huachuca water umbel, are most sensitive to groundwater decline (ADWR 1994). Abundance of obligate wetland herbs declines sharply as groundwater depth drops below approximately 10 inches beneath the soil's surface (Stromberg *et. al.* 1996). Recent changes in riparian and wetland vegetation suggest that groundwater declines are already affecting the habitat of the Huachuca water umbel. Groundwater declines of six feet and three feet have occurred since 1987 on the San Pedro River at Contention (roughly one mile north of the Tombstone gage) and Palominas, respectively. ADWR (1994) notes that "these groundwater declines have been great enough to cause loss of obligate wetland plants and facultative wetland plants." At Contention, seasonal groundwater flux is about six feet and flows are intermittent. In this area groundwater elevation declined too rapidly to allow survival of Fremont cottonwood seedlings (ADWR 1994). During surveys for southwestern willow flycatchers in July 1997, SAIC (1998b) noted that in the reach north of the Charleston Narrows to Boquillas, the river was dry and cottonwoods were beginning to lose their leaves. Riparian trees are typically growing vigorously in July.

Due to its ability to thrive on upper floodplain terraces, prevalence of salt cedar, *Tamarix chinensis*, is also predicted to increase under regimes of declining water tables. ADWR (1994) found that salt cedar is increasing on the San Pedro River below Benson and in the downstream end of the SPRNCA, where the river loses water to the floodplain aquifer. At Contention, where groundwater is declining, salt cedar is replacing cottonwoods on young floodplains (ADWR 1994). Loss of trees and possibly a change in tree species composition would cause changes in the habitat of herbaceous species, because canopy cover moderates ambient temperatures, alters light quantity and quality, and may affect channel morphology and dynamics (Menges and Waller 1983, Cross 1991, DeLoach 1991). The causes of apparent recent groundwater declines at Contention and Palominas are not known with certainty, but likely include agricultural and perhaps domestic groundwater pumping (Sharma *et. al.* 1997, MacNish 1998, ASL 1994, Jackson *et. al.* 1987, W&EST, Inc.1996).

In perennial reaches of the San Pedro River, as water levels decline, suitable water umbel habitat would likely move downslope into what is now the active river channel. Huachuca water umbel would likely be more vulnerable to flood events in these sites. With continuing water declines, perennial reaches would go dry seasonally (probably first in May-June). Huachuca water umbel typically occurs in very shallow water or wetted ground, but can withstand seasonal drought and persist in some intermittent reaches, such as in portions of Bear Canyon and Lone Mountain Canyon on the west slope of the Huachuca Mountains. In intermittent stream segments, increasing dry periods would reduce the ability of the plant to grow, reproduce, and expand populations. Even if the water umbel can survive long periods of drought as seeds or rhizomes (Haas and Frye 1997) at some point increasing aridity would eliminate the plant, including seed stock and rhizomes, from intermittent reaches. Other changes associated with declining water tables, described in the preceding paragraph, could result in changes in shading, temperature, and channel dynamics, with varying effects to water umbel habitat. However, by the time water levels declined to a point that riparian woodlands or shrubs were adversely affected, triggering these additional changes, the water umbel would likely already be extirpated due to dewatering.

Hydrology Modeling Efforts and Studies of Groundwater Use

Although there are a number of hydrology modeling efforts and studies in the Sierra Vista subwatershed, no current modeling effort or study considers the broad scope of conservation measures committed to by Fort Huachuca (reduce 2,784 ac-ft of water usage by year 2011). In addition, these modeling efforts and studies do not consider the anticipated commitment by the Upper San Pedro Partnership to reduce cumulative effects (3,599 ac-ft of water usage) to zero by the year 2011. Indeed the opposite is true. Often these modeling efforts and studies assume that water usage will go unmitigated. Therefore, the conclusions of these studies and modeling efforts must be updated in light of the new commitments by both Fort Huachuca and the Upper San Pedro Partnership.

The hydrology modeling efforts and studies are discussed in Section 3. In general, they conclude that in the long-term if groundwater pumping in excess of recharge continues unmitigated, the cone of depression will in time begin to reverse the groundwater gradient to the river, more and more of the effluent will flow to the cone of depression rather than to the river, and base flow will decline or be lost. Precisely when this would occur is not clear.

One modeling effort was done by W&EST, Inc. in 1996. This model estimated that agricultural users were responsible for 94% of the historic loss of river flow through 1988, while municipal and military users were only responsible for 6%. However, the authors did not calculate current contributions to observed base flow declines. In addition, these percentages have since changed significantly because agricultural water use continues to decline. Modeling by ASL (1998) suggests significant effects may occur by 2020 (assuming effluent recharge by Sierra Vista through 2020), while ADWR (1991) believes the river may not be significantly affected for 40 years or more. Of course, neither of these modeling efforts included the implementation of conservation measures of nearly 2,800 ac-ft by Fort Huachuca. In addition, these modeling efforts did not include that Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011.

In 1999 the San Pedro Expert Team (Team) considered a number of potential issues, initiatives and scenarios with regard to groundwater deficit in the Sierra Vista subwatershed. For example, the Team considered the effect of the City's effluent recharge project. The Team noted that the City's effluent recharge project could buffer the effects of groundwater pumping, but that the project would only recharge roughly 2,000 ac-ft per year under current plans. Currently the City's effluent recharge project is projected to recharge over 2,600 ac-ft. The Team also concluded that the water budget deficit in the Sierra Vista subwatershed was 7,000 ac-ft per year and that it was expected to grow (San Pedro Expert Study Team 1999). As previously noted, the current groundwater deficit in the Sierra Vista subwatershed is approximately 5,144 ac-ft and it is expected to decline as conservation measures are implemented.

The San Pedro Expert team also considered issues concerning the potential for additional agricultural development and increased pumping of groundwater in the floodplain of the San Pedro River in either the US or Mexico portions of the river. On the Mexico side, the Team noted that reprogramming of Land Water Conservation Funds for acquisitions in the

subwatershed as a part of the recent US-Mexico binational initiative could hasten retirement of agricultural lands for additional water savings of up to 3,500 acre feet per year.

On the US side of the Sierra Vista subwatershed, the Team noted that agricultural usage of water in the subwatershed has declined in recent years due to retirement of croplands (San Pedro Expert Study Team 1999, ADWR 1994). The Team concluded that initiatives to designate irrigable lands as irrigation non-expansion areas or to purchase lands or easements from willing sellers should be implemented. Fort Huachuca has since purchased one conservation easement for a savings of 630 ac-ft and further conservation easement efforts by the Fort, TNC and BLM are helping to retire and reduce the amount of agricultural lands near the River.

The San Pedro Expert Study Team (1999) estimated the water budget for the subwatershed through 2030 under a scenario in which the following projects would be implemented: 1) enhanced mountain front recharge of 1,000 ac-ft per year (corresponds to Fort Huachuca's proposed watershed improvements as described in SAIC (1998a)); 2) continued water conservation programs at Fort Huachuca (increased recharge of 500 ac-ft per year); 3) sewage effluent recharge at Sierra Vista of 2,600 ac-ft per year and; 4) water conservation and reduced pumping in domestic wells over a scenario without conservation (gain of 300 ac-ft per year), and retirement of all agriculture in the subwatershed (gain of 1,100 ac-ft per year). Assuming population growth projections of 73,900 and a consumptive use of 9,900 ac-ft per year in 2030, the deficit would be reduced to 6,770 ac-ft per year in 2030. If all irrigated agriculture in Mexico was eliminated, the deficit would be approximately 3,500 ac-ft per year. Thus, the authors found that, even with implementation of a number of major mitigating measures, threats to the base flow of the river were not eliminated. The San Pedro Expert Study Team found that a means to maintain a viable riparian system was to shift the protected area southward and create a cross-border riparian protection zone, which would probably have to be coupled with water importation from the Douglas basin or the Central Arizona Project. Other possible measures which either reduce consumptive use or increase water supply are described by the San Pedro Expert Study Team (1999) and the Upper San Pedro Advisory Panel (1998).

Since the release of the 2000 Census it is clear that the population growth projections used by the San Pedro Expert Study Team were too high. More importantly, Fort Huachuca's conservation measures (reducing 2,784 ac-ft of water usage by the year 2011) have gone well beyond those put forth by the San Pedro Expert Team. In addition, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects (3,599 ac-ft in water usage) associated with groundwater usage by 2011.

One measure with significant potential to bring the water budget into balance include capture of up to 6,100 ac-ft of ephemeral surface flows per year for use by Sierra Vista (ASL 1995). Implementation of this measure in addition to those described above would create a surplus even when increased population growth and subsequent increased demand for water is considered.

While the San Pedro Expert Team addressed issues related to the groundwater deficit, the Upper San Pedro Partnership (USPP) is the local organization which continues the day-to-day work required to address groundwater deficit issues in the Sierra Vista subwatershed. The list of USPP

measures and initiatives which they are currently working on is exhaustive and is included in Section 5 and Appendix L.

Potential risk factors affecting Huachuca Water Umbel

Population locations. Huachuca water umbel populations occur throughout the SPRNCA (Figure 22, page 103). For ease of discussion, the SPRNCA can be divided into four sections. These sections include: 1) the northern most section from Fairbank to the northern boundary of the SPRNCA (Tombstone gauge section), 2) from Charleston northward to Fairbank (Brunchow Hill section), 3) from Highway 90 north to Charleston (Lewis Spring section), and 4) from Hereford north to Highway 90 (near Hereford Bridge section).

Predicting which area might be affected first by declining groundwater levels is problematic and dependent on the estimated rate of decline and current base flow at specific sites. An examination of current base flow at each locality suggests that populations near Brunchow Hill, about one mile downstream of Charleston, are perhaps the most resistant to water level changes. Base flow at the Charleston Gage is more than three times that at Palominas and less variable than flows at the Tombstone Gage (ASL 1995, Vionnet and Maddock 1992). At Brunchow Hill, if water levels continue to decrease (flows have been declining at this site - ASL 1994), water umbel habitat would likely move deeper into the river channel as flows declined. Huachuca water umbel would be extirpated from the area if water levels declined enough to de-water water umbel habitat for extended periods of time. Extirpation could also occur if the taxon was restricted to the bottom of the river channel and a large flood scoured out the channel. The San Pedro Expert Study Team (1999) noted that although base flow at Charleston is dependably perennial, at times it is only barely perennial (flows as low as 0.05 cfs have occurred in the last ten years - see Table 2 of their report). Thus, although the population at Brunchow Hill may be more resistant to declining base flow than other populations, almost any reduction in flow will result in the river becoming intermittent in the Brunchow Hill-Charleston area.

The southernmost Huachuca water umbel locality in the SPRNCA (from Hereford Bridge north for approximately one mile) is at the upstream end of the perennial reach where base flows are relatively low. Low flows at Hereford are typically about 40% of low flows at Charleston, and periods of no flow have been recorded (Sharma *et. al.* 1997). Increasingly intermittent flows and extirpation of the umbel could result if water levels decline at this site. Based on flow data from the BLM gage at the International Boundary, median flows at the site just south of the international boundary are probably about 2 cfs less than at Charleston, and periods of no flow occur.

Flows in the vicinity of water umbel population near the Tombstone Gage are highly variable. ASL (1994) notes that it is not uncommon for there to be no measurable flow at the Tombstone Gage. As a result, populations in this area would probably be extirpated if base flow declined much at all during May-June.

.

At the Lewis Springs site, where a population occurs in the river, flows are somewhat more than 50% of flows at Charleston; periods of no flow have not been recorded (Sharma *et. al.* 1997). Relatively low flows at Highway 90 (about one to two miles south of the Lewis Springs site) and

Lewis Springs as compared to flows at Charleston, suggest populations at Lewis Springs and Highway 90 are more vulnerable to groundwater decline than the population at Brunchow Hill (near Charleston). However, the lack of no flow periods at Lewis Springs and Highway 90 suggests populations at these sites may be able to sustain greater declines in flow than populations at Tombstone Gage, Hereford, or the site south of the international boundary, where the river currently goes dry periodically.

Predicted rate of groundwater decline. Predicted rate of groundwater decline is the second factor in assessing risk of population extirpation. USGS (1998) believes "the San Pedro River above Charleston may not be as vulnerable to pumping from (Fort) Huachuca and Sierra Vista as the Babocomari River and the San Pedro River downstream of Charleston." The presence of a clay deposit reinforces this finding and suggests the reach in the vicinity of the Babocomari confluence would be the first area affected by groundwater pumping at Fort Huachuca and Sierra Vista, followed by the reach north of Charleston, and then the reach from Highway 90 to Charleston (Don Pool, pers. comm. 1999). A couple of water umbel populations occur near the Babocomari confluence (Tombstone gage population). Many populations of water umbel also occur in the perennial reach from Charleston north to the Babocomari, with several more populations occurring in the reach from Highway 90 to Charleston (at Brunchow Hill, Lewis Springs, and populations near Highway 90).

If Sierra Vista's effluent recharge project is successful, flows downstream of the project to at least Fairbank could be bolstered from 2000-2020 (ASL 1998). The fate of populations just south of the international boundary and at Hereford will probably depend on agricultural pumping in these areas and are much less likely to be significantly affected by groundwater pumping at Fort Huachuca or Sierra Vista than downstream populations.

Following from the discussions above, the populations near the Babocomari confluence are probably most at risk in the near future. Populations between Hwy 90 and Charleston (at Brunchow Hill, Lewis Springs, and Highway 90) are expected to be affected next; the former site may be the most robust of the three in terms of maintaining future base flow. Which of these populations are affected first will depend in part on the location and success of Sierra Vista's effluent recharge project. Flows in the vicinity of the populations near Hereford Bridge and near the international boundary will likely depend on the future of irrigated agriculture near the river both north and south of the border, and will likely not be affected by groundwater pumping at Fort Huachuca and Sierra Vista. Although groundwater elevation at Palominas, located between Hereford and the international boundary, has declined by about three feet since 1987 (ADWR 1994), Sharma *et. al.* (1987) report that the percentage of flow contributed by groundwater discharge has apparently increased at Hereford.

Mitigation of all Direct, Indirect, Interrelated and Interdependent Effects Attributable to Fort Huachuca's Groundwater Use

The purpose of this subsection is to address the water conservation measures which Fort Huachuca will implement by 2011 to significantly reduce the potential effects and risk factors to the Huachuca Water Umbel as outlined above.

As noted in Section 3 of the BA, there are 64,655 people in the Sierra Vista subwatershed. Of the total population in the Sierra Vista subwatershed, 34,993 people (54%) are related to Fort Huachuca as direct, indirect, interrelated and interdependent population. This includes 26,531 military, civilian employees, contractors, military retirees, survivors and family members. It also includes 7,093 induced employees and their family members, i.e., their off post groundwater pumping would not occur "but for" the presence of the Fort. Finally, it includes an increase of 1,369 projected Fort personnel and their family members.

The Fort applies the same 54% of the population in the Sierra Vista subwatershed to determine its share of the 5,144 ac-ft groundwater deficit. In this case, 54% of the groundwater deficit in the Sierra Vista subwatershed equals 2,784 ac-ft. This is the entire amount of the groundwater deficit attributable to the Fort's presence in the Sierra Vista subwatershed. This includes all direct, indirect, interrelated and interdependent effects associated with pumping groundwater.

As detailed in Section 5, Fort Huachuca has agreed to implement conservation measures which will completely offset all direct, indirect, interrelated and interdependent effects associated with its proposed action (i.e., 2,784 ac-ft) by the year 2011. In addition, Fort Huachuca will offset all increased water pumpage associated with potential personnel/mission increases in the future i.e., beyond 12,805 personnel. By reducing 2,784 ac-ft in groundwater usage, in 2011 there will be no effect on the Huachuca Water Umbel or its critical habitat associated with Fort Huachuca's groundwater usage.

Mitigation of Cumulative Effects of Groundwater Use in the Sierra Vista subwatershed

In addition, to the direct, indirect, interrelated and interdependent effects of groundwater usage associated with the Fort's proposed action, cumulative effects of groundwater use on water umbel habitat in the San Pedro River are also important to consider. Cumulative effects include the effects of future State, tribal, or local private actions that are reasonably certain to occur in the project area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Due to Fort Huachuca's ongoing water conservation efforts (reduced water consumption by over 1,000 ac-ft since 1993) and the City's effluent recharge project[3], the water deficit in the Sierra Vista subwatershed is 5,144 ac-ft, instead of the 1999 CEC estimate of 7,000 ac-ft. By subtracting Fort Huachuca's conservation measures, the groundwater deficit attributable to cumulative effects, not related to Fort Huachuca, is 2,360 ac-ft.

One cumulative effect to consider in the Sierra Vista subwatershed area is population growth. The best available data to project population growth and its associated water use is the 2000 Census data. There are approximately 64,655 people who live in the Sierra Vista subwatershed.

[3] Even if enough conservation measures are implemented so that water supply equals or exceeds water use, the cone of depression is expected to continue its lateral expansion as it flattens out and would likely de-water portions of the San Pedro River [see scenario (1) of W&EST, Inc. 1994 – Table 5, page 80]. The success of the City's effluent recharge project is critical to avoiding near-term effects to river base flow and water umbel habitats.

The Sierra Vista subwatershed area includes the cities of Sierra Vista, Tombstone, Huachuca City, Bisbee, Whetstone, Naco and unincorporated areas southeast of Sierra Vista. Some of these municipalities have not grown or have grown very little over the past 10 years. Sierra Vista increased its population, but it was much slower than anticipated. From 1990 to 2000, the City of Sierra Vista increased its population by 14.5% (37,775) while Cochise County increased by 20.4% (117,755). Overall the growth rate was approximately 2% per year. Using Fluid Solutions USPP Report (July 2001), the annual forecast for future population growth is 2% for Sierra Vista, 0.4% for Tombstone, 0.5% for Bisbee, 1.5% for Huachuca City, and 1.3% for unincorporated areas. Using an average of 2% this would equate to a total of approximately 77,586 people in the in the Sierra Vista subwatershed by 2010. Of the approximately 13,000 additional people, 6,500 people would be living in the City of Sierra Vista and 6,500 would be outside Sierra Vista.

Another important cumulative effect associated with population growth is the potential impact on groundwater resources. Due to Fort Huachuca's ongoing water conservation efforts (reduced water consumption by over 1,000 ac-ft since 1993) and the City's effluent recharge project, the water deficit in the Sierra Vista subwatershed is 5,144 ac-ft, instead of the generally used number of 7,000 ac-ft. By subtracting Fort Huachuca's conservation measures of 2,784 ac-ft, the groundwater deficit attributable to cumulative effects, not related to Fort Huachuca, is 2,360 ac-ft.

This figure of 2,360 ac-ft does not include the projected population growth in the future. The projected population increase would result in a net increase of 1,239 ac-ft of additional groundwater use in the Sierra Vista subwatershed by 2011. This figure includes the correction for the associated recharge going back into the aquifer from either effluent recharge facilities or septic systems. By taking the existing cumulative groundwater deficit of 2,360 ac-ft and adding 1,239 ac-ft of projected additional water usage, the total cumulative groundwater deficit by 2011 will be approximately 3,599 ac-ft.

Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 (3,599 ac-ft). This is a very achievable accomplishment. Bisbee alone is currently planning to begin construction of an effluent recharge plant in two years. When constructed in six years the effluent recharge plant is projected to recharge approximately 392 ac-ft.

Conclusion - Effects Determination for the Huachuca Water Umbel due to Groundwater Usage

The current groundwater deficit in the Sierra Vista subwatershed is 5,144 ac-ft. Although continued, unmitigated groundwater pumping in excess of recharge would, in time, result in loss of the Huachuca water umbel from portions of the San Pedro River, pumping will not continue unmitigated. Fort Huachuca has agreed to zero out all direct, indirect, interrelated and interdependent effects of its proposed action by 2011 (i.e., 2,784 ac-ft). Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to zero out all the cumulative effects

associated with groundwater usage in the Sierra Vista subwatershed by 2011 as well (i.e., 3,599 ac-ft). Successful implementation of the Sierra Vista effluent recharge project will assist in this effort and should prevent any potential near-term effects to River base flow.

By the year 2011, Fort Huachuca expects the entire groundwater deficit in the Sierra Vista subwatershed to be reduced to zero and there will be no effect to the Huachuca Water Umbel or its critical habitat associated with groundwater usage. For a detailed discussion of Fort Huachuca's conservation measures and on-going and proposed efforts by the USPP, please see Section 5 and Appendix L.

Effects of Human Disturbance (non-groundwater)

Activities proposed that have the potential to adversely affect the Huachuca water umbel or its habitat on the Fort include recreational activities, vehicle use, maintenance of roads and firebreaks, military testing and training activities, fire ignited by authorized ordnance use or recreation, and activities associated with prescribed fire or fire suppression. Military training and testing are limited in the canyons of the Huachuca Mountains where this species occurs, and vehicle use is restricted to existing roads and trails. A hiking trail passes by the population at Sawmill Spring. Limited trampling by recreationists likely occurs at this locality, but is not considered a serious threat to this population. The population at Middle Garden Canyon picnic ground is located in the picnic area and likely subject to trampling, but the Fort has placed large boulders around the area to prevent vehicles from driving through the habitat. Other populations in Garden and McClure canyons receive less use by recreationists, and trampling and damage by vehicles are less likely to occur in these areas.

Many DOD units train at Fort Huachuca. When training at Fort Huachuca, the effects of that training are part of the effects of the proposed action, because such training must be approved by Fort Huachuca. However, the effects of the activities of these units when not at Fort Huachuca are not effects of the proposed action, because they are not interrelated or interdependent to the proposed action. If these DOD units did not train at the Fort, they would train at another military installation. No unit could not exist or train but for the existence of Fort Huachuca, thus the activities of these units outside of Fort Huachuca are not interrelated to or interdependent on the proposed action.

A pipeline currently exists in Garden Canyon that has the potential of diverting a portion of the flow in Garden Canyon for downstream use. The potential amount is unknown, but the source is eight springs, with the uppermost spring located near the pictograph sites. From this point, water is collected and diverted in a pipeline from the various springs along Garden Canyon Creek (Tom Cochran, pers. comm. 1998). The Fort has removed all water uses from this pipeline. However, the pipeline infrastructure will remain intact and may be used in the future for mobilizing, emergencies, and fire fighting. These uses are expected to be infrequent and of short duration, and thus should have little affect on water umbel populations in Garden Canyon. The Fort has already implemented a couple of conservation measures to reduce the effect of human disturbance on the umbel populations and critical habitat. These include the protection of umbel populations with boulders and the closure of Gate 7.

Cumulative Effects of Human Disturbance (non-groundwater)

The presence of Fort Huachuca employees, contractors, dependents, and others in the Sierra Vista subwatershed may have effects on the water umbel and its habitat. Agricultural and urban development may result in watershed degradation and subsequent adverse effects to biotic integrity and habitat quality in adjacent riparian systems (Wang *et. al*. 1997). In Wisconsin, urbanization rates of between 10 and 20% in watersheds consistently resulted in low indices of biotic integrity (Wang *et. al*. 1997). Urbanization results in increased runoff, and resulting changes in flow regimes, water temperature, and channel morphology (Wang *et. al*. 1997, Schueler 1994). Runoff from urban areas also reduces water quality by carrying toxicants and high nutrient loads (Wang *et. al*. 1997).

The increased human population in the subwatershed as a result of Fort Huachuca probably also results in increased recreational use of Huachuca water umbel sites, both on- and off-Post. Increased recreational use results in greater chance of fire, trampling, and off-road vehicle damage, all of which can adversely affect water umbel populations.

Most activities that may adversely affect the Huachuca water umbel in the project area would involve a Federal action, and thus are not considered cumulative effects. Exceptions may include activities on private lands in Scotia, and Bear canyons on the west slope of the Huachuca Mountains, and at other sites in the San Rafael Valley. The most likely impacts in these areas would be livestock grazing. The species is apparently able to coexist with well-managed livestock grazing; however, historic and long-term effects of grazing on riparian systems supporting the water umbel have been detrimental. Effects of livestock grazing on the water umbel on lands managed by the Coronado National Forest were recently addressed in a formal Section 7 consultation. Private lands in Scotia Canyon may be acquired by the Coronado National Forest through a land exchange.

Effects of Erosion

Effects to the water umbel due to erosion of roads or firebreaks off the installation, but in the Sierra Vista subwatershed, are unknown, but are potentially a threat. The road through Garden Canyon is well-maintained and little erosion appears to be associated with its use and maintenance, at least below the mouth of Sawmill Canyon. However, portions of the road may be subject to periodic wash-outs and associated downstream impacts during severe storm events. As a result of a large storm event in October of 2000, Garden Canyon Road was severely eroded and required maintenance. Through informal consultation in May of 2001, the Fort was able to complete maintenance while minimizing potential adverse effects to umbel populations and critical habitat. A number of conservation measures for maintenance of Garden Canyon Road resulted from this consultation and they are included in Section 5.

The East Range, which encompasses approximately 28,544 acres, lies in the watersheds of the Babocomari and San Pedro rivers. The vegetation and soils of the East Range consist of highly impacted areas intermingled with large tracts of relatively undisturbed habitat. Disturbance has resulted from overgrazing and agricultural development, which predates military use, and military activities such as a landing strip and five off-road maneuvering areas currently not in

use. Watershed condition is degraded in a band, approximately two to three miles in width, that runs across the East Range from the northwest to the southeast. Brush encroachment and relatively steep slopes results in erosion and downstream sedimentation. Sheet, rill, and gully erosion occur extensively in this area (ENRD 1997). Along the eastern boundary of the East Range is an area of soil deposition. Soils eroded off the watershed to the west are being deposited here and later washed away towards the San Pedro River during gully headcutting. Brush is encroaching in this area as well. In other areas of the East Range, the nonnative Lehmann lovegrass, *Eragrostis lehmanniana*, is invading. Watershed condition is improving in these areas due to the ability of Lehmann lovegrass to slow runoff and soil erosion (ENRD 1997).

Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Belsky and Blumenthal 1997, DeBano and Schmidt 1989, Gifford and Hawkins 1978). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and sedimentation or erosion of the San Pedro and Babocomari rivers. Such conditions could result in increased likelihood that the Huachuca water umbel populations near Fairbank, which is downstream of the East Range, could be scoured out during peak flows or buried by sediment. However, studies by the Environment and Natural Resources Division at Fort Huachuca (1997) indicate that most sediment eroded from the East Range is deposited along the Fort's eastern boundary and does not reach the San Pedro or Babocomari rivers. The lower-elevation portions of San Pedro River watershed are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by watershed problems elsewhere along the San Pedro River. Fort Huachuca is committed to number of erosion conservation measures to reduce the affect of erosion on umbel populations and critical habitat (Section 5). These include no off road vehicle travel on the installation and implementation of the East Range Watershed Improvement Plan which includes activities such as revegetation, installation of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded roads.

Effects of Fire

Fire and subsequent runoff and erosion of canyon bottoms are the greatest threats to Huachuca water umbel populations on-post in the Huachuca Mountains. Degradation of watershed condition immediately after fires can result in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or drought (Rinne and Neary 1996). These conditions could result in decline or extirpation of Huachuca water umbel populations in Garden, and McClure canyons, or at Sawmill Spring on the Fort or in adjacent off-post canyons that might be affected by fire on Fort Huachuca (i.e. Scotia and Bear canyon populations). Fires could be intentionally ignited (prescribed fire or arson) or ignition could result from lightning strikes or unintended human ignition such as campfires, cigarettes, or ordnance. Fires associated with campfires or cigarettes are most likely to occur along roadways or at campgrounds and picnic sites. Live fire ranges and firing fans are shown in Figure 6, page 17. All Huachuca water umbel populations on Fort Huachuca are close enough to currently-used

firing fans that a fire ignited by ordnance could potentially reach the site and adversely affect habitat. Even non-explosive ordnance could result in fire if it landed or skipped on rocks, causing sparks.

Fires have been few or absent from the higher elevation Huachuca water umbel populations (McClure and Upper Garden canyons, and Sawmill Spring)(Figure 24, page 167). Several fires burned near the Middle Garden Canyon population and at or near the lower Garden Canyon populations. Although fires at high elevation are infrequent, recent high intensity crown fires at high elevation to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire in 1983), combined with high fuel loads in some of these areas (Danzer 1997), suggest that a stand-replacing fire could potentially occur at Fort Huachuca during the life of the project.

General Wildlife Services (1999) suggest that Garden Canyon "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage." They note that there have been no recent fires on the Garden Canyon watershed, fuels are relatively dense, the watershed probably has a deep "regolith" available for debris flow, and the watershed is large enough to collect a sizable runoff from a major storm event. The Fort is committed to initiating prescribed fires and fuels management in the Huachuca Mountains. A Fire Management Plan has been drafted (Robinett *et. al.* 1997) that provides a planning framework for reducing the risk of catastrophic stand-replacing fires. Over time, this effort should significantly reduce the threats to water umbel habitat due to possible erosion, scouring, and sedimentation following a severe wildfire. The risk of a stand-replacing fire that burns over a large area is also reduced due to a network of fire breaks that the Fort maintains along ridgelines and ridgetops.

Wildfires occurred infrequently on the East Range from 1973-2002 (Figure 24, page 167). Conceptually, a fire could start on the East Range and spread to the San Pedro River, which is approximately 0.6 mile away from the East Range boundary at its closest point. Fire could destroy riparian vegetation, change the microclimate of water umbel sites, and cause increased runoff, erosion, and sedimentation that could eliminate water umbel populations. However, fires are infrequent and small in the Chihuahuan desert scrub habitat of the East Range because there is little fuel to carry a fire, and fire breaks and roads prevent fires from spreading very far. There is a fire break around Impact Area Zulu, which is a live fire impact zone, and another fire break is located on the east boundary of the East Range. Only one, small fire occurred on the eastern half of the East Range from 1973-2002; and fires ignited on the East Range have never burned into the SPRNCA. The threat of fire spreading from the East Range to the San Pedro River is insignificant. Also, conceivably, a live shell could miss Impact Area Zulu, land in the SPRNCA, and start a fire. However, this has not happened to date and is considered highly unlikely.

Although active fire suppression is critical to reduce damage from wildfire, suppression activities can adversely affect the water umbel. Decisions made during fire suppression can affect the degree and intensity of fire effects, and the type and location of suppression activities could directly or indirectly affect water umbel habitat. Use of heavy equipment, such as tracked vehicles, to cut fire lines or reduce fuels could destroy habitat, cause erosion, or create new routes of travel that may lead to increased access and recreational impacts. However, the Fort is committed to making protection of water umbel habitat an objective of fire suppression, off-road

vehicle activity, including tracked vehicles, would be minimized, a resource advisor would be on-site during all fires to advise the fire boss of species issues, and areas disturbed would be kept to a minimum and located outside of areas important for the water umbel whenever possible.

Effects to Critical Habitat

Critical habitat for the Huachuca water umbel was designated July 12, 1999 (USFWS 65 FR 132), in the project area on 3.8 miles of upper Garden Canyon on Fort Huachuca, and 33.7 miles of the upper San Pedro River from approximately 600 feet south of Hereford Bridge to just north of Fairbank. Critical habitat was also designated in nearby Scotia Canyon, just west of Gate No. 7 of Fort Huachuca, and in other canyons on the west slope of the Huachuca Mountains. Critical habitat is defined in Section 3(5)(A) of the Act as

1. The specific areas within the geographic area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features:

    a. Essential to the conservation of the species, and

    b. That may require special management considerations or protection;

2. Specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.

The primary constituent elements identified in the final rule as necessary for the survival and recovery of the Huachuca water umbel include, but are not limited to, the habitat components which provide the following:

1. Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of Huachuca water umbel;

2. A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for water umbel expansion;

3. A riparian plant community that is relatively stable over time and in which nonnative species do not exist or are at a density that has little or no adverse effect on resources available for water umbel growth and reproduction; and

4. In streams and rivers, refugial sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstream rivers, that allows each population to survive catastrophic floods and recolonize larger areas.

Because the upper San Pedro River is the only large, contiguous habitat of the water umbel, it is the most important of the critical habitat areas to the survival and recovery of the species. Loss of

this habitat would appreciably diminish the value of critical habitat for both the survival and recovery of the Huachuca water umbel. In the final critical habitat rule, the Service found that activities such as excess groundwater pumping that appreciably decreases base flow and appreciably reduces the wetted surface area of perennial rivers or springs may destroy or adversely modify critical habitat.

As discussed previously, evidence suggests that de-watering is already occurring, although the cause is unclear and may or may not currently be attributable to effects of the action (San Pedro Expert Study Team 1999, Koehler and Ball 1998, Pool *et. al.* 1998, MacNish 1998, SAIC 1998b, Fenske 1998, Sharma *et. al.* 1997, W&EST, Inc. 1996, ADWR 1994, ASL 1994). Of particular concern is the potential for agricultural development near the river, which could result in de-watering the portion of critical habitat on the San Pedro River from Hereford to Highway 90. Critical habitat north of Charleston, particularly near the Babocomari confluence, (15.3 miles) is most at risk, followed by the reach from Highway 90 to Charleston (5.5 miles). Unless a concerted effort is made to manage water resources in the subwatershed, groundwater use will continue to exceed supply, resulting over time in a loss of Huachuca water umbel critical habitat on the upper San Pedro River.

A concerted effort to address these groundwater deficit concerns is occurring. Fort Huachuca has committed to conservation measures to balance its water usage and Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well. These efforts will offset any potential effects associated with groundwater pumping in the Sierra Vista subwatershed and will protect 33.7 miles of critical habitat for the Huachuca Water Umbel on the San Pedro River.

Activities at Fort Huachuca other than groundwater pumping also have a potential to adversely affect critical habitat. These activities include recreational activities, vehicle use and maintenance of roads and firebreaks, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. The most important of these are wildfire and prescribed fire, and fire suppression activities. Wildfire ignited by recreational users or ordnance, prescribed fire, and fire suppression activities could result in direct effects to water umbel critical habitat in Garden Canyon, or perhaps in nearby Scotia Canyon. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion, sedimentation, and changes in stream hydrology. The Fort is committed to a number of conservation measures to reduce the chance of catastrophic fire in the Huachuca Mountains and to minimize adverse effects to critical habitat due to fire suppression activities (see Section 5). Conservation measures are adequate to remove the most serious threats to Huachuca water umbel populations on the Fort. Conservation measures would improve degraded watershed conditions on the East Range and address fire, groundwater use and human disturbance threats to the species and its critical habitat.

Overall, ongoing and programmed future military operations and activities at and near Fort Huachuca may affect, and are likely to adversely affect Huachuca water umbel populations and designated critical habitat on and off the installation.

4.10.2 SOUTHWESTERN WILLOW FLYCATCHER

Similar to the effects analysis for the Huachuca Water Umbel[4], potential threats to the Southwestern Willow Flycatcher in the SPRNCA from the Fort's proposed action includes fire, human disturbance, erosion, and groundwater use.[5] However, the effects of the proposed action for the flycatcher are different in some respects from that of the water umbel with regard to timing of the effects. The water umbel is a semi-aquatic obligate wetland plant. This group of plants would be the first to be adversely affected by declining flows (ADWR 1994, Stromberg *et. al.* 1996). The southwestern willow flycatcher and its habitat could probably sustain small declines in groundwater elevation or flow in most areas, and thus would not be affected as rapidly as the water umbel. Also, flycatchers exhibit nest site fidelity (Sogge *et. al.* 1997), and may return to a site to nest even though the habitat has declined or is degraded.

Hydrology Modeling Efforts and Studies of Groundwater Use

Although there are a number of hydrology modeling efforts and studies in the Sierra Vista subwatershed, no current modeling effort or study considers the broad scope of conservation measures committed to by Fort Huachuca (reduce 2,784 ac-ft of water usage by year 2011). In addition, these modeling efforts and studies do not consider the anticipated commitment by the Upper San Pedro Partnership to reduce cumulative effects (3,599 ac-ft of water usage) to zero by the year 2011. Indeed the opposite is true. Often these modeling efforts and studies assume that water usage will go unmitigated. Therefore, the conclusions of these studies and modeling efforts must be updated in light of the new commitments by Fort Huachuca and those anticipated by the Upper San Pedro Partnership.

The hydrology modeling efforts and studies are discussed in Section 3. In general, they conclude that in the long-term if groundwater pumping in excess of recharge continues unmitigated, that base flows would decline or be lost, recruitment of cottonwoods would be affected, and saltcedar may replace cottonwood in some areas. Precisely when this would occur is unclear.

Potential Habitat for the Southwestern Willow Flycatcher

Southwestern willow flycatchers nest in dense riparian vegetation typically near surface water or saturated soil. In low elevation sites in Arizona (includes the upper San Pedro River), nests are most often found in nonnative saltcedar. However, only 15% of nests monitored in 1997 were

[4] The Fort's potential direct, indirect, interrelated/interdependent effects of groundwater usage on the Southwestern Willow Flycatcher are similar to those effects described for the Huachuca Water Umbel. In addition, the cumulative effects are very similar to those described in the Huachuca Water Umbel section. The effects analysis for the Huachuca Water Umbel, particularly with respect to the groundwater, is hereby incorporated by reference in this section.

[5] With respect to groundwater use, Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with the proposed action by 2011. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista Subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011.

located in monotypic stands of nonnative species. Although nests are typically placed in saltcedar, often other native tree species, such as cottonwood and willow are present (Paradzick *et. al*. 1999, McCarthey *et. al.* 1998, Sogge *et. al.* 1997). This BA will evaluate the potential effects to the Southwestern Willow Flycatcher in four locations.

Lower San Pedro River. The lower San Pedro River is one of the most important sites for the southwestern willow flycatcher. In 2001, the major concentration of southwestern willow flycatchers was documented in the Winkleman Study Area, near the confluence of the Gila and San Pedro Rivers

Upper San Pedro River. The upper San Pedro River has relatively few southwestern willow flycatchers, probably a result of the relatively narrow corridor of riparian forest; a lack of understory in most areas, and a history of grazing that probably reduced understory foliage density on the upper San Pedro River. A few flycatchers have been found along the upper San Pedro River from 1996 – 1999. These include areas near St. David, at Kingfisher (or Young-Block) ponds in the SPRNCA (McCarthey *et. al*. 1998), at Hereford Bridge (Paradzick *et. al.* 1999) and at Apache Powder Road (T. McCarthey, pers. comm. 1998).

Babocomari Cienega and Fort Huachuca. Although the Babocomari Cienega may have potential to support nesting southwestern willow flycatchers (D. Krueper, pers. comm. 1998), no flycatchers have been documented there. Riparian habitat suitable for nesting southwestern willow flycatchers is generally lacking at Fort Huachuca. Marginal habitat for the flycatcher that occurs on-post at Gravel Pit Pond and Middle Garden Canyon Pond was evaluated in May 2000. The areas were classified as unsuitable nesting habitat through an on-sight evaluation based on current described and classified plant species composition and habitat structure used by the southwestern willow flycatcher for nesting (EEC 2000b).

Babocomari River. The riparian woodlands on the Babocomari River downstream of Huachuca City have degraded over the years due to groundwater pumping. Whether this area would have potential to support flycatchers absent groundwater pumping is unknown.

Potential Effects to Flycatcher Habitat with Unmitigated Groundwater Use in the Sierra Vista subwatershed

The purpose of this subsection is to discuss the current baseline conditions and the potential effects of unmitigated groundwater use in the Sierra Vista subwatershed. As detailed throughout this BA, the proposed action is to implement conservation measures which will completely mitigate or offset all direct, indirect, interrelated and interdependent effects associated with the presence of Fort Huachuca in the Sierra Vista subwatershed. In addition, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

In the long-term, if unmitigated groundwater use continues in excess of supply, the cone of depression under Fort Huachuca and Sierra Vista will continue to grow and will capture an increasing percentage of the groundwater (including effluent recharge) that otherwise would

flow into the floodplain aquifer and the San Pedro River. As the cone of depression spreads towards the river it would cause gaining reaches to become losing reaches and result in further groundwater declines. Based on Don Pool's work and the presence of a clay deposit, baseflow near the Babocomari confluence may be affected first. The perennial reach upstream from the Babocomari confluence to Charleston may be the next reach affected, followed by the reach from Highway 90 to Charleston. In time, if groundwater withdrawals continue to exceed supply, groundwater elevation and baseflow are expected to decline enough to eliminate surface flow except during storm runoff, eliminate recruitment of cottonwood, willow, and saltcedar, and ultimately result in the death of obligate wetland plants (ADWR 1994, Stromberg *et. al.* 1996). Cottonwoods and willows typically do not grow where groundwater is deeper than about 8 feet (Anderson 1995). If groundwater declines of this magnitude occurred, mortality of cottonwoods and willows would be expected. Flycatcher habitat could be eliminated under this scenario (BLM 1998). Similar loss of cottonwood and willow riparian habitat has occurred on the upper Santa Cruz River as a result of declining groundwater elevation (Stromberg *et. al.* 1996.)

The timing of when loss of habitat might occur is disputed. The San Pedro Expert Study Team (1999) believe flows have been affected by the Fort Huachuca/Sierra Vista cone of depression since the 1960s or 1970s; MacNish (1998) believes the cone began affecting the river about 1990; but modeling by W&EST, Inc. (1996) estimated that municipal and military users were only responsible for 6% of the historic loss of river flow through 1988. Whether declines currently attributable to the Fort Huachuca/Sierra Vista cone of depression are currently great enough to adversely affect flycatcher habitat is unknown. ASL (1998), using MODFLOW and assuming a successful effluent recharge project, showed that baseflows in the reach from Lewis Springs to at least Fairbank may begin to decline significantly by 2020 (Table 5, page 80). Absent the Sierra Vista/Bureau of Reclamation effluent recharge project, baseflow in the same reach begins to decline by 2000.

Very small declines in baseflow could turn perennial reaches of the river into intermittent reaches. Table 1 of San Pedro Expert Study Team 1999, which shows the 90 driest days within the last 10 years at Charleston, illustrates that declines of less than 0.1 cfs will result in intermittent flows in this dependably perennial reach. These periods of no flow would occur when flycatchers are selecting nest sites and breeding, and when they are particularly sensitive to changes in flow patterns.

Lower San Pedro River. The lower San Pedro River is one of the most important sites for southwestern willow flycatchers. Further changes in southwestern willow flycatcher habitat on the lower San Pedro River could result if groundwater pumping in excess of recharge continues. Declining water tables have a disproportionate effect on obligate riparian trees, such as cottonwood and willows, which depend on relatively shallow groundwater (Snyder *et. al.* 1998, Busch *et. al.* 1992). Stromberg *et. al.* (1996) predicted that groundwater declines on the San Pedro River of one and three feet would result in 37 and 51% declines, respectively, in potential habitat for juvenile Goodding willow, *Salix gooddingii*. Declines of six feet would eliminate seedling recruitment sites for cottonwood and willow (ADWR 1994). Groundwater declines of this magnitude have been observed at Palominas and Contention (ADWR 1994). Habitat of plants characteristic of deep groundwater (i.e. velvet mesquite, *Prosopis velutina*, hackberry, *Celtis reticulata*, and sacaton, *Sporobolus contractus*) and upland species (i.e. catclaw acacia,

Acacia greggii, and rabbitbrush, *Chrysothamnus nauseosus*) was predicted to increase with increasing depth to groundwater (Stromberg *et. al.* 1996). Under continuing groundwater decline, cottonwood and willow establishment would become restricted to the bottom of the river channel in a narrow band, followed by elimination of recruitment and decline of existing stands (ADWR 1994).

The upper and lower reaches of the San Pedro River are hydrologically connected, so that effects in the upper basin could potentially affect flows and riparian habitat in the lower basin. Most of the San Pedro River from Benson northward is intermittent (ADWR 1991), thus flow between the basins occurs primarily as subsurface flow and flood flow. The reach from near the Aravaipa confluence downstream to the Gila River, where the most important flycatcher habitat exists, is described as intermittent by ADWR (1991), but perennial pools and river segments occur in adequate numbers to support fish populations. A perennial reach of about four miles in length occurs south of Redington where groundwater is forced to the surface by shallow hardrock. A perennial cienega habitat occurs at Cook's Lake approximately 1.5 miles downstream of the Aravaipa confluence (ADWR 1991).

Eighteen percent (7,054 acre feet) of the annual water volume that leaves the Sierra Vista subwatershed flows all the way to the Winkelman subwatershed (ADWR 1991). This amount includes flood flows and base flow would be much less. Groundwater inflow across subwatershed boundaries in the lower San Pedro River is insignificant (ADWR 1991). Flow between subwatersheds might be greater if water use did not exceed water supply in the Sierra Vista subwatershed, but because of the presence of cone(s) of depression, it is unlikely that any increased water supply would result in significant increases in subwatershed outflow. Even if the entire deficit (5,144 acre feet) was discharged as outflow from the Sierra Vista subwatershed, only 18% of that figure would be expected to reach the Winkelman subwatershed. Annual water supply to the Winkelman subwatershed is 73,760 ac-ft, thus under this scenario, eliminating the deficit in the Sierra Vista subwatershed and diverting all of the gain to subwatershed outflow would cause no more than approximately 2% increase in annual inflow into the Winkelman subwatershed, under the most optimistic conditions.

Based on the observation that saltcedar is replacing cottonwood in areas of groundwater decline of approximately six feet (ADWR 1994), cottonwood and willow communities could change to a community with young stands of salt cedar in the understory with an aging stand of mature cottonwoods and willows in the canopy. Under this scenario, the vegetation structure could still be adequate for southwestern willow flycatchers, depending on the height and density of the resulting salt cedar stands. However, if groundwater declined six feet, surface flows would likely become intermittent. Periods of no flow would be most likely to occur in May to early July when birds would be establishing territories and nesting. Lack of surface water would likely make these areas less suitable or unsuitable for nesting flycatchers. Relatively small declines in groundwater elevation would result in increased periods of no flow first where flows are currently very low or occasional periods of no flow already occur, such as at the Tombstone gage (see discussion for Huachuca water umbel). At Lewis Springs, near where flycatchers were found in 1997, flows are approximately 40% of those at the Charleston gage, but a lack of no flow records suggests flycatcher habitat at this site might be more resilient to groundwater decline than at Hereford or Tombstone gage.

Babocomari Cienega. The Babocomari Cienega contains potentially suitable habitat for southwestern willow flycatcher, but no flycatchers have been recorded there. The cienega is considerably upslope and upstream of the wells at Fort Huachuca and Sierra Vista. Brenda Houser, USGS, Tucson, AZ (1998) investigated the geology and hydrology of the area. Probably the most important structure in regard to the hydrology of the area is an east-west fault on the north side of the Babocomari River that brings relatively impermeable Tertiary conglomerate and volcanic rocks on the south side of the river in contact with Paleozoic limestone and dolomite units on the north. Houser (1998) suggests that groundwater from the Mustang Mountains on the north probably flows southward in fractures or solution channels in the Paleozoic and Mesozoic bedrock, and in the saturated zone of the gravelly upper Tertiary and Quaternary piedmont sediments. Where the water intersects the fractured zone of the fault, it would be forced upward along the more permeable fracture zone by the presence of impermeable conglomerate and volcanic rocks on the south side of the fault. The water would then flow along the base of Quaternary terrace gravel deposits until it intersects the ground surface on the north side of the Babocomari River and emerges as springs and seeps. ADWR (1991) also notes the presence of a volcanic dike in the area that apparently causes a pooling of groundwater and forces water to the surface forming cienega conditions. Trends in groundwater elevation have not been investigated; however Skagen (pers. comm. 1998) noted decadent stands of cottonwoods above and below the cienega where recruitment is apparently low due to livestock grazing, groundwater declines, and/or other factors. Although data is insufficient to make any conclusive statements, because the cienega is considerably upstream of wells at Fort Huachuca and the Sierra Vista wells, faulting and geology suggest much of the water in the area comes from the Mustang Mountains, a geological feature forces groundwater to the surface at this site, and the river flows from the west, it is unlikely that groundwater pumping by Fort Huachuca or Sierra Vista currently affects or would in the future affect riparian habitat at or near the cienega. If future groundwater pumping in excess of supply resulted in the cone of depression capturing groundwater inflow to the area, it would probably occur well after effects to the San Pedro River manifest.

Babocomari River. Groundwater pumping at the Fort and by Sierra Vista may have contributed to the degradation of riparian woodlands on the Babocomari River downstream of Huachuca City (Schwartzman 1990). Continued groundwater pumping at current rates is predicted to result in groundwater declines of 5.8 to 11.5 feet in 50 years, and 8.6 to 20.5 feet in 100 years in an area of considerable riparian vegetation downstream of Huachuca City (Schwartzman 1990). These declines are large enough to prevent recruitment of cottonwoods and willows, and will likely result in death of mature riparian trees (ADWR 1994, Stromberg *et. al.* 1996, Anderson 1995). Whether this area would have potential to support flycatchers absent groundwater pumping is unknown.

Direct, Indirect, Interrelated and Interdependent Effects Attributable to Fort Huachuca's Water Use

The previous subsection assumed that all groundwater usage was unmitigated in the Sierra Vista subwatershed. The purpose of this subsection is to clearly indicate that this assumption is false and to address the water conservation measures which Fort Huachuca will implement by 2011 to significantly reduce the potential effects and risk factors to the southwestern willow flycatcher as outlined above.

As noted in Section 3, there are 64,655 people in the Sierra Vista subwatershed. Of the total population in the Sierra Vista subwatershed, 34,599 people (54%) is related to Fort Huachuca as direct, indirect, interrelated and interdependent population. This includes 26,531 military, civilian employees, contractors, military retirees, survivors and family members. It also includes 7,093 induced employees and their family members, i.e., their off post groundwater pumping would not occur "but for" the presence of the Fort. Finally, it includes an increase of 1,369 projected Fort personnel and their family members.

The Fort applies the same 54% of the population in the Sierra Vista subwatershed to determine its share of the 5,144 ac-ft groundwater deficit. In this case 54% of the groundwater deficit in the Sierra Vista subwatershed equals 2,784 ac-ft. This is the entire amount of the groundwater deficit attributable to the Fort's presence in the Sierra Vista subwatershed.

As detailed in Section 5, Fort Huachuca has agreed to implement conservation measures which will completely offset all direct, indirect, interrelated and interdependent effects associated with its proposed action (i.e., 2,784 ac-ft) by the year 2011. In addition, Fort Huachuca will offset all increased water pumpage associated with potential personnel/mission increases in the future i.e., beyond 12,805 personnel. By reducing 2,784 ac-ft in groundwater usage, in 2011 there will be no effect on the Southwestern Willow Flycatcher or its habitat associated with Fort Huachuca's groundwater usage.

As discussed for the Huachuca water umbel, development attributable to Fort Huachuca may result in watershed degradation (Wang *et. al.* 1997). Urban development can adversely affect biotic integrity and habitat quality in adjacent riparian systems. Urbanization results in increased runoff, and resulting changes in flow regimes, water temperature, water quality, and channel morphology (Wang *et. al.* 1997, Schueler 1994). These changes may affect recruitment and development of riparian woodlands that the southwestern willow flycatcher uses as nesting and foraging habitat.

Development in the subwatershed attributable to Fort Huachuca probably also contributes to increased recreational use of the SPRNCA and other areas of the San Pedro River corridor. Increased recreational use results in greater chance of fire, off-road vehicle damage to riparian habitats, and disturbance of flycatchers by recreational users.

Mitigation of Cumulative Effects of Groundwater Use in the Sierra Vista subwatershed

In addition, to the direct, indirect, interrelated and interdependent effects of groundwater usage associated with the Fort's proposed action, cumulative effects of groundwater use on southwestern willow flycatcher in the San Pedro River are also important to consider. Cumulative effects include the effects of future State, tribal, or local private actions that are reasonably certain to occur in the project area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

Due to Fort Huachuca's ongoing water conservation efforts (reduced water consumption by over 1,000 ac-ft since 1993) and the City's effluent recharge project[6], the water deficit in the Sierra Vista subwatershed is 5,144 ac-ft, instead of the 1999 CEC estimate of 7,000 ac-ft. By subtracting Fort Huachuca's conservation measures, the groundwater deficit attributable to cumulative effects, not related to Fort Huachuca, is 2,360 ac-ft.

This figure of 2,360 ac-ft does not include the projected population growth in the future. The projected population increases in the Sierra Vista subwatershed would result in a net increase of 1,239 ac-ft of additional groundwater use in the subwatershed by 2011. This figure includes the correction for the associated recharge going back into the aquifer from either effluent recharge facilities or septic systems. By taking the existing cumulative groundwater deficit of 2,360 ac-ft and adding 1,239 ac-ft of projected additional water usage, the total cumulative groundwater deficit by 2011 will be approximately 3,599 ac-ft.

Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well i.e. reduce 3,599 ac-ft of water usage. This is a very achievable accomplishment. Bisbee alone is currently planning to begin construction of an effluent recharge plant in two years. When constructed in six years the effluent recharge plant is projected to recharge approximately 392 ac-ft.

Conclusion - Effects Determination for the Southwestern Willow Flycatcher due to Groundwater Usage.

Although the effects of groundwater pumping in the Sierra Vista subwatershed on downstream southwestern willow flycatcher habitat are uncertain, the best information available suggests that currently these effects are probably small or negligible. Effects of future groundwater pumping on flycatcher habitat are predicted to be insignificant because base flow from the Sierra Vista subwatershed into the Winkelman subwatershed, where flycatcher habitat primarily occurs, is very small. In addition, Fort Huachuca's significant conservation measures along with the expected commitment of the municipalities and agencies through the USPP will zero out cumulative effects by 2011. These measures are expected to protect base flows and flycatcher habitat in the Sierra Vista subwatershed. Successful implementation of the Sierra Vista effluent recharge project will assist in this effort and should prevent any potential near-term effects to River base flow.

Effects of Fire

As discussed for the Huachuca water umbel, fires are infrequently ignited on the East Range (Figure 24, page 167). Impact Area Zulu is a live fire impact area where fires could ignite from ordnance delivery. However, fires on the East Range are typically small and firebreaks around

[6] Even if enough conservation measures are implemented so that water supply equals or exceeds water use, the cone of depression is expected to continue its lateral expansion as it flattens out and would likely de-water portions of the San Pedro River [see scenario (1) of W&EST, Inc. 1994 – Table 5, page 80]. The success of the City's effluent recharge project is critical to avoiding near-term effects to river base flow.

Impact Area Zulu and on the eastern boundary of the installation make it highly unlikely that a fire ignited on the East Range would spread to the San Pedro River. Live munitions could also conceivably stray off course into the RNCA and start a fire. However, fires have never spread from the East Range to the San Pedro River, and fires have never been ignited on the San Pedro due to stray weapons fire. The chance of these events occurring during the life of the project is remote. The chance of fire spreading from the northwestern boundary of the installation to the Babocomari Cienega is also unlikely due to the presence of Chihuahuan Desert scrub containing little fuel to carry fire between the installation boundary and the cienega.

Effects of Human Disturbance

The Fort maintains 22 ASA sites within the boundaries of the San Pedro River RNCA (Figure 3, page 10). As described in Section 2, ASA sites are where the capabilities of electronic systems are tested. ASA sites are located along road shoulders or previously disturbed sites. At each site typically one or two vehicles and four to six personnel would be deployed for no more than 11 days. Occasional exercises involve up to 20 vehicles, 50 support personnel, and 60 to 70 students. Vehicles sometimes are mounted with large antennae, or ground-mounted antennae up to 80 feet in height are erected. Sites are located adjacent to the San Pedro River at the Charleston Road and the Highway 82 and 90 crossings; however, no suitable flycatcher habitat currently exists. If flycatchers nest immediately adjacent to ASA sites, the birds could be disturbed by training activities, particularly during an exercise involving many vehicles and personnel. Cigarettes discarded by personnel could potentially cause a fire and destruction of flycatcher habitat. Although unlikely, flycatchers could also potentially fly into an antennae and be killed or injured. These effects are mitigated by the Fort's commitment to not use ASA sites within 300 feet of southwestern willow flycatcher habitat from April 1 to September 1 of each year and to take precautions at ASA sites adjacent to suitable habitat, but farther than 300 feet, to minimize the chance that a fire occurs (Section 5).

Cowbirds are not known to occur at the Buffalo Corral on Fort Huachuca (SAIC 1998a), and regional populations are not likely significantly enhanced by other activities at Fort Huachuca. If cowbirds are occasionally attracted to the horse corral, golf course, urbanized portions of the cantonment area, or other portions of the installation, any effects to regional cowbird populations and resulting increased parasitism is likely masked by farming and ranching activities off of Fort Huachuca. Although Skagen (1995) found cowbirds to be common on the upper San Pedro River and at the Babocomari Cienega, there does not appear to be a source population or significant attractant at Fort Huachuca, which if eliminated, would reduce regional cowbird populations and risks to flycatchers.

Effects of Erosion

As discussed for the Huachuca water umbel, watershed condition on the East Range is degraded in a band, approximately two to three miles in width, that runs across the range from the northwest to the southeast. Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Belsky and Blumenthal 1997, DeBano and Schmidt 1989, Gifford and Hawkins 1979). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and

sedimentation or erosion of the San Pedro and Babocomari rivers. Such conditions could potentially lead to scouring of riparian vegetation or reduced flows during willow flycatcher breeding activity. However, studies by the Environment and Natural Resources Division at Fort Huachuca (1997) indicate that most sediment eroded from the East Range is deposited along the east boundary and does not reach the San Pedro or Babocomari rivers. The lower-elevation portions of the San Pedro River watershed outside of Fort Huachuca are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by these regional watershed problems along the San Pedro River. Fort Huachuca is committed to number of erosion conservation measures to reduce the affect of erosion on flycatcher populations (see Section 5). These include no off road vehicle travel on the installation and implementation of the East Range Watershed Improvement Plan which includes activities such as revegetation, installation of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded roads.

Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect and are likely to adversely affect the southwestern willow flycatcher.

4.10.3 MEXICAN SPOTTED OWL

Potential threats to the Mexican spotted owl and its designated critical habitat on Fort Huachuca include noise, fire, human disturbance, and direct mortality.

Twenty-seven Mexican spotted owl management territories, also called Protected Activity Centers (PACs) are known from the Huachuca Mountains, including eight within Fort Huachuca boundaries and nineteen on CNF lands to the south of the Fort (Tom Skinner, pers. comm., 2002). There are 21 known PACs in the Santa Catalina Mountains, 60 miles north-northwest of Fort Huachuca and 20 territories in the Santa Rita Mountains, 40 miles northwest of Fort Huachuca.

Effects of Human Disturbance

Owl territories and PACs are located in the canyons of the Huachuca Mountains where ground-based military training is limited primarily to existing routes of travel. Most human use of these areas is light and limited primarily to recreational pursuits such as birding, hunting, and hiking.

Recreational use in most canyons where territorial spotted owls have been recorded, or that contain PACs, is light because to reach these areas often requires considerable hiking over steep terrain. An exception is the PAC in Scheelite Canyon, which is well-known by birders as an easily accessible site to view Mexican spotted owls. Davis and Russell (1995) and Taylor (1995), popular birding guides for southeastern Arizona, provide directions to the site, and in the case of Taylor (1995), specific information on where the birds can be found. Most birders visiting Scheelite Canyon stay on the trail, and are conscientious and unobtrusive. Viewing of spotted owls in this wooded canyon no doubt has value in terms of environmental education and awareness.

The response of wildlife to recreational disturbance is complex, and the effects are not immediately obvious or easily determined (Hammitt and Cole 1987; Flather and Cordell 1995). Evidence suggests that recreational activity can harm wildlife (Knight and Cole 1995). Tolerance levels for wildlife interactions with humans will vary by time of year, breeding season, age, habitat type, and individual experience with recreationists (Hammitt and Cole 1987). Human activities can impact wildlife directly through exploitation and disturbance, or indirectly through habitat modification and pollution. Concerns with regards to the canyons in which owls are present include current and future recreation use and the potential direct effects to the Mexican spotted owl of disturbance and harassment, and to a lesser extent, the indirect effects of prey habitat modification. The Mexican Spotted Owl Recovery Plan (Recovery Plan) indicates that the determining factor of a recreational activity's impact on spotted owls is a combination of its location, intensity, frequency, and duration.

The physical characteristics of a canyon may provide topographic screening. Topographic screening between the area of disturbance and a bird's location creates a noise buffer, and may assist in the reduction of noise disturbance (Knight and Cole 1995). The physical structure of canyons can also tend to magnify disturbances and limit escape/avoidance routes for owls (USFWS 1995b). Scheelite Canyon is a narrow, deep canyon with limited perching and roosting sites and the owls are typically perched close to the trail.

The Recovery Plan states that groups of 12 or more hikers or a steady stream of hikers occurring in narrow canyon bottoms may be especially disturbing to owls. The spotted owl breeding season, which extends from March 1 through August 31, is an especially popular time for birders and other recreationists to visit the Fort. In addition, during high use periods, large groups of hikers may use the trail, whether intentionally hiking in groups, or because groups are formed unintentionally due to hikers backed up behind each other. The potential for disturbance to Mexican spotted owls in the PAC exists given the trail location relative to past owl locations, as well as the high recreational use level on the trail during the breeding season.

There are three learned responses wildlife may show to recreationists: habituation, attraction, and avoidance (Knight and Temple 1995). Recreational disturbance during the breeding season may affect an individual's productivity; disturbance outside the breeding season may affect the individual's energy balance and, therefore, its survival. Birds may respond to disturbance during the breeding season by abandoning their nests or young, by altering their behavior such that they are less attentive to the young, which increases the risk of the young being preyed upon, or by disrupting feeding patterns, or by exposing young to adverse environmental stress (Knight and Cole 1995).

Owls have more sensitive hearing than other birds (Bowles 1995). If a noisy sound source arouses an animal, it has the potential to affect its metabolic rate by making it more active. Increased activity can, in turn, deplete energetic reserves (Bowles 1995). Noisy human activity can cause raptors to expand their home ranges, but often the birds return to normal use patterns when the humans are not present (Bowles 1995). Such expansions in home ranges could affect the fitness of the birds, and thus their ability to successfully reproduce and raise young. Species that are sensitive to the presence of people may be displaced permanently, which may be more detrimental to wildlife than recreation-induced habitat changes (Hammitt and Cole 1987;

Gutzwiller 1995; Knight and Cole 1995). If animals are denied access to areas that are essential for reproduction and survival, then that population will decline. Likewise, if animals are disturbed while performing essential behaviors such as foraging or breeding, that population will also likely decline (Knight and Cole 1995). There is also evidence that disturbance during years of a diminished prey base can result in lost foraging time which, in turn, may cause some raptors to leave an area or not to breed at all (Knight and Cole 1995).

There are no completed studies to date on the effects of recreational activities specific to the Mexican spotted owl. Research on all subspecies of the spotted owl indicate that it exhibits docile behavior when approached by researchers, and there is no clear evidence of significant impact by research activity except for a negative effect on reproduction from back-pack radio transmitters (Gutierrez *et. al*. 1995). However, researchers purposefully make as little noise as possible, and disturbance is very limited in duration. In the long term, some species may become less responsive to human disturbance if they are not deliberately harassed; others may become very stress-prone towards humans (Bowles 1995; Hammitt and Cole 1987). Excessive interaction with humans may cause a lowering of call response rates or habituation; the effects of habituation on spotted owls are unknown (Gutierrez *et. al.* 1995). Owls have been known to begin calling during the breeding season in response to the sound of human voices (M. James, Service, Flagstaff, pers. com. 1998). Such behavior is likely characteristic of a certain percentage of individuals, and this response to humans may create a situation where these owls are discovered by hikers, thereby exposing themselves to potential direct impacts.

Ecologists suspect that spotted owls select habitats partially because of the availability of prey (USFWS 1995b). Ward and Block (1995) found that the reproductive success of the Mexican spotted owl was not influenced by a single prey species, but rather by many species in combination. Trails in riparian areas affect the soil and riparian vegetation adjacent to the trail, as well as the aquatic system itself. By directly impacting these components, recreationists affect an animal's food supply and availability as well as its habitat; in turn, impacts on food and habitat influence behavior, survival, reproduction, and/or distribution (Cole and Landres 1995). Impacts on soil include compaction of mineral soil, reductions in total porosity, reductions in infiltration rates, and increased soil erosion (Cole and Landres 1995). These changes in soil characteristics can adversely affect the germination, establishment, growth and reproduction of plants. Direct impacts to vegetation also come from crushing and uprooting of vegetation. Consequently, recreation areas characteristically have vegetation that is less abundant (reduced density and cover), of a reduced stature, and with different species composition from undisturbed areas (Cole and Landres 1995). Removal of living vegetation affects the habitat and food sources of small mammals (Hammitt and Cole 1987) that comprise owl prey items.

The owls in Scheelite Canyon appear to be mostly oblivious to human presence. However, there is some evidence of trampling and soil compaction off the trail and in recent years large groups of birders, apparently birding tour groups, have visited the canyon. Russell Duncan (pers. comm. 1998) reported a group of approximately 50 birders lead by a trip leader that was calling or hooting for owls in Scheelite Canyon. The Service requires a Section 10(a)(1)(A) permit for use of tape recorded calls or hooting to locate Mexican spotted owls. The Service does not issue such permits for commercial or recreational viewing of listed species. Also, as discussed, a group of 50 individuals may be a large enough presence to elicit an alarm response or to otherwise harm

or harass the spotted owls in Scheelite Canyon, or disturb habitat (USFWS 1995b). In December 1992, Duncan (1993) found an adult female spotted owl in Scheelite Canyon on the ground in a lethargic state. The bird was taken to a veterinarian in Tucson where it died after seven days. The cause of death was a pneumonia-like lung infection complicated by a subdermal hematoma probably caused by a blow to the back of the head. Duncan (1993) stated that a human-related cause of the hematoma can not be ruled out.

Hunting for big and small game is allowed within spotted owl habitat at Fort Huachuca. Potentially, a hunter could discharge a firearm near a roosting or nesting spotted owl and cause an owl to flush or elicit a startle response. However, this type of disturbance is likely to be infrequent. Most hunting occurs during the fall and winter months, outside of the spotted owl breeding season, and at lower elevations.

The Recovery Plan notes that birders and wildlife photographers actively seek spotted owls and are therefore more disruptive than the accidental encounters associated with other recreational activities. The Plan goes on to say that hooting for spotted owls or using mousing techniques to attract owls, if practiced to excess, may disrupt an owl's territorial, mating, and nesting activities (USFWS 1995b). The Plan finds that most owls appear to be relatively undisturbed by groups of people of 12 or less. In response to the recommendations of the Recovery Plan, the Fort has posted and maintained a sign at the mouth of Scheelite canyon that informs visitors that groups are limited to 12 or less; calling, hooting, or playing taped recordings to elicit responses from owls is prohibited; and that visitors should stay on the trail and be as quiet and unobtrusive as possible. This should reduce possible harassment or disruption of Mexican spotted owls in the canyon.

Rappelling or rock climbing on cliffs supporting active Mexican spotted owl nests could result in disturbance of nesting owls. Recreational rappelling and rock climbing are prohibited on Fort Huachuca; however, rappelling as part of military training occurs on cliffs in Garden Canyon. The rappelling cliff is located outside of current spotted owl PACs, and if owls are found nesting within 0.25 mile of the rappelling cliff, rappelling shall be moved at least 0.25 mile away during March 1 through August 31, or until nestlings fledge. These measures should help reduce the potential for adverse effects to the Mexican spotted owl and its critical habitat.

Effects of Direct Mortality

PACs in Training Area Papa are within portions of the firing fan of tank gunnery range 12C. However, this firing range is inactive and, if proposed for use in the future, would be the subject of separate consultation. PACs in Training Areas Oscar and Sierra fall within portions of firing ranges 12A&B and 9. Range 12B is a tank gunnery range that is currently not in use. As with 12C, if 12B is proposed for future use, it would be the subject of separate consultation. Machine guns (.50 and 90mm caliber) and recoilless rifles are discharged at Range 9. At Range 12A, .50 caliber, 7.62mm, and 40mm weapons are discharged. The PACs are in the upper reaches of the firing ranges, at least 2.4 miles from where weapons would be fired. Ordnance and shells would reach PACs only if the targets were overshot. The likelihood that ordnance or shells would strike a spotted owl or nest is highly unlikely, particularly because owls are typically in wooded

canyons that would be sheltered from stray weapons fire. Occasional stray bullets have much greater implications for igniting fire with its associated impacts, as discussed below.

Mortality or injury of Mexican spotted owls could also occur due to collisions with vehicles, aircraft, power/communications lines, or as a result of electrocution on powerlines. However, reports of such mortality are rare in Arizona. Mortality or injury from collisions or electrocution could possibly occur during the life of the project, but are unlikely.

Effects of Noise

Sources of noise other than those made by hikers or birders may also disturb spotted owls and include explosive ordnance discharge and delivery, discharge of firearms by hunters, small arms ammunition firing on the South Range, and aircraft overflights. Delaney *et. al*. (1997) reviewed literature on the response of owls and other birds to noise and drew the following conclusions: 1) raptors are more susceptible to disturbance-caused nest abandonment early in the nesting season; 2) birds generally flush in response to disturbance when distances to the source are less than approximately 200 feet and when sound levels are in excess of 95 dBA; and 3) the tendency to flush from a nest declines with experience or habituation to the noise, although the startle response cannot be completely eliminated by habituation.

Small arms firing on the South Range could potentially disturb Mexican spotted owls. However, the firing ranges are all at least 2.4 miles from spotted owl PACs, and any noise from such firing that reaches the PACs is likely to attenuate well below 95 dBA. Artillery and mortar firing occurs at several areas on the East Range. Ordnance is directed eastward from these sites and is delivered into Impact Area Zulu, also on the East Range. Noise from these sources is likely louder than the small arms firing on the South Range. However, mortar and artillery firing on the East Range occur at a much greater distance from owl territories. All mortar and artillery firing sites and the impact zone in Impact Area Zulu are over seven miles from the nearest PAC. No effects to spotted owls are anticipated as a result of mortar and artillery firing on the East Range.

Low-level flights are sometimes authorized over the canyons of the Huachuca Mountains where Mexican spotted owls nest. Fixed wing aircraft are generally limited to elevations of 500 feet agl or higher, although AGFD is granted authority to fly lower to conduct wildlife surveys. Helicopter flights may occur at elevations below 500 feet agl. UAV flights may also occur at low levels over the Huachuca Mountains. Low-level flights are infrequent and of short duration. During extensive wildlife and plant field work at Fort Huachuca, Russell Duncan (pers. comm. 1998) has not observed low-level fixed wing or helicopter flights in montane canyons, but has observed occasional UAVs flying at low levels. To reduce the potential for noise effects, the Fort is committed to minimizing low-level helicopter flights within one mile of active nests and has prohibited helicopter flights within 0.25 mile of an active nest from March 1 – August 31.

According to a "Report to Congress on Effects of Aircraft Overflights on the National Park System" (NPS 1994), wildlife respond to low-level aircraft overflights, although the manner in which they do so depends on life-history characteristics of the species, characteristics of the aircraft, flight activities, and a variety of factors such as habitat type and previous exposure to aircraft. The primary concern stemming from these low-level overflights related to wildlife are the physiological and/or behavioral responses caused by the flights. These responses may reduce

the wildlife's fitness or ability to survive. Overflights may cause stress, and if chronic, stress can compromise the general health of the animal. Overflights may interfere with raising young, habitat use, and physiological energy budget. Indirect effects, such as accidental injury, energy loss, habitat avoidance and abandonment are very difficult to detect, but some experts suspect they occur (NPS 1994).

Studies that have investigated the effects of low-level aircraft overflights on birds have determined that such flights disturb raptors (Manci *et. al*. 1987). Disturbances include interrupting nesting activities by flushing from nesting and roost, displacing birds returning to nests, flushing or displacing birds from foraging areas, provoking interactions with sympatric raptors, and exposing eggs and nestlings to predators and extreme heat. Studies have also suggested that human activities within breeding and nesting territories may affect raptors by changing home range movements (Anderson *et. al*. 1990) and causing nest abandonment (Postovit and Postovit 1987, Porter *et. al*. 1973). While these studies have not demonstrated a causal link between low-level overflights and reproductive success, they do document a level of disturbance that clearly is equivalent to harassment. Under Section 9(a)(1)(B) of the Act, harassment is a form of take.

Compared to jets and light planes, helicopters tend to elicit a heightened response from nesting raptors (Watson 1993, Grubb and Bowerman 1997). Noise from low-level jets and sonic booms have been found to have little effect on nesting peregrine falcons and other raptor species (Ellis 1981, Ellis *et. al*. 1991). UAVs are small and relatively quiet, and are expected to elicit less of a response than either helicopters or fixed-wing aircraft. Studies of the effects of aircraft overflights on nesting raptors often show slight, but non-significant decreases in reproductive success and number of young fledged (Platt 1977, Windsor 1977, Anderson *et. al*. 1989, Ellis *et. al*. 1991). Nest abandonment due to disturbance is most likely to occur early in the nesting season before birds have invested much energy in the nest and nestlings (Knight and Temple 1987). White and Sherrod (1973) found that nesting raptors flushed from nests when overflown by helicopters that approached unseen, suggesting that raptors may be more likely to flush if the noise or sight of the aircraft is sudden and in close range.

Studies of the effects of aircraft overflights on raptors have generally noted a slight but non-significant decrease in reproductive success and number of young fledged at sites exposed to overflights versus control sites without overflights (Delaney, *et. al*. 1997). Of the authorized flights over spotted owl habitat, low-level helicopter flights have the greatest potential to disturb owls (Delaney *et. al*. 1997), because they move slowly and are relatively noisy. Delaney *et. al*. (1999) evaluated the effects of the Sikorsky, HH-60G, and Pave Hawk helicopter overflights on Mexican spotted owls in the Lincoln National Forest, New Mexico. Owl territories were randomly presented with one of three helicopter flight profiles, including 50 feet vertical, 100 feet vertical/100 feet lateral, and 200 feet vertical. Territories with overflights did not differ in reproductive success from territories without overflights. As the distance to the helicopter decreased, owl flush response increased. Owls did not flush in response to helicopters beyond 345 feet, and no owls flushed during the incubation and nestling phases. Flush responses occurred at a rate of 14% within 345 feet, 19% within 200 feet, and 50% within 100 feet. Flushing responses also did not occur when noise levels were less than 92 dBA; however, distance to the helicopter was a better predictor of spotted owl response than sound level. Net differences in prey deliveries for the 24 hour periods after and before noise manipulations were

highly correlated with stimulus distance. Delaney *et. al.* (1999) estimated that the threshold for negative effect on prey deliveries was 315 feet. On average, an alert response (i.e., head movements) was elicited when helicopters approached within 1,330 feet, but no response was noted when helicopters were beyond 2,165 feet from an owl. Short duration, single pass aircraft flights appeared to have little effects on spotted owls; diurnal flights affected owls less than nocturnal flights; and although multiple low-level flights were not recommended, the authors believed spotted owls would habituate with repeated exposures and as the nesting season progresses (Delaney *et. al.* 1997, 1999). Although the effects of overflights may vary with locations, specific conditions, and aircraft type, the following management implications emerged from the results of Delaney *et. al.* (1997, 1999):

1. A 345-foot hemispherical management/protective zone should minimize, and possibly eliminate, spotted owl flush response and negative effects to prey delivery rates associated with helicopter overflights.

2. Flights over owls should be separated by at least seven days.

3. Overflights should be limited to diurnal flights if possible, and nocturnal flights, particularly within three hours of sunrise or sunset, should be minimized.

4. Helicopter flights near roosts or nests that are single pass and of short duration may be less disturbing than other flight maneuvers such as circling, hovering, landing, etc.

Service policy is to limit disturbing activities within 1,320 feet of nest sites during the breeding season (March 1-August 31). This corresponds well with the Delaney *et. al.* 1,330-foot threshold for alert responses to helicopter flights. Encounters between low-level flights and spotted owls are expected to be infrequent. Russell Duncan (pers. comm. 1998) during extensive wildlife and plant surveys, has never observed a low-level helicopter or fixed-wing aircraft flight in the Huachuca Mountains. Low-level UAV flights are more common, but UAVs are small and relatively quiet compared to helicopters, and are expected to elicit minimal response from spotted owls. The Fort has committed to minimizing low-level helicopter flights within 1.0 mile of spotted owl nests, or the last previously known nest. Helicopter flights closer than 0.25 mile of active nests will be prohibited from March 1 to August 31 (Section 5). These commitments should minimize adverse effects, including the potential for take, associated with low-level aircraft flights.

Effects of Fire

Stacey and Hodgson (1995) evaluated the impacts of a 24,000 acre natural fire on Mexican spotted owls in the San Mateo Mountains, New Mexico. Birds present in four territories before the fire remained within their same territories after the fire. However, a small sample size of owls combined with an apparent low-intensity fire (the fire burned patchily, only 600 acres burned hot enough to kill all trees, and much undamaged roosting and foraging habitat remained) makes the applicability of the study results to other owl territories or other fires questionable. Relatively few wildfires have burned in the montane portion of the Fort in recent times (Figure 24, page 167); however, fuel loads are high in some areas (Robinett *et. al.* 1997), and several stand-

replacing fires have occurred in the Huachuca Mountains to the south of the Fort in recent years. Thus, a very hot, stand-replacing fire could potentially burn in owl territories on Fort Huachuca, perhaps with much more severe impacts than those observed by Stacy and Hodgson (1995) in New Mexico. Prescribed fire, managed natural fire, or wildfire ignited by recreationists or by ordnance strikes in the Huachuca Mountains, could result in adverse effects to owls and their habitat. Direct effects to Mexican spotted owl may include death of adults and/or juveniles, flushing of Mexican spotted owl off nests/roosts, smoke inhalation, and human disturbance related to fire suppression actions. Indirect effects may include loss or degradation of nesting or foraging habitat, and reduced prey densities and availability.

Patton *et. al*. (1991) found lower survival rates among radio-tagged female northern spotted owls following a forest fire. This was attributed to radio tags, but the birds in this study were exposed to dense smoke and high levels of carbon monoxide by an inversion that trapped smoke near the ground for 25 days following a fire which burned for 50 days. Flames and smoke from fire may cause Mexican spotted owls to flush from nests and/or roosts, and may impair hunting opportunities through interfering with audio and visual methods of detecting prey. If fire occurs within PACs, there exists some possibility that nest and/or roosts trees may be killed through crowning or extreme heat. All of these may result in direct mortality, failed reproductive efforts and/or starvation of young and adult Mexican spotted owl.

Disturbance to the Mexican spotted owl may also be caused by human activities in, adjacent, and above PACs and potentially occupied habitat during fire suppression or management activities. Disturbance may be caused by fire resource personnel digging fire lines with shovels and other hand tools, walking and igniting with drip torches if "burning out" is needed to control a fire, use of chainsaws and heavy equipment, the dropping of slurry, and monitoring fire conditions from the ground or air. Human disturbance in an occupied PAC during the breeding season may result in failed reproductive efforts, abandonment of the nest, and/or starvation of young.

The indirect effects of fire include both negative and beneficial effects on Mexican spotted owl habitat. Beneficial aspects would include increased response of herbaceous vegetation after a fire and possible reduced future occurrence of stand-replacing fire. Negative effects would include the loss of Mexican spotted owl prey habitat components such as herbaceous cover, down logs and snags. The effects of fire on the prey base of the Mexican spotted owl are complex and are dependent on the variations in fire characteristics and in prey habitat. Fire intensity, size, and behavior are influenced by numerous factors such as vegetation type, moisture, fuel loads, weather, season, and topography. Fire can effectively alter vegetation structure and composition thereby affecting small mammal habitat. The initial effects of fire are likely to be detrimental to rodent populations as cover and plant forage species would be reduced.

Population responses by small mammals to fire-induced changes in their habitat vary. For example, deer mouse populations might increase immediately following fire and then decrease through time (Ward and Block 1995). Campbell *et. al*. (1977) noted that populations of peromycid mice decreased immediately following fire in an Arizona ponderosa pine forest that removed one-fourth (moderately burned) to two-thirds (severely burned) of the basal area; populations then returned to pre-fire numbers two years following the burn. Furthermore, no differences were found in rodent populations between moderately and severely burned areas.

They concluded that the effects of the fire that they studied were short-term, and the short-term positive numerical responses of mice were attributed to an increase in forage, particularly grasses and forbs after the fire (Ward and Block 1995). Irvine (1991) documented post-fire declines in deer mice populations at study sites on the Coconino National Forest. Irvine attributed these declines to reduced food supplies. Lowe *et at*. (1978) noted an increase in deer mice populations the first year after a fire in ponderosa pine near Flagstaff, Arizona. Small mammal diversity and densities are typically depressed for one to three years after a fire (Wright and Bailey 1982). Biswell *et. al*. (1973) suggested that rodent populations would be less affected during fall fires, because at that time of year rodents have accumulated seed caches that will mitigate loss of food sources. Predation of surviving rodents that are part of the diet of the Mexican spotted owl may increase immediately after the fire. In one study in northern California, radio-collared northern spotted owls spent considerable time in burned-over areas. This activity was assumed to be due to easy capture of prey (Patton and Gordon 1995).

It is suspected that the effects of intense stand-replacing wildfires that dramatically alter forest structure and move the system to earlier successional stages would have longer-term effects on some rodent populations. Likely, early successional species such as deer mice and those that require open habitat with a well-developed herbaceous understory, such as microtine voles and pocket gophers, would benefit. In contrast, species that require a wooded or forested overstory would exhibit population declines. The net effect of such fires on the Mexican spotted owl is unclear. A fire that removes the tree canopy would likely render a portion of the area unusable for foraging by Mexican spotted owl, but if the spatial extent of crown loss is limited, a mosaic is created that could provide a diversity of prey for the owl and actually be beneficial (Ward and Block 1995). Because owl prey species evolved in ecosystems where fire was a natural process, we assume that historically, these species survived, and some even benefited from the occurrence of fire. Fire has been excluded from most southwestern ecosystems during the 20th century, resulting in systems where fire behavior may deviate substantially from natural conditions. Effects of fire on small mammals under present environmental conditions are unclear (Ward and Block 1995).

Fire is likely to have immediate short-term adverse effects to Mexican spotted owl prey habitat. Although fire may enhance vegetative density and abundance in the long-term, short-term effects of burning, particularly in the spring and early summer when herbaceous vegetation is most critical for reproducing rodents, may limit available forage immediately after the fire event. Wildfire would most likely occur in June before the onset of the summer rains. Nesting Mexican spotted owls would be most affected during this time, as they would be nesting and require a consistent supply of prey to successfully fledge young.

Prescribed and managed natural fire are extremely important management tools needed to enhance, and often to restore many of the ecosystem functions and processes. Reduction in habitat and various habitat-based threats have contributed to the listing of the Mexican spotted owl. The long-term benefits to the Mexican spotted owl of many land management actions may contribute, in the short-term, to certain adverse affects to the owl. Prescribed and natural fire projects often fall into this category. Species such as the owl, whose habitats have been reduced, degraded, or altered, may currently respond to fire differently than they did historically when fire occurred in a more natural setting. Therefore, it is important to address such concerns by

minimizing, to the greatest extent practical, those short-term adverse effects, and move forward with proactive land management as fire is applied in efforts to restore ecosystem functions and community dynamics.

Fires have played an important role in the composition and structure of conifer forests. Generally, historic natural fires in ponderosa pine were light, its intensity depending on fuel loadings and weather conditions. This created a situation whereby some areas did not burn, some areas burned intensely with crown fires, and most areas burned lightly leaving large fire resistant trees, killing shrub topgrowth, and removing dead fuels (Wright and Bailey 1982). In mixed conifer forests, historic fires often were composed of intense, crown-replacement in small patches. Prescribed fire may be expected to alter mixed conifer habitats of the Mexican spotted owl in the short-term to a greater extent now than historically because the fuel accumulations that are characteristic of many Mexican spotted owl nest and roost sites generally place them at higher fire risk.

Prescribed or managed natural fires are likely to create small openings in the canopy caused by single or groups of trees crowning. The risk of trees crowning is more probable in Mexican spotted owl nesting/roosting habitat. The location of quality owl habitat often corresponds to characteristics that put these sites at higher risk of crowning such as dense, multi-layered canopies, and high fuel loadings resulting from high densities of down logs. Where fire does not crown, some loss of the lower canopy is expected. This is likely to be particularly true in mixed conifer habitats which are usually denser and contain more of the "ladder fuels" created by smaller conifer trees. The loss of some of the lower branches in the canopy may have some effect on Mexican spotted owl foraging. Mexican spotted owls utilize the "perch and pounce" method of hunting, using the lower branches of trees for perching. The loss of some perching sites when burning within prescription is not expected to significantly affect the ability of Mexican spotted owl to forage successfully.

The Recovery Plan encourages fire management programs that take an active role in fuels management and understand the ecological role of fire. The Recovery Plan also recognizes that catastrophic wildfire is one of the primary threats to the owl. Therefore, fire plays the dual role of being both potentially beneficial and catastrophic to the owl and its habitat. The Service stresses the need to apply adaptive management when using fire. Prescriptions that maintain key structural features of owl and small prey habitats should be developed and tested. These features include large trees, snags, logs, and overstory. Treatments to produce or maintain such habitat components must be assessed by monitoring to evaluate if treatment objectives were met in both the short and long term. Wholesale use of fire without understanding or monitoring its effects on habitat may render these areas unusable by owls, and may also miss opportunities to improve our knowledge of fire effects on these habitats (Moir *et. al.* 1995). In regard to managed natural fire in the Kachina Burn Plan, the Coconino National Forest committed to protecting 80-90% of the downed logs 12 inches diameter at breast height (dbh) and greater, and to hand-lining snags 18 inches dbh and greater for all managed natural fire actions within Mexican spotted owl protected and restricted habitat as defined by the Mexican Spotted Owl Recovery Plan (USFWS 1995b). These protective measures will assist in maintaining these important components of Mexican spotted owl prey habitat.

The Recovery Plan recognizes that managed natural fire may be beneficial to owl habitat in several ways: 1) it can aid in reducing fuel loads and the risk of catastrophic wildfire which may result in the loss of habitat over large areas; 2) it can create a diverse landscape with considerable horizontal heterogeneity which seems to be relatively characteristic of many areas occupied by spotted owls and also provides for a diverse prey base; 3) it can create conditions that maintain shade-intolerant species in the landscape.

Prescribed fire should be used carefully in owl habitat (USFWS 1995b). Fire is one of the most rapidly acting of natural disturbances. A crown fire can quickly consume vast tracts of forested habitat. After a large crown fire, habitat components for Mexican spotted owl nesting, roosting, and foraging are reduced or eliminated. Small-scale natural fires and prescribed burns, however, can reduce fuel loadings and create small openings and thinned stands that increase horizontal diversity and reduce the spread of catastrophic fire. Small-scale fires and lightning strikes also create snags, canopy gaps, and large downed logs, plus they perpetuate understory shrubs, grasses, and forbs which are important habitat components to the owl and its prey (Moir *et. al.* 1995).

The Recovery Plan states that the nest site should be known before burning occurs in the PAC, as this information is needed to determine the location of the 100-acre activity center and protect it from fire. The most accurate, up-to-date information needs to be used to determine 100-acre activity centers before prescribed or managed natural fire is allowed to burn in PACs. Service policy is to consider PACs occupied each breeding season.

The following summarizes recommendations from the Mexican Spotted Owl Recovery Plan in regard to prescribed fire in PACs:

1. Experimentally treat (prescribed fire and fuels management) 10% of PACs within each recovery unit that exhibits high fire risk conditions (use of prescribed fire without mechanical treatments is not limited, except within the 100-acre nest site).

2. Treatments should retain or enhance owl habitat components

3. Treatments should only occur during the non-breeding season (September 1 to February 28).

4. A 100-acre area around the known nest site is to be excluded from treatments.

5. Effects of treatments on the owl, prey species, and their habitats should be assessed.

If such effects are not negative, an additional sample of PACs can be treated. If negative effects are detected, measures should be developed to ameliorate those effects. If effects cannot be mitigated, no additional treatments should be permitted.

The Recovery Plan finds that catastrophic wildfire is a primary threat to the Mexican spotted owl. In some areas of the Huachuca Mountains prescribed fire or fuels treatment is necessary to avoid occurrence of a stand-replacing fire that would be highly deleterious to spotted owl habitat.

Where the risk of stand-replacing fire is high in the Huachuca Mountains, the benefits of treatments to reduce that risk are likely to outweigh possible direct adverse effects of such treatments on the owl or its habitat.

The Fort has adopted the recommendations of the Recovery Plan in regard to prescribed fire, managed natural fire, and fuel treatments, with some modifications as suggested by the Service (Section 5). Commitments include not burning within the 100-acre core areas, not removing trees larger than 9 inches dbh in PACs, enhancement or retainment of owl habitat components during treatments, limiting prescribed or managed natural fire treatments within PACs to 100 acres at a time and only outside of the breeding season, and other measures as described in Section 5. Although fire is an imprecise tool, these measures greatly reduce the likelihood that treatments will damage spotted owl habitat or result in take. Properly applied, a fire program should provide long term protection of owl habitat from catastrophic wildfire.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area in the foreseeable future. Future Federal actions would be subject to the consultation requirements established in Section 7 of the Act and, therefore, are not considered cumulative to the proposed action. Because of the extent of Federal lands in the area (CNF, Fort Huachuca, Coronado National Memorial, and BLM), many activities will involve Federal agencies, and thus are not considered cumulative effects. In particular, potential nesting habitat of the Mexican spotted owl in the project area is in the montane canyons of the Huachuca Mountains. These canyons are, for the most part, managed by Federal agencies. Exceptions include the Peterson Ranch in Scotia Canyon, lower Ramsey Canyon, and other small parcels, mostly in the lower reaches of the canyons. Most of these sites are too low in elevation to support nesting spotted owls, although the species may use these areas when not nesting.

Population growth in the Sierra Vista area and the popularity of the area as a recreational destination is resulting in increased use of Mexican spotted owl habitat in the Huachuca Mountains. In addition, private lands at the mouths of many canyons to the south of Fort Huachuca are being developed as housing tracts or ranchettes. The lower reaches of these canyons may provide wintering spotted owl habitat. This increasing human presence is likely to result in increased disturbance of any Mexican spotted owls in the area. The Fort's commitment to restricting certain recreation activities should reduce the potential for recreational activities to adversely affect the owl and its critical habitat.

Critical Habitat

Critical habitat was designated for the Mexican spotted owl on January 18, 2001 (50 CFR 17). This included 4.6 million acres on federal lands in Arizona, Colorado, New Mexico and Utah. A total of 830,000 acres were designated in Arizona of which 24,038 acres occur on Fort Huachuca. Critical habitat designated includes areas within the mapped boundaries that meet the definition of protected and restricted areas. Protected areas are areas where owls are known to occur or are likely to occur. Protected areas include, (1) 600 acres around known owl sites within

mixed conifer forests or (2) pine-oak forests with slopes greater than 40% and where timber harvest has no occurred in the past 20 years. Restricted habitat includes areas outside of protected areas which may contain Mexican spotted owls. Restricted areas include mixed conifer forest, pine-oak forest and riparian areas.

Effects analyses for critical habitat must determine if the proposed action would destroy or adversely modify critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical (50 CFR 402.02). The primary constituent elements identified as necessary for the survival and recovery of the Mexican spotted owl include those physical and biological features that support nesting, roosting and foraging. This includes all vegetation and other organic materials with PACs. Within restricted areas this includes:

1. High basal area of large diameter trees
2. Moderate to high canopy closure
3. Wide range of tree sizes suggestive of uneven-age stands
4. Multi-layered canopy with large overstory trees of various species
5. High snag basal area
6. High volumes of fallen trees and other woody debris
7. High plant species richness, including hardwoods
8. Adequate levels of residual plant cover to maintain fruits, seeds and regeneration to provide for the needs of Mexican spotted owl prey species.

These constituent elements are provided by warm-temperate and cold-temperate forests, and, to a lesser extent, woodlands and riparian deciduous forests.

As discussed previously, some activities at Fort Huachuca have the potential to adversely affect critical habitat. These activities include recreational and aviation activities, wildfire ignited by authorized ordnance use or recreation, prescribed fire, and fire suppression. The most important of these are wildfire and prescribed fire, and fire suppression activities. Wildfire ignited by recreational users or ordnance, prescribed fire, and fire suppression activities could result in direct effects to owl critical habitat in the forested area on the installation, or perhaps on nearby USFS lands. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion and sedimentation. Effects from recreational use, to include the cumulative effects of an increasing population in the region, also have the potential to affect owl critical habitat.

Fort Huachuca has committed to a number of important conservation measures as part of the proposed action that would reduce or eliminate most potential adverse effects to the Mexican spotted owl and its critical habitat (Section 5). Some of these conservation measures include wildfire suppression and prevention measures, prescribed fire and fuels management to reduce fuel loads and the chance of catastrophic fire, minimal military training in the Huachuca Mountains, limiting aircraft flights below 500 feet agl and helicopter flights near PACs and nest sites and limitations on recreational activities in canyons where Mexican spotted owls occur.

Overall, ongoing and programmed future military operations and activities at and near Fort Huachuca may affect, and are likely to adversely affect Mexican spotted owl populations and designated critical habitat on and off the installation.

4.10.4 LESSER LONG-NOSED BAT

Effects of the proposed action that may affect the lesser long-nosed bat include fire, noise, habitat loss, direct mortality, and human disturbance.

The lesser long-nosed bat is most sensitive to activities that might adversely affect roost sites, particularly recreational caving. Other elements of the proposed action may affect foraging habitat or foraging bats, including fire ignited by ordnance, recreationists or other human activities; prescribed or managed natural fire; noise from aircraft or weapons firing; collisions of bats with vehicles, powerlines, wind turbines and other project features; grazing by horses; construction activities that might result in mortality of forage plants; and individual agaves that may be damaged directly by ordnance or by bivouacs or other training activities.

The lesser long-nosed bat has been recorded in southern Arizona from the Picacho Mountains (Pinal County) southwest to the Agua Dulce Mountains (Pima County), southeast to the Chiricahua Mountains (Cochise County), and south to the international boundary. Records of the lesser long-nosed bat at Fort Huachuca and areas within foraging distance of the Fort (~40 miles) include at least two large post-maternity roosts; observers have recorded over 15,000 lesser long-nosed bats at a mine in the Coronado National Memorial, approximately 10 miles from Fort Huachuca, and over 30,000 bats at Patagonia Cave, at a distance of approximately 20 miles from the Fort (Sidner 1996). Three major maternity roosts and five major post-maternity roosts are known in Arizona. Of the sites at Fort Huachuca, lesser long-nosed bats have been found day roosting at Pyeatt Cave and Manila Mine (some night roosting occurs at these sites as well). Wren Bridge is a night roost, and lesser long-nosed bats were mist-netted in Woodcutters Canyon (Sidner 1994, 1996, 1999). Upper Pyeatt Cave and Indecision Cave are considered potential day roosts, but the species has yet to be documented at these sites (Sidner 1996, 1999,2000).

Effects of Human Disturbance

Roosting lesser long-nosed bats are very sensitive to human intrusion. Recreational cavers entering Manila Mine, Pyeatt Cave, or other sites where lesser long-nosed bats might day roost could result in temporary or permanent desertion of the roost. However, Manila Mine and Pyeatt Cave (where lesser long-nosed bats have been confirmed), as well as upper Pyeatt Cave

(potential habitat) are closed seasonally from April-October when bats may be present. The Fort protects the entrances of these roosts with chain link fence (but the bats can still get through), the entrances are posted, the access roads to Manila Mine and Pyeatt Cave are gated and locked seasonally, the road to Upper Pyeatt Cave is rough and little used, and a live video surveillance system alerts the Fort of illegal entry. Thus, the Fort has taken many precautions to ensure that the bats are not disturbed. Disturbance of known roosts sites appears to be minimal. Hunting is allowed in the vicinity of the three known lesser long-nosed bat roosts. Potentially, a hunter could discharge a weapon near a roost site and disturb bats or cause them to temporarily abandon the roost. However, this type of disturbance is likely to be infrequent and most hunting occurs after the bats have left in the fall.

Some training activities, such as bivouacs, ordnance delivery, and other activities that may result in disturbance that could damage or destroy agaves, or result in soil compaction and reduced agave establishment. However, personnel are instructed to avoid disturbance to agaves, nearly all such training occurs at established sites or previously disturbed areas, areas directly disturbed by ordnance delivery are relatively small and the most significant stands of Palmer's agave are designated as Agave Management Areas and protected from training activities. Very little training occurs in the habitat of Parry's agave (i.e. at higher elevations).

Effects of fire on the various components of the proposed action, prescribed or managed fire and wildfire suppression have the greatest potential to adversely affect agaves, and forage plant availability. It appears that forage resources are not limiting to lesser long-nosed bat populations in the Huachuca Mountains, or at least it is unlikely (Steidl 2001). Liz Slauson working at several sites in southeastern Arizona, has never observed agave flowers drained of nectar, suggesting nectar availability is not limiting. However, the bats fly south in September or October at a time when blooming agaves are becoming less and less abundant, suggesting a waning food supply may be one of the factors that triggers migration. Yar Petryszyn (pers. comm. 1999) has observed apparent antagonistic behavior of bats at agave flowers late in the season, suggesting possible competition for resources. If forage resources are limiting at times or certain places, we would expect that in some years or some areas, numbers of bats may be reduced, or bats may have to fly farther from their roosts to obtain sufficient resources, as a result of insufficient blooming agaves. Bats that fly greater distances are probably more vulnerable to predation or accidental death. Under a scenario of limiting food resources, damage or death of agaves due to prescribed fire could conceivably further reduce forage resources and bat numbers. Although there is some uncertainty whether agaves are limiting to lesser long-nosed bats in the project area, it seems likely that landscape-scale projects, such as a prescribed fire, that are adjacent to important roosts will probably have some effects on bat foraging behavior, and some of these are likely to be adverse effects. The Service considers loss of forage resources a great enough threat to include protection of foraging areas and food plants as a priority 1 task in the lesser long-nosed bat recovery plan.

Mortality of leaf succulents exposed to fire is extremely variable. The Baker prescribed fire was conducted recently in the southern Peloncillo Mountains in extreme southeastern Arizona and southwestern New Mexico. According to preliminary monitoring efforts conducted after the fire, there were seven to 11% mortality of Palmer's agaves exposed to fire (Peter Warren, pers. comm. 1997). Additional mortality may accrue through loss of the smallest and least detectable size

classes of agave. On the Maverick Prescribed Fire, also in the Peloncillo Mountains, less than 5% of agaves in burned areas were killed by the fire. Because of a mosaic of burned and unburned areas, overall mortality in the project area was perhaps less than 1% (T. Roller, pers. comm. 1998). Thomas and Goodson (1992) reported an average mortality of 28% of five species of leaf succulents from nine burned sites in southern Arizona. Palmer's agave mortality averaged 18%. However, post-fire grazing may have influenced reported mortality. Concentrations of paniculate agaves are primarily on the rocky, shallow soils of hills and ridges, particularly on southerly and southeasterly facing slopes. Other Palmer's and Parry's agaves are found scattered in areas of deep, heavy soils where thick stands of shrubs and mesquite form heavy fuel loads. The relative fuel loading and potential exposure of agaves to intense fire is lower on rocky soils.

Agave mortality due to fire may affect the abundance and distribution of blooming agaves on the landscape for many years into the future, especially if there is high mortality within certain age/size classes (e.g seedlings). In addition, natural recruitment of agaves may be very episodic and the effects of fire on the agave seed bank in the soil are unknown. Often one of the objectives of prescribed fire is to increase abundance of grasses. Grasses are probably one of the strongest competitors with agave seedlings (Tony Burgess, pers. comm. 1997). Increased abundance of grass could result in reduced agave abundance. Agave stalks, as they begin to bolt, are particularly palatable to domestic livestock and wild herbivores, including deer, javelina, rodents, and rabbits (Michelle Hawks, University of Arizona, Tucson, pers. comm. 1997; Wendy Hodgson, pers. comm. 1997). Since agaves often remain partially green, succulent, and available to herbivores when food resources are low immediately following a fire, they may be preferentially selected by herbivores. This may in turn affect the availability of agave flowering stalks to bats.

Besides direct mortality of agaves, fire may alter the availability of blooming agaves. By early spring, an agave plant would have physiologically committed to bolt (send up a flowering stalk). If the plant is burned and lives, bolting continues though the flower stalk is smaller with fewer flowers (Howell 1996; Liz Slauson, pers. comm. 1997). If the stalk burns directly the reproductive effort of that plant and the availability of flowers and nectar to *Leptonycteris* has been lost. A fire may actually stimulate flowering in adult agaves one to two years following a burn (Liz Slauson pers. comm. 1997). However, in subsequent years following the period of increased flowering there may be a reduced number of flowering agaves. Although the availability of blooming agaves may be affected by fire, the nectar production and sugar content of surviving plants is little effected. Working in the Peloncillo Mountains, Slauson (pers. comm. 1997) found that nectar production and sugar content did not differ between unburned agaves and burned agaves that did not have greater than 80-90% of the leaf area burned. The complexity of variables influencing agave flowering may mask the effects of a burn on agave flowering within several years of a fire.

Reintroducing fire into fire-adapted communities, such as desert grassland and oak/juniper savanna systems, can also have many benefits and may improve overall long-term "ecosystem management" objectives. Among these is the reduction of woody fuels resulting in decreased probability of intense fires and resulting erosion, soil sterilization, and increased plant mortality. Ultimately, if fire continues to be excluded from fire-adapted systems a major wildfire will occur with potentially devastating effects. Returning to a more natural regime of low-intensity fires

would help to maintain a mosaic of grasslands, woodlands, and shrublands across the landscape and may enhance refugia in which fuel loads and the chances of damaging fires are low. However, even under a prescribed fire regime there are potential adverse effects of fire to forage plants that may affect resource availability for the lesser long-nosed bat.

Activities that directly or indirectly promote invasion or increased density of nonnative grasses, particularly Lehmann lovegrass, may result in increased fire frequency or intensity, reduced densities of Palmer's agave, and thus reduced forage resources for the lesser long-nosed bat. Lehmann lovegrass is abundant in some portions of the West and South ranges at Fort Huachuca. This species increases after fire (Ruyle *et. al*. 1988, Sumrall *et. al*. 1991, Martin 1983, Howell 1996), but also produces an abundance of fine fuel that promotes hot fires (McPherson 1995). Thus, frequent fire is likely to increase the abundance of Lehmann lovegrass, and increased abundance of this grass will likely fuel more fires and hotter fires, creating a positive feedback loop (Anable *et. al*. 1992). Frequent, hot fires brought about by prescribed fires and increasing prevalence of Lehmann lovegrass will likely reduce densities of Palmer's agave. Howell (1996) found that Lehmann lovegrass creates areas of continuous fuels at Fort Huachuca that burn at a constant temperature versus stands of native grasses that are patchy in regard to fuels and fire intensity. Agaves can persist in fire-prone native grasslands in bare areas or refugia that burn lightly or not at all. Such refugia are less common in Lehmann lovegrass stands. Howell (1996) also noted a negative relationship between the proportion of agave seedlings and ramets and the amount of Lehmann lovegrass. She suggested that Lehmann lovegrass appears to suppress agave recruitment independent of the fire effects just described. The mechanism of suppression is unclear, but Howell (1996) suggests Lehmann lovegrass may compete effectively with agaves for nutrients and/or light. If agave densities are reduced due to elevated fire effects or recruitment suppression caused by Lehmann lovegrass invasion, forage resources of the lesser long-nosed bat will be reduced.

Howell (1996) found that a fire frequency of three to six per decade on the South Range is "clearly too high to allow sexual reproduction to persist in the agave community...too high to permit seedling establishment and too high to allow even the fast growing clones to achieve reproductive status." Howell (1996) suggested that fires be managed on the South Range to approximate the natural fire frequency, which is likely 10-15 years (8-22 years range). She also recommended suppressing fires in plots with demography biased towards young and/or middle age class agaves, because of their sensitivity to fire damage. Examination of Figure 24 (page 167) reveals that some areas of the South Range, and fewer areas on the West Range, burned four or more times from 1973-2002, which is, according to Howell (1996), too often for healthy agave stands. Most of the West Range, and large portions of the eastern and southern parts of the South Range burned at approximately the 10-15 year frequency recommended by Howell (1996). As discussed, the relationship of fire frequency and intensity to agave population dynamics is complex. The Service recommends adaptive management in regard to fire management to ensure maintenance of viable, healthy agave populations. The Fort has several conservation measures that will reduce the effect of fire on agave (Section 5). One of these is the suppression of fires in agave management areas unless the area is approaching its natural fire return interval of 10 years.

The importance of Parry's agave stands in the Huachuca Mountains as a forage resource for the lesser long-nosed bat is unknown. As discussed, Parry's agave generally occurs at higher

elevation than Palmer's agave, and occurs in forest openings throughout the Huachuca Mountains to the mountain's crest. Benson and Darrow (1982) note that it typically flowers in June and early July, which is before the lesser long-nosed bat arrives at roosts at Fort Huachuca. However, J. Rorabaugh (pers. comm. 1998) noted many Parry's agave in flower high in the Huachuca Mountains on the crest trail during late July in 1997. It may be that agaves at high elevation bloom later than at lower sites, and could potentially be blooming and be used as a forage resource when lesser long-nosed bats arrive in July or early August.

The only significant threat to stands of agaves in the forested portions of the Huachuca Mountains is fire. As discussed for the Huachuca water umbel and Mexican spotted owl, fuel loads are high in some portions of the Huachuca Mountains, and a stand-replacing, catastrophic wildfire could occur due to lightning strikes or project-related causes such as recreational use or ordnance. Because Parry's agave occurs primarily in openings and often on rocky slopes where fuel loads are relatively light, agave populations may not be severely directly affected by wildfire. Openings created by fire could conceivably increase habitat for agaves, temporarily. However, post-fire erosion of slopes could bury or scour hillsides and rocky places where agaves occur. The Fort will be implementing a Fire Management Plan to reduce fuel loads and the chance of catastrophic fire in the Huachuca Mountains. With implementation of this plan, threats to agave populations posed by wildfire would be reduced.

Implementation of Howell and Robin's (1996) agave management plan, as proposed by the Fort (Section 5.4.11), would provide good protection for key agave stands and bat foraging areas in the lower elevation areas of Fort Huachuca. The plan provides for minimizing or eliminating possible adverse effects of training activities, provides a means for fire to play a more natural role without inhibiting agave population health or viability, and sets up an administrative network and environmental education programs to ensure that protective measures are carried out. However, some flexibility should be built into the plan and the recommendation to apply prescribed fire only from November through March in the agave management areas may not be necessary to maintain healthy and viable agave populations. As demonstrated in the Baker and Maverick fires in the Peloncillo Mountains, warm season fire may not result in significant mortality. Exclusion of fire during the warm season could encourage invasion of woody species. However, cool season burns may be warranted to protect small size classes of agaves, particularly if Lehmann lovegrass is present, which could increase fire intensity. As discussed, due to uncertainties and the need to make changes as monitoring data and new research results become available, the Service favors an adaptive management approach in which management of key agave stands would evolve with new information.

Effects of Noise

Howell (1992) examined the effects of UAV (Sky Owl and Hunter) testing on the lesser long-nosed bat at Fort Huachuca. Fort Huachuca proposes testing of the Pioneer and Hunter UAVs; the Pioneer and Sky Owl are both relatively small UAVs and very similar in regard to noise output. Howell (1992) concluded that lesser long-nosed bats would not hear noise of UAVs cruising at 1,000 to 3,000 feet agl. Currently, typical cruising elevation is above 3,500 feet agl, with some flights as low as 1,000 feet. Noise generated by UAVs is relatively low intensity. Also, lesser long-nosed bats are not very sensitive to sounds below frequencies of 10 kHz

(Howell 1974). The high frequency sounds to which the bat is sensitive attenuate very rapidly with distance (Howell 1992). Thus, noise generated by typical UAV flights over Fort Huachuca, to the Canelo Hills, the Altar Valley, or other destinations should not disturb foraging or roosting lesser long-nosed bats.

Noise is also generated during rolling or rocket-assisted takeoffs (RATOs) of UAVs. Most proposed UAV take-offs and landings would occur on the Pioneer and Rugge-Hamilton (formerly Raven) airstrips at the Black Tower Complex on the West Range, but occasional take-off and landings would occur at the Hubbard airstrip. The Hunter UAV uses the Rugge-Hamilton strip, whereas the smaller Pioneer uses the Pioneer strip. Howell (1992) concluded that UAV take-off at Hubbard airstrip would not affect lesser long-nosed bats because agaves are scarce to non-existent in that area and the airstrip is over nine miles from known roosts. However, good stands of agaves are present near the Black Tower UAV facility, and bats probably forage near the facility. In regard to RATOs, Howell (1992) found that noise generated is well above the minimal noise that triggers a response in the bats auditory system. She recommended that nocturnal RATOs of UAVs from Black Tower only occur from November through May to avoid the season when the bat is present at Fort Huachuca. Howell (1992) also recommended that RATOs be attended by fire crews due to the high probability of fire and potential adverse effects to agave communities. The Fort has adopted these recommendations (Section 5), except that RATOs may occur through June. This is an appropriate modification because lesser long-nosed bats have not been recorded at Fort Huachuca until late June. The Fort has also adopted policies calling for nocturnal flights of UAVs to be above 500 feet from July 1 to October 31, and take-off and landing approaches at Rugge-Hamilton and Pioneer airstrips would be modified to avoid flying low-level over agave management areas.

Disturbance of bats as a result of noise could also occur due to low-level fixed-wing and helicopter flights, small arms or other weapons fire associated with military training, or discharge of a firearm by a hunter. Dalton and Dalton (1993) investigated the effects of low-level (500 feet agl) military jet flights on the lesser long-nosed bat in a mine that served as a day roost at Organ Pipe Cactus National Monument. Bats exposed to low-level flights exhibited no acute responses (panic flights, falling young bats, or startle responses). No significant differences in bat orienting responses were noted before, during, or after jet flights, but depressed levels of bat flights were noted for up to 30 minutes following the jet noise. Low-level jet noise attenuated rapidly within the roost, particularly the high frequency sounds to which bats are particularly sensitive. The authors note that extrapolation of the results to other sites with different terrain or mine tunnel geometry may not be valid. They also find that the study did not address any potential long-term effects to the bat colony. As discussed previously, wildlife typically respond more to helicopter flights than fixed-wing aircraft. A helicopter flying very low over a bat roost could produce noise as well as high winds that could disturb bats.

The findings of Dalton and Dalton (1993) combined with the apparent infrequency of low-level flights at Fort Huachuca suggest that noise from overflights probably does not significantly adversely affect lesser long-nosed bats that are roosting deep in a mine or cave, at least in the short-term. Low-level nocturnal military flights may affect bats that are foraging or night roosting differently, and as Dalton and Dalton (1993) note, the long-term effects of repeated low-

level flights are unknown. Again, however, the infrequency of low-level flights at Fort Huachuca reduces the probability of this being a significant adverse effect.

Noise from military weapons fire is unlikely to disturb lesser long-nosed bats. Small arms firing would occur on the South Range; however, the firing ranges are all at least five miles from Pyeatt Cave and Manila Mine, and over three miles from Wren Bridge. Noise from weapons fire would attenuate dramatically over that distance, particularly the high frequencies. Artillery and mortar firing occurs at several areas on the East Range. Ordnance is directed eastward from these sites and is delivered into Impact Area Zulu, also on the East Range. Noise from these sources is louder than the small arms firing on the West Range. However, mortar and artillery firing on the East Range occur at a much greater distance from the known bat roosts. All mortar and artillery firing sites and the impact zone in Impact Area Zulu are more than six miles from Wren Bridge and more than 7 miles from Pyeatt Cave and Manila Mine. No effects to lesser long-nosed bats are anticipated as a result of mortar and artillery firing on the East Range.

Effects of Direct Mortality

Mortality or injury of lesser long-nosed bats could also occur due to collisions with vehicles, aircraft, ordnance, power/communications lines, wind turbines, antennas, or other project features on Fort Huachuca. The frequency of such collisions is unknown, but the potential exists for bats to collide with such features. The Fort has proposed no nighttime training in agave management areas from July 1 through October 31, no nighttime use and no tracer fire on live fire ranges 2, 3, and 4 from July 1 through October 31, no use of pyrotechnics within 0.25 mile of agave management areas, and no off-road vehicle use and restrictions on low-level flights, that collectively greatly reduce the likelihood of take resulting from collisions (see Section 5).

Effects of Habitat Loss

UAVs crash on or off-post approximately once per year. There have also been two manned aircraft crashes at Fort Huachuca (at Libby Airfield) in the past ten years. Search and rescue operations are carried out for manned aircraft that crash, and aerial or ground searches occur following crashes of UAVs. Some potential exists for aircraft crashes to directly impact agaves or to start fires that affect agaves. The potential for a crash to directly affect a roost site on or off-post is remote.

Predation of agaves by gophers and ungulates on the West Range was found to be inhibiting sexual reproduction of agaves. Howell (1996) suggested that if areas of the West Range are to be managed for agaves "attention will have to be paid to the intense predation." Predator control (coyotes and other carnivores) was carried out on the South Range in the 1980's and early 1990s' in an attempt to increase populations of Chihuahuan pronghorn. Reduced predator densities could theoretically contribute to increased populations of gophers and ungulates that in turn result in increased predation of agaves. However, Howell (1996) found no correlation between predator control activities and agave demographics on the West versus the South ranges, and predation of agaves appeared to be higher on the West Range where predator control has not been implemented. Fort Huachuca no longer carries out any predator control activities.

Cattle grazing can adversely affect agave survivorship and bolting. Prior to the summer monsoons at Four Peaks on Tonto National Forest, cattle were observed eating the unprotected apex of several agave plants (Tricia Roller, Service, Tucson, AZ pers. comm. 1997). Cattle probably trample young agaves, as well. Although cattle have been excluded from Fort Huachuca for many years, grazing by horses occurs on 1,433 acres of the West Range within 0.6 mile of protected agave stands and Wren Bridge. The horse pastures are approximately three miles from Manila Mine and Pyeatt Cave. Thus, the grazed area is likely foraging habitat for the lesser long-nosed bat. There are some differences in grazing behavior between horses and cattle. It is unknown whether horses browse agave bolts, but if they do, forage resource availability for the bat would be reduced by such browsing. Horses, like cattle, probably also trample young agaves and may compact soils and reduce germination and survival. Although horses tend to avoid areas of high densities of agaves (Howell and Robinett 1996), any trampling or browsing of agaves would reduce forage resources available to the lesser long-nosed bat. Direct effects due to grazing may be more intense in areas grazed during the flowering season of agave and where horses congregate near water sources.

The Fort proposes a number of building/construction projects over the next 12 years (Table 3, page 36). Most of these would occur in the cantonment area in previously disturbed areas, or would constitute improvements to existing structures. Few, if any, of these projects have potential to disturb habitats that may contain agaves. An exception may be the RV park expansion on the northwestern side of the cantonment area. However, the expansion is small, and any effects to bat forage resources at Fort Huachuca would be relatively very small. The Fort is also proposing to build a new ASP in 2011. The project would disturb approximately 25 acres of grassland on the south range where few, if any, agave are known to occur. The Fort has adopted conservation measures to ensure minimal disturbance of lesser long-nosed bat foraging habitat during construction activities (see Section 5).

The Fort proposes to exchange a 26-acre parcel near Kayetan Drive and Buffalo Soldier Trial to the Arizona State Land Department for state in-holdings on the East Range. This exchange was authorized by special state legislation in 1987. If all or part of the 26 acre parcel is developed, some foraging habitat of the bat could be lost. It is unknown whether agaves occur on the parcel, but it is rather low on the bajada where agaves are uncommon or absent.

A related land exchange is also being planned to gain full title to several parcels of land on the East Range of the Fort. In cooperation with the BLM and the State of Arizona, state trust lands may be exchanged to ensure that full title to those parcels is conveyed to the federal government. This administrative action will not change land use or activities on those inholdings.

The City of Sierra Vista has proposed to acquire from Fort Huachuca 203 acres adjacent to Libby Airfield pursuant to the Airport Improvement Act. The land would be used for aviation-related uses. This action is currently set aside (Appendix D). If this realty action is proposed in the future, it will be the subject of separate ESA consultation.

Off-post activities are unlikely to affect lesser long-nosed bats or their habitat. These activities occur in previously-disturbed areas and therefore should have little affect on agave. As discussed for the southwestern willow flycatcher, activities off-post could potentially increase the chances

of fire, which may adversely affect agave plants and bat forage resources. However, the Fort has several conservation measures in place to reduce the chance of this occurring (see Section 5).

Interrelated and Interdependent Effects

As discussed for the Huachuca water umbel and the southwestern willow flycatcher, some of the existing development and population in the Sierra Vista area can be attributed to Fort Huachuca, because some employees, contractors, military dependents, military retirees, and others live in the Sierra Vista area because of job opportunities or military benefits provided by the Fort. Thus, some of the residents and development off-post would not be there but for the presence of Fort Huachuca. Some of this development may result in destruction of lesser long-nosed bat foraging habitat. However, the best agave populations appear to be concentrated on the upper bajadas, while most of the development has occurred lower on the slope where agaves are uncommon. Also, as discussed previously, predicted growth in the Sierra Vista area has achieved a momentum that is separate from any influence Fort Huachuca might have.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Much of the land in the project area is managed by Federal agencies, particularly the BLM, CNF, and Coronado National Memorial. The only significant known roost in the Huachuca Mountains outside of Fort Huachuca is the State of Texas Mine on the Coronado National Memorial. Activities on State and private lands may require permits or funding from Federal agencies. Thus, many of the actions that are reasonably expected to occur in the project area that may adversely affect the lesser long-nosed bat would be subject to Section 7 consultations. However, grazing, development, and other activities occur on large tracts of State and private lands within the project area. The effects of these activities are considered cumulative to the proposed action. Development near the base of the Huachuca Mountains or at the mouths of canyons on the east slope south of Fort Huachuca could result in destruction of bat foraging habitat and agaves. Compliance with the Act for activities on State and private lands that may affect the lesser long-nosed bat, but are not addressed by Section 7 consultation, could occur through Section 10(a)(1)(B) of the Act.

The Fort has developed many valuable conservation measures to protect the lesser long-nosed bat and its habitat. A thorough list of these conservation measures can be found in Section 5. These conservation measures will largely reduce or eliminate most of the potential adverse effects to the lesser long-nosed bat as a result of the proposed action. The timing or seasonality of when specific conservation measures would apply is generally July 1 through October 31. This encompasses most of the period when lesser long-nosed bats have been observed at Fort Huachuca (June 30 – November 26). Numbers of bats typically peak in early September (Sidner 1999). Fleming (1995) notes that male lesser long-nosed bats arrive at East Whitetail Canyon in the Chiricahua Mountains as early as late April; however, Sidner (2001) has monitored roosts for 12 years at Fort Huachuca and has documented the earliest arrival of bats on June 30th and the latest departure on November 26. Sidner's roost surveys suggest that a sensitive period for the bat, when activities should be actively managed to protect foraging bats, should be July 1 to

October 31. Although lesser long-nosed bats may occur on the installation outside of these dates, it is unlikely that they are foraging on agave stands, and would require special conservation measures. Closure of roosts will begin in early April and continue until all lesser long-nosed bats have departed. This roost closure will not only help the lesser long-nosed bat but will also protect other non-listed species of bats that arrive sooner, such as pallid bats, *Antrozous pallidus,* and cave myotis, *Myotis velifer.*

Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect and are likely to adversely affect the lesser long-nosed bat.

4.10.5 SONORA TIGER SALAMANDER

Potential threats to Sonora tiger salamanders from the proposed action include fire and human disturbance.

All sites where Sonora tiger salamanders have been confirmed are located in the San Rafael Valley and adjacent portions of the Patagonia and Huachuca mountains in Santa Cruz and Cochise counties in Arizona. The Sonora tiger salamander is known from approximately 53 breeding localities (Collins and Jones 1987, Collins 1996, USFWS 1997, Abbate 1998, Ziemba *et. al.* 1998, Jon Snyder, Arizona State University, pers. comm., 1999; Mike Pruss, AGFD, pers. comm. 1999); although at any one time not all of these sites are occupied. During intensive surveys in 1997, from one to 150 Sonora tiger salamanders were found at 25 stock tanks (Abbate 1998). Three populations of Sonora tiger salamanders are known to exist in the Huachuca Mountains. These salamanders occur in Scotia and Copper Canyons off-post, and in Upper Garden Canyon on post. On Fort Huachuca, tiger salamanders are known from upper Garden Canyon Pond near the crest of the Huachuca Mountains and the junction of Sawmill and Garden Canyons.

Effects of Fire

Fire and fire-related activities associated with the proposed action have the potential to adversely affect the salamander. These include fires ignited by ordnance, recreational users, vehicles, and prescribed fire, managed natural fire and fire suppression activities.

We are not aware of any studies that evaluated the effects of fire on salamanders. However, fire could potentially result in direct death or injury of salamanders, and reduced habitat quality or quantity. Degradation of watershed condition immediately after fires results in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or drought (Rinne and Neary 1996). Fire, whether ignited by a natural or human-caused source, could result in degradation of the immediate watershed around a pond, and result in erosion, sedimentation, and ash flow into the pond. Although effects on salamanders are unknown, in salmonid fish, ash and slurry flow into streams can be toxic and populations of macroinvertebrates (salamander prey species) can be drastically reduced after a fire (Rinne 1996), at least temporarily (Roby and Azuma 1995). Smoke diffusion into water and

ash flow can result in high level of phosphorus and nitrogen (Spencer and Hauer 1991) with unknown effects to salamanders. James Petranka (University of North Carolina at Ashville, pers. comm. 1998) notes that fire can be detrimental to plethodontid salamanders by eliminating ground cover and associated invertebrates that are key food sources. Mike Lanoo (Indiana University School of Medicine, Muncie, pers. comm. 1998) has never observed any direct effects to tiger salamanders as a result of summer fires in Indiana prairies, but he has noted reduced invertebrate populations in high sediment habitats that resulted in lower food availability for salamanders. In this case, a red-leg (a bacterial infection) outbreak occurred. Dr. Lanoo suspected that ash flow into a pond could cause the same result.

Siltation of a pond due to erosion and runoff following a fire could eliminate habitat. However, the effects of siltation may also be more subtle. Lefcort *et. al.*(1997) examined the effects of silt on growth and metamorphosis of larval mole salamanders, *Ambystoma opaceum* and *A. tigrinum tigrinum*. Salamanders in silty water grew more slowly, metamorphosed sooner, and were more susceptible to infection by a water mold, *Saprolegnia parasitica*, than salamanders in non-silty water.

Fire effects could occur on or off of Fort Huachuca. A wildfire or prescribed or managed natural fire that escapes prescription could potentially burn onto CNF land west of the Fort and affect salamander populations and habitat on the west slope of the Huachuca Mountains and adjacent areas of the San Rafael Valley. The chances of a large regional fire resulting from an ignition at Fort Huachuca during the life of the project is probably low, but high fuel loads in portions of the Huachuca Mountains on post (Danzer *et. al*. 1997) and recent large stand-replacing fires in the Huachuca Mountains to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire in 1983) suggest that such a fire is possible. General Wildlife Services (1999) suggests that the Garden Canyon area "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage." The Fort has committed to implementing prescribed fire and fuels management as soon as possible to reduce the fire risk (see Section 5).

Upper Garden Canyon Pond is the most important habitat for the salamander at Fort Huachuca, because it is where breeding and larval development occurs. Little is known about where adult terrestrial Sonora tiger salamanders go when not at the breeding ponds. Unlike some salamanders, terrestrial Sonora tiger salamanders are virtually never encountered on the surface, except at or in the immediate vicinity of breeding ponds. However, a Sonora tiger salamander was captured in a pit fall trap at Oak Spring in Copper Canyon, Huachuca Mountains, by AGFD personnel. The nearest known breeding site is approximately 0.6 mile to the south, suggesting the salamander may have moved at least that far. Capture in a pit fall trap also confirms that the individual was surface active. In other subspecies of *Ambystoma tigrinum*, metamorphs may disperse hundreds of meters from the breeding pond, or may remain nearby (Petranka 1998, Gelbach *et. al*. 1969). Of hundreds of marked *Ambystoma tigrinum nebulosum,* two were found to move from 0.9-1.2 miles to new ponds (J. Collins, pers. comm. 1998). Referring to conservation of the California tiger salamander, *A. californiense*, Petranka (1998) finds that based on studies of movements of other *Ambystoma* species, conservation of a 650-1,650 foot radius of natural vegetation around a breeding pond would protect the habitat of most of the adult terrestrial population.

Adults of western subspecies of *A. tigrinum* typically live in or around mammal burrows (Petranka 1998), although metamorphs may construct their own burrow, as well (Gruberg and Stirling 1972, Semlitsch 1983). Some species of salamanders exhibit seasonal migrations of up to several miles each way from breeding sites to upland habitats (Stebbins and Cohen 1995). There is no information available about migration, migration corridors or non-breeding habitat for the Sonora tiger salamander. Because of the arid nature of the environments in this region, if salamanders move very far from breeding ponds, they might be expected to use wet canyon bottoms, such as Scotia and Garden canyons, as movement corridors.

Probably the greatest threat to non-breeding terrestrial salamanders is fire. Erosion and increased runoff could bury or flood burrows, burrow entrances, rock shelters, or other cover sites. Fire may also reduce surface cover such as logs and debris, resulting in reduced invertebrate populations and reduced prey densities for salamanders (James Petranka, University of North Carolina, Asheville, pers. comm. 1998). Reduced cover may also result in heating and desiccation of moist cover sites that salamanders require.

Fire suppression activities could also affect salamanders or their habitat. Most importantly, during fire suppression helicopters are sometimes used to scoop water from ponds or lakes and then drop that water on the fire. Ponds that are depleted from such operations are often refilled from a nearby large lake or reservoir. Because of the location of upper Garden Canyon Pond at Fort Huachuca and its small size, it is unlikely that a helicopter would attempt to take water from it for fire suppression. However, if that was done, aquatic salamanders could be scooped out of the pond and dropped on the fire. If the pond was refilled from Parker Canyon Lake or one of the impoundments on the Fort, nonnative predaceous fish, bullfrog tadpoles, or *Ambystoma tigrinum mavortium* could be introduced into the pond with deleterious effects. Introduction of *A. t. mavortium* into the range of *A. t. stebbinsi* could be particularly damaging, and once introduced it could spread to other ponds. If fish were introduced into the upper Garden Canyon Pond, they likely would not survive for a long period, because the pond dries periodically.

Effects of Human Disturbance

There are 16 ponds (approximately 32 acres) located on Fort Huachuca. Seven of these ponds are stocked with trout if water conditions are favorable (Table 2, page 29), and some ponds are known to contain bass, sunfish, catfish, bullfrogs and/or crayfish. Fishing on Fort Huachuca is open to the general public and can be done year round. Fishing requires a state license and Fort Huachuca fishing permit and can only be done during daylight hours. Most fishing occurs at Golf Course, Gravel Pit, Lakeside, and Woodcutter's ponds. In Arizona, anglers commonly move fish among aquatic sites, either to create new fishing opportunities, or by use of bait fish. The introduction of sunfish, bass, mosquito fish, or catfish could result in elimination of aquatic salamanders from upper Garden Canyon Pond.

Collecting, transporting, or releasing salamanders or live fish, using live bait for fishing, and driving off established roads and through ponds are all prohibited activities at Fort Huachuca. However, an employee of the Fort admitted to collecting and selling tiger salamanders (probably *Ambystoma tigrinum mavortium*) from ponds on the bajada at Fort Huachuca east of the Huachuca Mountains (Jon Snyder, Arizona State University, Tempe, pers. comm. 1998). Effects

of collection, sale, and use of salamanders by anglers, and effects of other such illegal activities are considered interrelated and interdependent to the Fort's activities. The Fort has committed to conservation measures to reduce human disturbance to the salamander. These measures include placing boulders around the pond to prevent vehicles from accessing the pond, placing a sign at the pond to make recreational users aware of that there is no fishing in upper Garden Canyon Pond and that it is illegal to collect, transport or release salamanders on the installation.

Tiger salamanders are commonly moved among sites by anglers and bait collectors. Illegal transport and introductions of salamanders in the San Rafael Valley were documented by Collins and Jones (1987), and as noted above, illegal collection and sale of salamanders has occurred at Fort Huachuca. Salamanders could be collected from upper Garden Canyon Pond by bait collectors. The relatively clear water in the pond facilitates detection and collection. If salamanders were transported to the upper Garden Canyon Pond from ponds elsewhere at Fort Huachuca or from other locales east of the Huachuca Mountains, these salamanders would likely be *Ambystoma tigrinum mavortium*; which could genetically swamp *A. t. stebbinsi* at upper Garden Canyon Pond and could potentially move down Scotia Canyon to other salamander localities. Transport of salamanders among ponds could also spread the iridovirus that regularly decimates populations in the San Rafael Valley. The disease could also be spread by anglers via waders, tackle or other equipment used at a pond where the disease is present and then using that same wet or muddy equipment at upper Garden Canyon Pond.

With the implementation of conservation measures discussed below, the likelihood of salamander collecting, intentional or unintentional stocking of fish or salamanders at upper Garden Canyon Pond, and that spread of disease to the pond by anglers, is probably low. Conservation measures include: 1) transport and release of live salamanders and fish are illegal at Fort Huachuca, thus these activities probably occur infrequently; and 2) fisherman are required to obtain a Fort Huachuca fishing permit and permitted individuals are given a fact sheet that clearly states the capture, transport, or release of live salamanders is strictly prohibited and live fish may not be transported or used as bait on Fort Huachuca. If fish were illegally introduced to upper Garden Canyon Pond, periodic drying of the pond would eliminate them, but perhaps not before the fish had eliminated the aquatic salamanders.

Cumulative Effects

Cumulative effects are those adverse effects of future non-Federal (State, local government, and private) actions that are reasonably certain to occur in the project area. Much of the land in the project area is managed by Federal agencies, particularly the CNF, Fort Huachuca, and Coronado National Memorial. However, several of the known occupied breeding localities are located on private lands to the west of Fort Huachuca, and others are likely to occur on private lands because only the Federal lands have been surveyed extensively. These private lands are used primarily for grazing, but potentially could be subdivided and developed as ranchettes, or used for other purposes. Compliance with the Act for activities on private lands that may affect the Sonora tiger salamander, but are not addressed by Section 7 consultation, could occur through Section 10(a)(1)(B) of the Act.

The Fort has proposed substantial measures that should eliminate or reduce the adverse effects of the proposed action on the salamander. The threat of wildfire is expected to be reduced through a comprehensive fire management plan that calls for prescribed fire and reduction of fuel loads. Human disturbance will be addressed by those measures discussed above and listed under salamander conservation measures in Section 5.

Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect and are likely to adversely affect the Sonora tiger salamander.

4.10.6 YELLOW-BILLED CUCKOO

Potential threats to the cuckoo from the proposed action include fire, erosion, human disturbance and groundwater use.

The yellow-billed cuckoo (YBCU) occurs in the Apache- Sitgreaves, Coconino, Coronado, Prescott, and Tonto National Forests of Arizona. The species has been found at Cienega Creek, Arivaca Creek, the San Pedro River, the Tanque Verde Wash, Rincon Creek, and Green Valley, Sahurarit, Bill Williams River, Havasu, Buenos Aires and Imperial NWRs of Arizona. They have been recorded as rare transients in Saguaro National Park and documented at Picacho State Recreation Area. YBCU has been extirpated from most lower elevation localities and most of the Santa Cruz River in Pima County (Corman and Magill 2000). In 2001, thirty-six individuals, paired and single, were detected while surveyors were conducting southwestern willow flycatcher surveys on the San Pedro River within the SPRNCA (EEC 2001c). The SPRNCA has previously been documented as having the highest concentration of breeding YBCU in the state of Arizona, and throughout the southwestern United States (EEC 2001c). In September 2001, a single male YBCU was detected calling while EEC biologist was conducting habitat evaluation for Huachuca water umbel at Middle Garden Canyon Pond on Fort Huachuca (Kirchner, personal observation 2001).

Effects of Groundwater Use

Portions of the effects of groundwater use for the Huachuca water umbel and southwestern willow flycatcher are included here by reference. The following conclusions are drawn from that discussion:

1. Annual low flows have declined on the upper San Pedro River at the Charleston and Palominas gages since 1942 or earlier (Koehler and Ball 1998, Corell *et. al.* 1996, Jackson *et. al.* 1987, Geraghty and Miller, Inc. 1995). From 1987-1994, low flows or periods of no flow became more frequent on the San Pedro River at Hereford, Charleston Bridge, and Fairbank. Inflows below Lewis Springs are diminished as a percentage of flows at Charleston gage (Sharma *et. al.* 1997). Groundwater declines of three to six feet have occurred at Palominas and Contention, respectively, since 1987 (ADWR 1994).

2. Groundwater decline is reducing recruitment of cottonwoods, resulting in a loss of obligate and facultative wetland plants, saltcedar is apparently replacing cottonwood

on young floodplains at Contention (ADWR 1994), and during July, 1997, the river just north of the Charleston Narrows was dry and cottonwoods there were stressed, apparently due to lack of water (SAIC 1998b).

3. Currently, groundwater use in the Sierra Vista subwatershed exceeds supply by roughly 5,144 ac-ft per year. As a result of groundwater overdraft, a cone or cones of depression in the groundwater aquifer have formed that are approximately 7.5 square miles in size and up to 90 feet deep. The cone(s) of depression has probably not reversed the flow of groundwater to the San Pedro River, but it captures mountain front recharge that otherwise would flow to the river and has likely reduced the hydraulic head adjacent to the river (Fenske 1998, ASL 1995, ADWR 1991, 1994). The cone of depression has affected flow patterns in the Babocomari River in the vicinity of northern Huachuca City and the Fort, where baseflow is severely depleted or absent during the dry season (Schwartzman 1990).

4. Possible causes of observed declines in base flow on the San Pedro River include: 1) changes in runoff from the watershed due to changes in watershed condition; 2) influences of near-stream groundwater pumping for agricultural purposes; 3) changes in water use in Mexico; 4) changes in riparian vegetation along the river; and 5) groundwater pumping from the regional aquifer (ASL 1994, Jackson *et. al.* 1987). Jackson *et. al.* (1987), Sharma *et. al.* (1997), and MacNish (1998) believe that groundwater pumping outside of the SPRNCA, particularly in the Hereford/Palominas area, is the most important causal factor in observed declines in baseflow. The San Pedro Expert Study Team (1999) believe the Fort Huachuca/Sierra Vista cone of depression began reducing the hydraulic head at the river in the 1960s or 1970s; while MacNish (1998) believes that base flow in the Lewis Springs to Charleston reach began declining due to the cone of depression about 1990. The importance of the Fort Huachuca/Sierra Vista cone of depression as a causal factor in current observed base flow declines is uncertain (Koehler and Ball 1998, Fenske 1998, ASL 1994, ADWR 1991); however, modeling by W&EST, Inc. (1996) suggested municipal and military users were only responsible for 6% of the historic loss of river flow through 1988.

5. Groundwater modeling efforts suggest that if groundwater pumping in the Fort Huachuca/Sierra Vista area has not yet significantly affected flows, it is predicted to do so in the future unless those effects are mitigated. Reaches of the San Pedro River could become intermittent where perennial flows now occur, and groundwater elevation under the river could decline (Table 5, page 80). The reach from Charleston north past the Babocomari confluence is most at risk, followed by the reach from Highway 90 to Charleston. Because of a clay deposit under at least some portions of the river, future changes in baseflow in the reach from Hereford to Highway 90 will probably be linked more to the future of irrigated agriculture in that area than effects of the Fort Huachuca/Sierra Vista cone of depression. In the absence of a concerted effort to reverse current trends, the most likely future scenario is one of continued water use in excess of supply, continued enlargement of the cone of depression under Fort Huachuca and Sierra Vista, and in time dewatering of portions of the San Pedro

River in the Sierra Vista subwatershed. In the long-term, if the cone of depression continues to grow, base flows and groundwater elevation under the San Pedro River are expected to decline, with associated loss of wetland and riparian vegetation and changes in species composition (see Table 3, ADWR 1994, Stromberg *et. al.* 1996).

6. Many viable water management options exist to offset the effects of groundwater withdrawals, and many have been implemented or are in the planning stages.

In time, if unmitigated groundwater withdrawals continue to exceed supply, groundwater elevation and baseflow are expected to decline enough to eliminate surface flow except during storm runoff, eliminate recruitment of cottonwood, willow, and saltcedar, and ultimately result in the death of obligate wetland plants (ADWR 1994, Stromberg *et. al.* 1996). Cottonwoods and willows typically do not grow where groundwater is deeper than about 8 feet (Anderson 1995). If groundwater declines of this magnitude occurred, mortality of cottonwoods and willows would be expected. Cuckoo habitat could be eliminated under this scenario. Similar loss of cottonwood and willow riparian habitat has occurred on the upper Santa Cruz River as a result of declining groundwater elevation (Stromberg *et. al.* 1996.)

However, groundwater use in the Sierra Vista subwatershed will not go unmitigated and a concerted effort will be made to reduce or eliminate potential effects to the cuckoo. With respect to groundwater usage, Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with its proposed action by 2011. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well. In the near-term, successful implementation of the Sierra Vista effluent recharge project will assist in this effort and prevent any potential near-term effects to river base flow. These combined efforts will help to maintain base flows in the upper San Pedro River sufficient to sustain cuckoo populations and habitat.

Effects of Human Disturbance

The Fort maintains 22 ASA sites within or on the boundaries of the SPRNCA (Figure 3, page 10). As described in Section 2, ASA sites are where the capabilities of electronic systems are tested. ASA sites are located along road shoulders or previously disturbed sites. At each site typically one or two vehicles and four to six personnel would be deployed for no more than 11 days. Occasional exercises involve up to 20 vehicles, 50 support personnel, and 60 to 70 students. Vehicles sometimes are mounted with large antennae, or ground-mounted antennae up to 80 feet in height are erected. Sites are located adjacent to the San Pedro River at the Charleston Road and the Highway 82 and 90 crossings. If cuckoos nest immediately adjacent to ASA sites, the birds could be disturbed by training activities, particularly during an exercise involving many vehicles and personnel. Cigarettes discarded by personnel could potentially cause a fire and destruction of cuckoo habitat. Although unlikely, cuckoos could also potentially fly into an antennae and be killed or injured. These effects are reduced by the Fort's commitment to conservation measures for the flycatcher. These include not using ASA sites within 300 feet of southwestern willow flycatcher habitat from April 1 to September 1 of each year and to take

precautions at ASA sites adjacent to suitable habitat, but farther than 300 feet, to minimize the chance that a fire occurs (Section 5).

For cuckoo populations that occur on the installation, whether at middle Garden Pond or elsewhere, the Fort will reduce any potential human disturbance by implementing conservation measures that are in place for other species (see Section 5). There is the potential for a cuckoo to collide with a vehicle, antennae or other device, but this is unlikely since little training activity occurs in or in close proximity to suitable cuckoo breeding habitat on the installation.

Effects of Fire

As discussed for the southwestern willow flycatcher, fires are infrequently ignited on the East Range as a result of training (Figure 24, page 167). Area Zulu is a live fire impact area where fires could ignite from ordnance delivery. However, fires on the East Range are typically small and fire breaks around Impact Area Zulu and on the eastern boundary of the installation make it highly unlikely that a fire ignited on the East Range would spread to the San Pedro River. Live munitions could also conceivably stray off course into the SPRNCA and start a fire. However, fires have never spread from the East Range to the San Pedro River, and fires have never been ignited on the San Pedro due to stray weapons fire. The chance of these events occurring during the life of the project is remote. Chances of fire spreading from the northwestern boundary of the installation to the Babocomari Cienega is also unlikely due to the presence of Chihuahuan Desert scrub containing little fuel to carry fire between the installation boundary and the cienega.

The on-post fire conservation measures identified in Section 5 should be adequate to reduce any effects to cuckoo populations in middle Garden Canyon Pond or elsewhere on the installation where the cuckoos may occur.

Effects of Erosion

The watershed condition on the East Range is degraded in a band, approximately two to three miles in width, that runs across the range from the northwest to the southeast. Degraded watersheds can cause increased surface runoff and sediment transport, and decreased infiltration of precipitation (Belsky and Blumenthal 1997, DeBano and Schmidt 1989, Gifford and Hawkins 1979). Potentially, degraded watershed conditions on the East Range could result in higher peak flows, lower low flows, and sedimentation or erosion of the San Pedro and Babocomari rivers. Such conditions could potentially lead to scouring of riparian vegetation or reduced flows during cuckoo breeding activity. However, studies by the Environment and Natural Resources Division at Fort Huachuca (ENRD 1997) indicate that most sediment eroded from the East Range is deposited along the east boundary and does not reach the San Pedro or Babocomari rivers. The lower-elevation portions of the San Pedro River watershed outside of Fort Huachuca are much degraded due to development, a long history of livestock grazing, and conversion of grasslands to shrublands. The effects of watershed degradation on the East Range are probably largely masked by these regional watershed problems along the San Pedro River. Fort Huachuca is committed to number of erosion conservation measures to reduce the affect of erosion on umbel and flycatcher populations (Section 5). These measures should be adequate to reduce any erosion effects to the cuckoo. These measures include no off road vehicle travel on the installation and

implementation of the East Range Watershed Improvement Plan which includes activities such as revegetation, installation of structures to slow erosion and trap sediment, placement of waterbars along roads, and closure of unneeded roads.

The Fort is committed to a number of conservation measures that will reduce or eliminate the potential adverse effects of fire, groundwater use, erosion and human disturbance on cuckoo populations in the SPRNCA and on Fort Huachuca. With these in place, ongoing and programmed future military operations and activities at Fort Huachuca may affect and are likely to adversely affect the cuckoo.

4.10.7 HUACHUCA SPRINGSNAIL

Potential impacts to the Huachuca springsnail from the proposed action include fire and human disturbance.

The springsnail is found in springs or within a few meters of springs located in southern Santa Cruz and Cochise counties as well as northern Sonora, Mexico. It has been collected from nine sites in the upper San Pedro River drainage (Huachuca Mountains, Canelo Hills, and San Rafael Valley), and four sites in the upper Santa Cruz River drainage (Sonoita Creek drainage, San Rafael Valley, Santa Cruz River drainage). In 1992, 16 areas with potential habitat were surveyed on Fort Huachuca and nine populations were located. These include three populations in Garden Canyon, one in McClure Canyon, one at Cave Spring, one at Sawmill Spring, two in Huachuca Canyon and one in Blacktail Canyon (Landye 1993).

Effects of Human Disturbance

Recreational activities have the potential to adversely affect springsnail populations. This includes vehicle use, incidental human-caused fire and disturbance through trampling of populations. A hiking trail passes by the population at Sawmill Spring. Limited trampling by recreational users likely occurs at this locality, but is not considered a serious threat to this population. Most other populations of springsnail occur in remote areas that are relatively difficult to access on foot or by vehicle. For this reason, they receive less recreational use, and trampling and damage by vehicles are less likely to occur in these areas.

Although spring development and spring water diversion are general threats to the species, on Fort Huachuca these threats are not an issue. The Fort has removed all spring water uses and there are no plans to develop any springs in the near future. However, there is the possibility of the Fort using spring water in the event of an emergency, such as a catastrophic fire, but this is unlikely to occur and would occur only on a very infrequent basis.

Military training and testing are limited in the canyons of the Huachuca Mountains and seldom occur in known springsnail locales. Therefore, it is unlikely that military training and testing will have an adverse affect on springsnail populations.

Effects of Fire

Fire is the greatest threat to the Huachuca springsnail populations in the Huachuca Mountains. This includes fires ignited by recreational users, prescribed fire, managed natural fires, fire suppression activities, and the indirect effects of a large fire event.

Degradation of watershed condition immediately after fires can result in a dramatic increase of runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). In degraded watersheds, less precipitation is captured and stored, thus perennial aquatic systems downstream may become ephemeral during dry seasons or drought (Rinne and Neary 1996). These conditions could result in the decline or extirpation of springsnail populations in the canyons on the installation, or in adjacent off-post canyons that might be affected by fire on Fort Huachuca. Fires could be intentionally ignited (prescribed fire or arson) or ignition could result from lightning strikes or unintended human ignition such as campfires, cigarettes, or ordnance. Fires associated with campfires or cigarettes are most likely to occur along roadways or at campgrounds and picnic sites. Fire ignited by ordnance could potentially reach the springsnail populations and adversely affect habitat. Even non-explosive ordnance could result in fire if it landed or skipped on rocks, causing sparks.

Fires have been few or absent in the higher elevations where many springsnail populations occur (Figure 24, page 167). Although fires at high elevation are infrequent, recent high intensity crown fires at high elevation to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire in 1983), combined with high fuel loads in some areas of Fort Huachuca (Danzer 1997), suggest that a stand-replacing fire could potentially occur at Fort Huachuca during the life of the project.

General Wildlife Services (1999) suggest that Garden Canyon "is perhaps primed for a catastrophic fire that could lead to major erosion and debris flow on the mid-elevations of the watershed and possible flooding and channel scouring in the lower drainage." They note that there have been no recent fires on the Garden Canyon watershed, fuels are relatively dense, the watershed probably has a deep "regolith" available for debris flow, and the watershed is large enough to collect a sizable runoff from a major storm event.

The Fort is committed to initiating prescribed fires and fuel management in the Huachuca Mountains as well as numerous fire conservation measures (see Section 5). A Fire Management Plan has been drafted (Robinett *et. al.* 1997) that provides a planning framework for reducing the risk of catastrophic stand-replacing fires. Over time, this effort should significantly reduce the threats to springsnail populations and habitat due to possible erosion, scouring, and sedimentation following a severe wildfire. The risk of a stand-replacing fire that burns over a large area is also reduced due to a network of fire breaks that the Fort maintains.

Although active fire suppression is critical to reduce damage from wildfire, suppression activities can adversely affect the springsnail. Decisions made during fire suppression can affect the degree and intensity of fire effects, and the type and location of suppression activities could directly or indirectly affect springsnail habitat. Use of heavy equipment, such as tracked vehicles, to cut fire lines or reduce fuels could destroy habitat, cause erosion, or create new routes of travel that may

lead to increased access and recreational impacts. However, the Fort is committed to making the protection of listed species an objective of fire suppression. This includes minimizing off-road vehicle use during fire suppression activities (including tracked vehicles), requiring a resource advisor on-site during all fires to advise the fire boss of species issues, and minimizing disturbance to locations outside of areas important for the springsnail whenever possible.

The Fort's conservation measures should reduce adverse effects to the springsnail.
Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect and are likely to adversely affect the Huachuca springsnail.

4.10.8 RAMSEY CANYON LEOPARD FROG

Potential threats to the Ramsey Canyon leopard frog from the proposed action include fire, human disturbance and erosion.

The Ramsey Canyon leopard frog is limited to artificial ponds in Brown, Ramsey, Miller and Tinker canyons within a 6 km (3.7 miles) radius on the east slope of the Huachuca Mountains (AGFD 1995). On Fort Huachuca, the Ramsey Canyon leopard frog is known from one site (Tinker Pond) that occurs in Tinker Canyon. The frog is currently being managed under a conservation agreement between Fort Huachuca, USFWS, AGFD, USFS, and a private landowner.

Effects of Fire

The effects of fire on the Ramsey Canyon leopard frog are similar to those discussed for the Sonora tiger salamander and are summarized below.
Fire and fire-related activities associated with the proposed action with the potential to adversely affect the frog include fires ignited by recreational users, vehicles, and prescribed fire, managed natural fire and fire suppression activities.

Fire could potentially result in direct death or injury of salamanders, and reduced habitat quality or quantity. Degradation of watershed condition immediately after fires results in dramatically increased runoff, sedimentation, and debris flow that can scour aquatic habitats in canyon bottoms or bury them in debris (DeBano and Neary 1996). Fire, whether ignited by a natural or human-caused source, could result in degradation of the immediate watershed around a pond, but could also result in ash flow and smoke diffusion into the pond with deleterious effects to the frog. Siltation of a pond due to erosion and runoff following a fire could eliminate habitat. In addition, it could stress frog populations and make them more susceptible to a disease outbreak.

Fire effects could occur on or off of Fort Huachuca. A wildfire or prescribed or managed natural fire that escapes prescription could potentially burn off post and affect Ramsey Canyon leopard frog populations and habitat. The chance of a large regional fire resulting from an ignition at Fort Huachuca during the life of the project is probably low, but high fuel loads in portions of the Huachuca Mountains on post (Danzer *et. al.* 1997) and recent large stand-replacing fires in the Huachuca Mountains to the south of Fort Huachuca (Carr Peak fire in 1977, Pat Scott Peak fire

in 1983) suggest that such a fire is possible. The Fort has committed to implementing prescribed fire and fuels management to reduce the risk of fire (see Section 5).

Fire suppression activities could also affect frog populations or their habitat. Most importantly, during fire suppression helicopters are sometimes used to scoop water from ponds or lakes and then drop that water on the fire. Ponds that are depleted from such operations are often refilled from a nearby large lake or reservoir. Because of the location of Tinker Pond at Fort Huachuca and its small size, it is unlikely that a helicopter would attempt to take water from it for fire suppression. However, if that was done, Ramsey Canyon leopard frogs could be scooped out of the pond and dropped on the fire. If the pond was refilled from Parker Canyon Lake or one of the impoundments on the Fort, nonnative predaceous fish, bullfrog tadpoles, or other nonnative species could be introduced into the pond with deleterious effects.

Effects of Human Disturbance

Under current conditions, recreational activities have the potential to adversely affect this species due to incidental capture of individuals, driving through or next to the pond, and the accidental introduction of bullfrogs or other organisms into the pond.

There are 16 ponds (approximately 32 acres) located on Fort Huachuca. Seven of these ponds are stocked with trout if water conditions are favorable (Table 2, page 29), and some ponds are known to contain bass, sunfish, catfish, bullfrogs and/or crayfish. In Arizona, anglers commonly move fish among aquatic sites, either to create new fishing opportunities, or by use of baitfish. The introduction of sunfish, bass, mosquito fish, or catfish could result in the elimination of Ramsey Canyon leopard frogs from Tinker Pond.

The Fort has committed to conservation measures to reduce human disturbance to the frog, to include being a signatory to the Ramsey Canyon leopard frog conservation agreement. These measures include placing boulders around the pond to prevent vehicles from accessing the pond, placing a sign at the pond to make recreational users aware of that there is no fishing in Tinker Pond and that it is illegal to collect or release any plants or animals on the installation.

Effects of Erosion

Increased sedimentation that may result from a large storm event could have an adverse effect on the Ramsey Canyon leopard frog and its habitat. As discussed in the salamander section, this increase in sedimentation could have deleterious effects by causing additional stress that might make it more susceptible to disease. Watershed improvement conservation measures identified in Section 5 would help reduce the potential for adverse effects to the Ramsey Canyon leopard frog.

Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect and are likely to adversely affect the Ramsey Canyon leopard frog.

4.10.9 SPIKEDACE

Potential threats to the spikedace and its critical habitat include fire, erosion, human disturbance and groundwater use.

Historically, the spikedace is endemic to the Gila River basin of New Mexico, Arizona, and Sonora, Mexico below 1,828m (6000 ft)(SFB 1996). Spikedace are currently known only from Aravaipa Creek (Graham and Pinal Counties, Arizona), the upper Gila River (Grant and Catron Counties, New Mexico), the middle Gila River (Pinal County, Arizona), Eagle Creek (Greenlee County, Arizona), and the Verde River (Yavapai County, Arizona) (Barber and Minckley 1966, Minckley 1973, Anderson 1978, Barrett *et. al.* 1985, Bestgen 1985, Marsh *et. al.* 1990, Sublette *et. al.* 1990, Jakle 1992, Knowles 1994). The Aravaipa Creek population is the only extant population in the San Pedro River basin (NMDGF 1996). This fish has otherwise been extirpated from the mainstream of the San Pedro River and its tributaries (SFB 1996; BLM 1989). Although the species is currently extirpated from the San Pedro River, the upper San Pedro River is considered important recovery habitat for the spikedace.

Effects of Groundwater Use

The Fort's proposed action does not include activities on Aravaipa Creek or at other spikedace localities, thus no direct effects to the species would occur. As discussed in the southwestern willow flycatcher section, the upper and lower reaches of the San Pedro River are hydrologically connected, so that effects in the upper basin could potentially affect flows and riparian habitat in the lower basin. If groundwater pumping attributable to the Fort caused a reduction in flows on the lower San Pedro River, the spikedace could potentially be adversely affected. This possibility was examined in the flycatcher section. In that discussion, we concluded that groundwater pumping in the upper basin would not significantly affect flows in the lower basin for the following reasons: 1) flood flows are not affected by groundwater pumping; 2) the water budget prepared by ADWR (1991) estimates that no groundwater inflow occurs into the Benson subwatershed from the Sierra Vista subwatershed; and 3) groundwater inflow across subwatershed boundaries in the lower San Pedro River is insignificant (ADWR 1991).

Groundwater flow between subwatersheds might be greater if water use did not exceed water supply in the Sierra Vista subwatershed, but because of the presence of a cone of depression, it is unlikely that any increased water supply would result in significant increases in subwatershed outflow. Even if the entire deficit (5,144 acre feet) was discharged as outflow from the subwatershed, this would only account for approximately 15% of the water supply in the Benson subwatershed. How much of this outflow might reach the river downstream of the Aravaipa confluence where spikedace are most likely to occur is unknown. The reach downstream of the Aravaipa confluence is in the Winkelman subwatershed immediately upstream of the Gila confluence. Annual water supply to the Winkelman subwatershed is 73,760 ac-ft, of which only 150 ac-ft is groundwater inflow from upstream (ADWR 1991). Although the effects of groundwater pumping in the Sierra Vista subwatershed on potential downstream spikedace habitat are uncertain, the best information available suggests that currently these effects are probably small or negligible. Effects of future groundwater pumping are predicted to be insignificant because baseflow into the subwatershed where spikedace may occur is very small.

Moreover, by implementing Fort Huachuca's conservation measures, water usage will continue to decline to zero by the year 2011.

As discussed for the Huachuca water umbel and the southwestern willow flycatcher, if unmitigated groundwater pumping by Fort Huachuca and other water users in the Sierra Vista subwatershed is in excess of supply, it will eventually lead to de-watering of all or portions of the upper San Pedro River and loss of recovery habitat and opportunities for the spikedace (see Huachuca water umbel section for detailed discussion). However, groundwater use in the subwatershed will not go unmitigated. With respect to groundwater usage Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with its proposed action by 2011. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well. It is expected that implementation of Fort Huachuca water conservation measures and regional water resources planning and implementation efforts will be successful in mitigating any potential adverse effects to the River and spikedace recovery habitat.

Effects to Critical Habitat

A total of 807 miles of rivers and creeks are designated critical habitat in the middle and upper Gila River basin of Arizona and New Mexico. This designation includes occupied and unoccupied habitat that is essential for the recovery of the species. Critical habitat includes the stream channels within the identified stream reaches and areas within these reaches potentially inundated by high flow events (i.e.100-year floodplain) (50 CFR 17). This critical habitat designation includes 37 miles of the upper San Pedro River from the Babocomari River confluence south to the international boundary.

Critical habitat is defined in Section 3(5)(A) of the Act as:

1. The specific areas within the geographic area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features:

    a. essential to the conservation of the species, and

    b. that may require special management considerations or protection;

2. Specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.

The primary constituent elements identified in the final rule as necessary for the survival and recovery of the spikedace include:

1. Permanent, flowing unpolluted water

2. Living areas for adult spikedace with slow to swift flow velocities in shallow water with shear zones where rapid flow borders slower flow, areas of sheet flow at the upper ends of mid-channel sand/gravel bars, and eddies at downstream riffle edges

3. Living areas for juvenile spikedace with slow to moderate flow velocities in shallow water with moderate amounts of instream cover

4. Living areas for larval spikedace with slow to moderate flow velocities in shallow water with abundant instream cover

5. Sand, gravel, and cobble substrates with low to moderate amounts of fine sediment and substrate embeddedness

6. Pool, riffle, run, and backwater components present in the aquatic habitat

7. Low stream gradient

8. Water temperatures in the approximate range of 1-30 degrees Celsius (35-85 degrees Fahrenheit), with natural diurnal and seasonal variation

9. Abundant aquatic insect food base

10. Periodic natural flooding

11. A natural, unregulated hydrograph or, if the flows are modified or regulated, then a hydrograph that demonstrates an ability to support a native fish community

12. Habitat devoid of nonnative aquatic species detrimental to spikedace, or habitat in which detrimental nonnative species are at levels which allow persistence of spikedace.

As discussed previously, without a concerted effort to mitigate the impacts of groundwater pumping, dewatering and loss of riparian vegetation is possible on portions of the San Pedro River, to include the 37 miles of spikedace critical habitat. The habitat north of Charleston, particularly near the Babocomari confluence, is most at risk, followed by the reach from Highway 90 to Charleston. Evidence suggests that dewatering is already occurring, although the cause is unclear (San Pedro Expert Study Team 1999, Koehler and Ball 1998, Pool *et. al.* 1998, MacNish 1998, SAIC 1998b, Fenske 1998, Sharma *et. al.* 1997, W&EST, Inc. 1996, ADWR 1994, ASL 1994). Of particular concern is the potential for agricultural development near the river, which could result in dewatering the portion of critical habitat on the San Pedro River from Hereford to Highway 90.

However, groundwater use in the Sierra Vista subwatershed will not go unmitigated and a concerted effort will be made. With respect to groundwater usage, Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with its proposed action by 2011. More importantly, Fort Huachuca will request that the communities

and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011. In the near-term, successful implementation of the Sierra Vista effluent recharge project will assist in this effort and prevent any potential near-term effects to River base flow.

With this commitment to long-term involvement in the resolution of regional groundwater deficit, groundwater use in the region may affect, but is not likely to adversely affect the spikedace and its critical habitat.

Effects of Fire

Wildfire ignited by recreational users or ordnance, prescribed fire, and fire suppression activities could result in direct effects to spikedace critical habitat. Indirect effects could also occur from these activities, particularly as a result of watershed degradation and subsequent erosion, sedimentation, and changes in stream hydrology. Wildfire on the East Range could escape fire suppression measures and spread into the SPRNCA; however, the probability of this occurring is low. Fires started on the East Range are infrequent and there are no records of fires spreading to the SPRNCA. In addition, if a fire did start in the East Range, it would not likely spread far because of low fuel loads in the Chihuahua desert shrub habitat.

Effects of Erosion

Erosion within the East Range is the highest on the installation, with sheet and rill erosion within the central portion of the range the most significant. Through analysis and field observation, the majority of sediment from areas within the central zone of the East Range is deposited within the respective stream channels on the installation (ENRD 1997). These findings suggest that, while significant erosion and sediment transfer continue to occur across the East Range, the extent of deposition is predominantly limited to areas within Fort Huachuca and not in the adjacent SPRNCA.

Fort Huachuca conservation measures would improve degraded watershed conditions on the East Range and address fire and groundwater threats to the species and its critical habitat (see Section 5).

Overall, ongoing and programmed future military operations and activities at and near Fort Huachuca, to include groundwater usage, may affect, but are not likely to adversely affect the spikedace or its designated critical habitat.

4.10.10 LOACH MINNOW

Historic range of the loach minnow included the basins of the Verde, Salt, San Pedro, San Francisco, and Gila rivers (Minckley 1973, Sublette *et. al.* 1990). Loach minnow are not currently known from Fort Huachuca or the upper San Pedro River basin (Sally Stefferud, pers. comm. 1998); however, the species occurred in the river historically (BLM 1998). Within the San Pedro River watershed, the loach minnow is found in Aravaipa Creek and two tributaries to Aravaipa Creek: Deer Creek (Hell Hole) and Turkey Creek. Although the loach minnow is not

present within the proposed action area, the recovery plan for the loach minnow (USFWS 1990b) recommends reintroducing this species within its historical range, including perennial reaches of the San Pedro River and Babocomari Rivers.

Potential threats to loach minnows include fire, erosion, and groundwater use.

Effects of the proposed action on loach minnow are similar to those described for the spikedace, except that loach minnow is not currently suspected to occur in the lower San Pedro River. Thus, any possible effects would be to critical habitat; and as described for the spikedace, the only potential effects would be in the upper San Pedro River.

If unmitigated groundwater pumping by Fort Huachuca and other water users in the Sierra Vista subwatershed continues in excess of supply, it will eventually lead to dewatering of all or portions of the upper San Pedro River and loss of recovery habitat (see Huachuca water umbel section for detailed discussion). However, groundwater use in the subwatershed will not go unmitigated. With respect to groundwater usage, Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with its proposed action by 2011. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

Effects to Critical Habitat

Critical habitat was designated for the loach minnow on May 25, 2000. This designation included 898 miles of rivers and creeks to include reaches located in the middle and upper Gila River basin of Arizona and New Mexico. This includes 37 miles of the upper San Pedro River from the Babocomari River confluence south to the international boundary. Critical habitat includes the stream channels within the identified stream reaches and areas within these reaches potentially inundated by high flow events (50 CFR 17, 24327 – 24372).

The primary constituent elements identified in the final rule as necessary for the survival and recovery of the loach minnow include:

1. Permanent, flowing unpolluted water

2. Living areas for adult loach minnow with moderate to swift flow velocities in shallow water with gravel, cobble and rubble substrates

3. Living areas for juvenile loach minnow with moderate to swift flow velocities in shallow water with sand, gravel, cobble and rubble substrates

4. Living areas for larval loach minnow with slow to moderate velocities in shallow water with sand, gravel and cobble substrates and abundant instream cover

5. Spawning areas for loach minnow with slow to swift flow velocities in shallow water with uncemented cobble and rubble substrate

6. Low amounts of fine sediment and substrate embeddedness

7. Riffle, run and backwater components present in the aquatic habitat

8. Low to moderate stream gradient

9. Water temperatures in the approximate range of 1-30 degrees Celsius (35-85 degrees Fahrenheit), with natural diurnal and seasonal variation

10. Abundant aquatic insect food base

11. Periodic natural flooding

12. A natural, unregulated hydrograph or, if the flows are modified or regulated, then a hydrograph that demonstrates an ability to support a native fish community

13. Habitat devoid of nonnative aquatic species detrimental to loach minnow, or habitat in which detrimental nonnative species are at levels which allow persistence of loach minnow.

As discussed previously, without a concerted effort to balance the water budget or otherwise mitigate the impacts of groundwater pumping, dewatering and loss of riparian vegetation is possible on portions of the San Pedro River, to include the 37 miles of loach minnow critical habitat. The habitat north of Charleston, particularly near the Babocomari confluence, is most at risk, followed by the reach from Highway 90 to Charleston. Evidence suggests that dewatering is already occurring, although the cause is unclear (San Pedro Expert Study Team 1999, Koehler and Ball 1998, Pool *et. al.* 1998, MacNish 1998, SAIC 1998b, Fenske 1998, Sharma *et. al.* 1997, W&EST, Inc. 1996, ADWR 1994, ASL 1994). Of particular concern is the potential for agricultural development near the river, which could result in dewatering the portion of critical habitat on the San Pedro River from Hereford to Highway 90.

However, groundwater use in the Sierra Vista subwatershed will not go unmitigated and a concerted effort is underway. With respect to groundwater usage, Fort Huachuca's conservation measures will offset all direct, indirect, interdependent and interrelated effects associated with its proposed action by 2011. More importantly, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011. Fort Huachuca will also continue to contribute vigorous leadership, technical support, funding, and other resources to hasten the success of these efforts .In the near-term, successful implementation of the Sierra Vista effluent recharge project will assist in this effort and should prevent any potential near-term effects to River base flow.

As discussed for the spikedace, fire and erosion may also have adverse effects to loach minnow critical habitat. However, Fort Huachuca’s conservation measures should improve degraded

watershed conditions on the East Range and address fire and groundwater threats to the species and its critical habitat (see Section 5).

Overall, ongoing and programmed future military operations and activities at and near Fort Huachuca, to include groundwater usage, may affect, but are not likely to adversely affect the loach minnow or its designated critical habitat.

4.10.11 CANELO HILLS LADIES' TRESSES

Primary threats to Canelo Hills ladies' tresses are fire and the cumulative effects of groundwater use in the region.

Four of the five populations of Canelo Hills ladies' tresses occur to the west of Fort Huachuca in the San Rafael Valley and Canelo Hills. TNC, USFS (Coronado NF), and private landowners maintain management responsibility for these known populations (Arizona Rare Plant Committee 2002). The fifth population occurs on private land at the Babocomari Cienega, located approximately 1.5 miles north of the northwest corner of Fort Huachuca (Figure 23, page 104).

Effects of Groundwater Use

The potential effects of groundwater use on the Babocomari Cienega were evaluated in the Huachuca water umbel section. Based on available data, it is unlikely that groundwater pumping by Fort Huachuca or Sierra Vista currently affects, or in the future would affect, riparian or wetland habitat at or near the cienega. This conclusion is based on: 1) the cienega being located considerably upstream of wells at Fort Huachuca and the Sierra Vista wells; 2) faulting and geology that suggests that much of the water in the area comes from the Mustang Mountains (Houser 1998); 3) a geological feature that forces groundwater to the surface at this site (ADWR 1991); 4) the fact that the Babocomari River flows from the west; 5) Fort Huachuca will implement conservation measures to offset all water usage associated with direct, indirect, interrelated and interdependent effects; 6) Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects associated with groundwater usage by 2011 as well.

Based on the foregoing analysis, water use attributable to the proposed action may affect, but is not likely to adversely affect the Canelo Hills ladies' tresses.

Effects of Fire

The chance of fire spreading from the northwestern boundary of the installation to the Babocomari Cienega is unlikely because there is little fuel present between the installation boundary and the cienega due to the presence of Chihuahuan Desert scrub habitat and off-post grazing. Also, the Fort's perimeter road and fuel breaks located in Training Area Juliet reduce the likelihood of the spread of fire off the installation. Figure 24 (page 167) shows that areas near the northwestern boundary have burned infrequently from 1973-2002.

Off-post activities, such as ASA sites are not located adjacent to Canelo Hills ladies' tresses localities. UAVs or other aircraft could potentially crash at a locality, but the chances of this occurring during the life of the project is remote.

With the implementation of Fort Huachuca's water and fire conservation measures, any potential adverse effects to Canelo Hills ladies' tresses or its habitat are unlikely. Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect, but are not likely to adversely affect the Canelo Hills ladies' tresses.

4.10.12 BALD EAGLE

A potential threat to the bald eagle from the proposed action is direct mortality.

The bald eagle does not nest in southern Arizona, and is generally not present during summer months. Consistent wintering areas have not been documented in southeastern Arizona during statewide, yearly winter surveys (Beatty 1997b). However, in southeastern Arizona, the species is known to occur in winter in the Sulphur Springs Valley and has been observed at Parker Canyon Lake. No suitable nesting habitat or habitat for congregations of wintering birds exists on Fort Huachuca.

Because the bald eagle is only a transient visitor to Fort Huachuca during the winter months, direct mortality is unlikely. A bald eagle could collide with the Bergey wind turbine on the West Range or possibly with a vehicle, wind data tower or other man-made structure, but the possibility is low. If direct mortality of a bald eagle is detected, the Fort will enter into formal consultation.

Overall, current and programmed future activities at Fort Huachuca may affect, but are not likely to adversely affect the bald eagle.

4.10.13 JAGUAR

A potential threat to the jaguar from the proposed action is fire.

The current range of the jaguar is the southern areas of central Mexico, central America, and northern Argentina (USFWS 1997c). Currently, there is no known resident population of jaguars in the US (USFWS 1997c). In Arizona, transient jaguars are occasionally observed. These observations may be evidence that the jaguar is becoming more abundant within its historical range. Because jaguars use a wide variety of habitat types and regional jaguar sightings are rare, the probability of jaguars occurring within Fort Huachuca is low.

Although no confirmed sighting of a jaguar have occurred on Fort Huachuca, the availability of suitable jaguar habitat in the Huachuca Mountains suggests that the species may occur on the installation in the future if regional jaguar populations recover. Suitable habitat includes approximately 23,300 acres of oak-grass savanna, oak woodlands, mixed woodlands, mahogany woodlands, and conifer woodlands on the South and West Ranges. Proposed construction activities would not disturb these habitat types. Few operational activities take place in these

areas; thus the potential for direct mortality would be limited to collisions with operational vehicles that infrequently travel these areas, or with RVs which utilize the canyons. Recreational activity is not permitted beyond the cantonment area at night, when jaguars are most active, so the overall risk of jaguars colliding with vehicles would be negligible.

Suitable habitat for the jaguar could potentially be affected by wildland fire, prescribed fire or managed natural fire. Such fires could result in loss of foraging or denning habitat. However, with the Fort's commitment to fire prevention, prescribed burning and fire suppression procedures outlined in Section 5, particularly in wooded habitat, the potential for fire to adversely affect the jaguar and its habitat is reduced.

Overall, ongoing and programmed future military operations and activities at Fort Huachuca may affect, but are not likely adversely affect the jaguar.

4.10.14 CHIRICAHUA LEOPARD FROG

The Chiricahua leopard frog has two separate ranges: the montane portions of the Mogollon Rim extending into New Mexico; and the southeast montane regions of Arizona and adjacent Sonora, Mexico (Platz and Mecham 1979). The frog is known from 231 sites in Arizona, 182 sites in New Mexico and 12 or 13 sites in Mexico. This species was not located on Fort Huachuca during surveys conducted by AGFD in 1996.

Potential habitat exists on the South and West Ranges for the Chiricahua leopard frog, but the frog is not known to occur on Fort Huachuca. If populations of the frog were found on the Fort in the future, they would be subject to those threats already discussed for the Ramsey Canyon leopard frog (i.e. fire, human disturbance and erosion). Those conservation measures identified for the Ramsey Canyon leopard frog would reduce potential adverse effects to the Chiricahua leopard frog as well.

In the absence of known populations of the Chiricahua leopard frog, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on the species.

4.10.15 MOUNTAIN PLOVER

The mountain plover is a migratory species that occupies breeding and wintering locales. Breeding occurs in the Rocky Mountain States from Canada south to Mexico. Most wintering occurs in California with fewer birds found in Arizona, Texas, and Mexico.

This species inhabits short grass prairie habitats and is often associated with heavily grazed sites or man-made landscapes, such as cultivated fields and agricultural lands. The mountain plover is known to occur locally over a large area of Arizona during the winter. They are consistently reported from the Sulphur Springs Valley during the winter (Davis and Russell 1995, Taylor 1995).

The mountain plover is not known to occur on Fort Huachuca, but potential habitat may exist on the installation. Potential habitat is more likely to occur for the plover on the Willcox Playa, a

property that is withdrawn from public entry and is located in Sulphur Springs Valley. There is the potential for military testing and training activities at Fort Huachuca or the Willcox Playa to affect the plover or its grassland habitat. However, this is unlikely because: 1) military testing and training activities on the Fort typically occur periodically and in regularly sites; 2) military activities at the Playa are infrequent; and 3) the species is not known to occur on the installation, and if it does occur on the installation or the Playa, it occurs infrequently and only during the winter months.

Overall, ongoing and programmed future military operations and activities associated with the proposed action will have no effect on the mountain plover.

4.10.16 OCELOT

The ocelot ranges from northern Argentina to the extreme southern portions of Arizona and Texas (Hoffmeister 1986, USFWS 1990d). The last confirmed ocelot observation in Arizona was in 1964 in the Huachuca Mountains (Girmendonk 1994). Since that time, only a few unconfirmed sightings have occurred. Potential habitat in the area is limited to mesquite woodland vegetation along the Babocomari and San Pedro Rivers, but the density of the vegetation in these areas may be too low to support ocelots (Tewes 1997).

Because ocelots are rare and no confirmed sighting have occurred in over 30 years, the chance of an ocelot occurring on Fort Huachuca or in the region is remote. Therefore, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on the ocelot.

4.10.17 BLACK-TAILED PRAIRIE DOG

Historically, this species is known from Canada to Mexico throughout the Great Plains states and west to southeastern Arizona. The historic range of the black-tailed prairie dog included portions of 11 States, Canada, and Mexico. Today it occurs from extreme south-central Canada to northeastern Mexico and from approximately the 98th meridian west to the Rocky Mountains. The species is currently present in 10 States including—Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.

The black-tail prairie dog was extirpated from Arizona circa 1960. Therefore it is not known or likely to occur on Fort Huachuca or in the region. However, suitable habitat is present on the installation and Fort Huachuca is being considered as a potential reintroduction site for the prairie dog in southeastern Arizona.

Since no black-tailed prairie dogs currently exist in the region, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on the black-tailed prairie dog.

4.10.18 DESERT PUPFISH

Historically, the desert pupfish was once common, but not continuous, below 1,500 m (5,000 ft) in southern Arizona, southeastern California, New Mexico, and Mexico (USFWS 1993). In Arizona, the desert pupfish was once found within the Gila River basin, and probably in lower Colorado, Agua Fria, Hassayampa, and Verde Rivers (USFWS 1993).

Only one indigenous population of desert pupfish exists in Arizona at the Quitobaquito Spring (SFB 1996a). Reintroduction endeavors have been attempted in a number of locations throughout Arizona, including three unsuccessful efforts on Fort Huachuca at the Boston Water Cachement and Kino Springs in 1982, and Buffalo Corral Spring in 1988 (SFB 1996a). No reintroduction efforts have been made within the San Pedro River due to lack of suitable habitat and exotic fish predators (SFB 1996a).

Desert pupfish populations would not be affected by the proposed action because they are not known to exist on Fort Huachuca or in the San Pedro River. Desert pupfish reintroduction efforts at Buffalo Coral and Kino Springs on Fort Huachuca in the 1980s were unsuccessful, and successful future reintroductions are unlikely because of insufficient habitat requirements.

Because the desert pupfish is not known to occur on the Fort or in the San Pedro River, and suitable habitat is lacking, ongoing and programmed future military operations and activities at Fort Huachuca will not affect the desert pupfish.

4.10.19 GILA TOPMINNOW

In Arizona, the Gila topminnow was once common and abundant in the Rio Yaqui basin and the Gila River basin, including the San Pedro River until the mid to late 1970s (BLM 1989).

Reintroduction of the Gila topminnow in Arizona has been successful in restoring populations and establishing new ones in some areas (NMDGF 1996). Since the 1960s, 180 reintroduction of the Gila topminnow have occurred throughout its historic range (AGFD 1996b). Thirty-seven of these reintroduction have occurred on Fort Huachuca, Aravaipa Creek, and Babocomari Creek; all of these reintroduced population have since disappeared (SFB 1996). However, the Gila topminnow now occurs in 11 indigenous localities in southern Arizona (AGFD 1996b). All but a few populations are considered to be in danger of extirpation (SFB 1996).

The Gila topminnow would not be affected by the proposed action because it is not known to occur on Fort Huachuca. Attempts at reintroducing the Gila topminnow at Buffalo Coral and Kino Springs on Fort Huachuca in the 1980s were unsuccessful. Future reintroduction effort on Fort Huachuca are unlikely because of insufficient habitat requirements (i.e. permanent water sources are too cold for the species).

Since the species does not occur in the region and no suitable habitat exists on Fort Huachuca, current and future programmed actions would have no effect on the Gila topminnow.

4.10.20 GILA CHUB

Historically the Gila chub is known from rivers, streams, and stream-fed tributaries in Arizona, New Mexico, and likely in the San Pedro and Santa Cruz River systems in Sonora Mexico.

The Gila chub is currently known from the following drainages: Santa Cruz River, Middle Gila River, San Pedro River (Bass, O'Donnell, and Redfield Canyons, Babocomari River, and Turkey Creek), Agua Fria River and the Verde River.

The Gila chub is not known to presently occur on Fort Huachuca or in the SPRNCA. Potential habitat may be present on Fort Huachuca and the SPRNCA (EEC 2000c); however, since there are no known population of the chub in the region, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on the Gila chub.

4.10.21 WHOOPING CRANE

Historically this species ranged throughout North America but has declined over time to three wild populations and four captive populations (BISON 2002). The current nesting range of the natural wild population is restricted to Wood Buffalo National Park in Canada. In the Rocky Mountains, the whooping crane population includes middle Rio Grande Valley of New Mexico, the lower San Luis Valley of Colorado, and summering areas in southeastern Idaho and western Wyoming. Since, 1975, the range of the Rocky Mountain experimental population of the whooping crane has extended into Idaho, northern New Mexico, northwestern Colorado, southwestern Montana, northeastern Utah, with occasional strays appearing in Arizona and Mexico (Pratt 1996).

This species is known as an accidental species in Arizona, which means it occurs rarely. Since this species is unlikely to occur on Fort Huachuca or in the region, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on the whooping crane.

4.10.22 NORTHERN APLOMADO FALCON

Historically, the northern aplomado falcon was fairly common from southeastern Arizona and southwestern Texas through Guatemala and Nicaragua (Palmer 1988; USFWS 1990c). While the northern aplomado falcon was still breeding within the US in 1952, it disappeared from most of its US range by 1940 (USFWS 1990c).

Reintroduction of aplomado falcons in Texas by The Peregrine Fund, Inc. began in 1985 and continues today, with 104 falcons released through 1995 (TPF 1994).

The USFWS 1990 aplomado falcon recovery plan recommended reintroducing this species to its historic range. This recovery plan proposed several potential release areas within Arizona including Fort Huachuca.

In a 1992 AGFD evaluation of potential release sites in southeastern Arizona, a site on the San Pedro River near Hereford, approximately 12 km (8 miles) from Fort Huachuca, was ranked second of 10 potential reintroduction sites evaluated (Corman 1992). Rankings were based on relative density and diversity of potential prey species; habitat characteristics most closely resembling those of historical use by aplomado falcons in Arizona; and vegetation structure unlikely to hinder the hunting success of released falcons.

Based on the AGFD evaluations in 1992, semidesert grassland and riparian communities on Fort Huachuca have a strong potential to support released or re-colonizing aplomado falcons. The proximity of these habitat types on the East and South Ranges to abundant songbird populations in the SPRNCA suggests that foraging or nesting falcons may occur through much of these areas as aplomado falcon populations recover in the future.

Although aplomado falcons are not known to occur on Fort Huachuca or in the region, potential habitat exists in the open grassland and savanna vegetation types found on the Fort and in the region.

Since the species is not known to occur on Fort Huachuca or in the region, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on the northern aplomado falcon.

4.10.23 LEMMON FLEABANE

Historically its range was thought to include a wider area of Arizona. However, recent taxonomic analysis has indicated that Lemmon fleabane is endemic only to Scheelite Canyon of the South Range of Fort Huachuca in the Huachuca Mountains (Warren *et. al.* 1991b).

In 1991, surveys for Lemmon fleabane located 441 individual plants in Scheelite Canyon on two separate cliff faces between 1,920 and 2,012m (6,300 and 6,600 ft) in elevation. While no plants were found outside of Scheelite Canyon in surveys conducted in 1997, potential habitat may occur in other areas on Fort Huachuca (Warren *et. al.* 1991b, Tandy 1997).

Because Lemmon fleabane occurs in relatively remote and inaccessible cliff habitat, it is largely protected from activities associated with the proposed action. There is a chance that fire or unauthorized rock climbing could have a potential adversely affect to this species, but the chance is remote due to the isolated nature of the cliff habitat and the Fort's commitment to conservation measures for other species. Overall, ongoing and programmed future military operations and activities at Fort Huachuca will have no effect on Lemmon fleabane.

SECTION 5
CONSERVATION MEASURES

5.1 INTRODUCTION

For years, Fort Huachuca has been a recognized leader in environmental conservation and stewardship.[7] Since 1995, the Fort has been studying the impact of its operations within southeastern Arizona, with particular emphasis on addressing any concerns covered by Section 7 of the ESA. To ensure that its operations comply with the ESA, Fort Huachuca has spent millions of dollars in environmental studies, projects, and conservation efforts. The Fort has invested in a broad range of environmental initiatives that are providing remarkable water savings (Fort Huachuca has reduced its on-post water consumption by almost 45% since 1993 – from more the 3,000 ac-ft annually to 1,655 ac-ft in 2001).

Despite the progress made, Fort Huachuca is committed to do more. As detailed in Section 3, Fort Huachuca is responsible for 54% of the 5,144 ac-ft groundwater deficit in the Sierra Vista subwatershed, or 2,784 ac-ft. As part of the proposed action, Fort Huachuca commits to reducing its net water consumption in the Sierra Vista subwatershed to zero by the year 2011. This consists of water conservation savings (437 ac-ft), conservation easements (1,600 ac-ft), and storm water recharge (1,040 ac-ft).

Stated another way, Fort Huachuca anticipates that water use attributable to its operations will have "no effect" on endangered or threatened species and their habitats in the Upper San Pedro River basin area by the year 2011. These goals were virtually unthinkable just a few years ago. However, thanks to continuing studies, improved science, and partnerships with Federal and state agencies, the Fort is convinced that it can commit to concrete, quantifiable, measurable, and time-sensitive water conservation goals.

Fort Huachuca will accomplish these goals within the above time frames through construction projects, multi-million dollar realty procurements, conservation initiatives, and participation in the USPP – all of which are discussed in this Section.

---

[7] Fort Huachuca and its personnel have been honored to receive numerous awards recognizing the Fort's conservation and environmental stewardship work, to include:

- Program Recognition:
  - 2000 State of Arizona Conservation Organization of the Year
  - 2000 TRADOC Natural Resources Conservation Award
  - 2000 Department of Army Natural Resources Conservation Award (Runner-Up)
  - 1999 Department of Energy Water Conservation Award
  - 1999 Federal Energy Efficiency Award
  - 1997 Department of Army Energy Conservation Award
- Individual Recognition:
  - 2000 TRADOC Civilian Engineer of the Year (Mr. Tom Cochran)
  - 1999 Arizona Game and Fish Commission Award of Excellence (MG John Thomas)
  - 1996 Federal Energy Management Award (Mr. Vince Moreau)
  - 1995 Department of Energy Beneficial (Water Reducing) Landscaping Award (Mr. John Miller)
  - 1992 Federal Energy Efficiency Award (Mr. Bill Stein)

Fort Huachuca recognizes that despite its conservation measures resulting in a net reduction of 2,784 ac-ft, this will not completely eliminate the groundwater deficit in the Sierra Vista subwatershed. Indeed by subtracting 2,784 ac-ft from the total groundwater deficit of 5,144 ac-ft, the current groundwater deficit attributable to cumulative effects is 2,360 ac-ft. Moreover, the projected population increase of 12,931 people would result in a net increase of 1,239 ac-ft of additional groundwater use in the Sierra Vista subwatershed by 2011. By taking the existing cumulative groundwater deficit of 2,360 ac-ft and adding 1,239 ac-ft of projected additional water usage, the total cumulative groundwater deficit by 2011 will be approximately 3,599 ac-ft.

Logically, Fort Huachuca cannot commit to a conservation measure that requires the Army to balance all of the cumulative effects contributing to the groundwater deficit in the entire Sierra Vista subwatershed. Such a measure presumes that Fort Huachuca has direct authority and influence over the activities of private citizens, corporations, state agencies, federal agencies, and other entities. Absent martial law or other war authority given by Congress to the military, such a state of affairs is without precedent in American history.

However, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to reduce net water consumption by 3,599 acre feet to completely offset all cumulative effects and the entire groundwater deficit by 2011. To reduce the entire groundwater deficit by 2011 is an enormous challenge and will require a comprehensive and collaborative effort by local, state, and Federal agencies. Whether committed to as a conservation measure or not, Fort Huachuca stands ready to assist (where possible) and provide strong environmental leadership, funding, and direction using the best scientific and commercial data available to assist these entities to reduce cumulative effects of groundwater water usage in the Sierra Vista subwatershed.

5.2 WATER RELATED CONSERVATION MEASURES

In accordance with the USFWS Consultation Handbook, dated March 1998, page 4-19, "Conservation measures represent actions pledged in the project description that the action agency or applicant will implement … Since conservation measures are part of the proposed action, their implementation is required under the terms of the consultation."

Fort Huachuca is committed to accomplishing substantial quantifiable, measurable, and timely conservation measures as part of the proposed action. Fort Huachuca will focus primarily on conservation measures that show a direct and measurable reduction of its net groundwater use in the Sierra Vista subwatershed.

In light of its water savings achievements over the past decade and water savings anticipated with the conservation measures and projects cited in this section, Fort Huachuca will reduce its net on-post water use to zero by the year 2007.[8] Moreover, once the conservation measures listed in Sections 5.2.1 through 5.2.6 are implemented, Fort Huachuca's water consumption in the Sierra Vista subwatershed will be completely offset and reduced to zero by the year 2011. Projected pumping is shown in Appendix M. The Fort calculates its direct, indirect, interrelated,

[8] In 2001, Fort Huachuca's water use was 1,655 ac-ft, a 19-year low.

and interdependent effects to be 2,784 ac-ft. Thus, once Fort Huachuca's total groundwater usage of 2,784 ac-ft is reduced to zero, Fort Huachuca will have "no effect" on listed species or their critical habitat related to groundwater usage in the Sierra Vista subwatershed.

What follows is a detailed description of the conservation measures that Fort Huachuca will implement, the timeline for their implementation, and the amount of net water usage that each conservation measure/project will save. Several of the conservation measures listed have been implemented, while other conservation measures are in various stages of development or completion. Taken together, these conservation measures will dramatically reduce potential adverse effects on listed species and critical habitat attributable to Fort Huachuca's water use.

5.2.1 WATER CONSERVATION

The water conservation measures and projects cited in this subsection will reduce Fort Huachuca's net water consumption in the Sierra Vista subwatershed to zero. By implementing these conservation measures, Fort Huachuca expects to reduce its on-post water use by 437 ac-ft (Table 14). Water meters at the Post's wells will measure and report annually the water savings to the USFWS.

Fort Huachuca is proud of its water conservation record. Since 1989, Fort Huachuca has reduced its water pumpage from over 3,000 ac-ft to its current baseline of 1,655 ac-ft in 2001. This remarkable water conservation achievement is the result of aggressive water conservation measures. These measures include active enforcement of an installation-wide irrigation policy, closure of the Quartermaster laundry, education and Energy Smart /Water Wise programs, a multi-hundred-thousand installation program of waterless urinals in Post facilities, water harvesting, closure and demolition of aged facilities, installation of horizontal axis washing machines at student dorms and troop billets, low-flow fixtures, leak detection devices and monitoring, replacement of water intensive evaporative cooling systems on individual residences with air conditioning, xeriscaping and desertscaping throughout the Post, and the closure of garden plots.

Fort Huachuca recently completed Phase I of its Army Water Resource Management Plan (AWRMP) and Phase II will be completed in December 2002. Water savings identified in the AWRMP are reflected in the projected pumping analysis (Appendix M). Fort Huachuca expects the AWRMP to achieve a net water conservation savings of 437 ac-ft.

5.2.2 EFFLUENT REUSE

Increased effluent reuse will assist in reducing Fort Huachuca's net water consumption in the Sierra Vista subwatershed to zero. This conservation measure will reduce Fort Huachuca's groundwater pumpage by 116 ac-ft.

TABLE 14 WATER CONSERVATION PROJECTS AND ESTIMATED SAVINGS

PROJECT	CALENDAR YEAR	ESTIMATED SAVINGS
Horizontal Axis Washers	2002 - 2003	30 ac-ft
Xeriscaping	2002 - 2006	5 ac-ft
residential greywater	2003 - 2010	120 ac-ft
barracks/transient greywater	2002 - 2011	160 ac-ft
Replace Evap with AC	2002 - 2011	114 ac-ft
Rooftop Capture	2004 - 2011	100 ac-ft
Irrigation with Effluent	2004	116 ac-ft
	Gross Conservation Savings	645 ac-ft
	Less Projected Mission Needs[9]	208 ac-ft
	Net Conservation Savings	**437 ac-ft**

For over 30 years, as a role model leader for environmental stewardship, Fort Huachuca has used treated effluent to irrigate its community golf course and the Chaffee Parade Field. The annual effluent required for these two activities varies depending upon rainfall and weather conditions. Over the past five years the amount of effluent used to irrigate the Post's community golf course is 437 ac-ft. In recent years, however, effluent use at the golf course has declined. In Calendar Year 2001 (baseline), 350 ac-ft of effluent was used to irrigate the Post's community golf course and 12 ac-ft of effluent was used to irrigate the Chaffee Parade Field. Effluent reuse to irrigate these areas is a significant water conservation measure that eliminates the need to pump groundwater for irrigation.

The Fort Huachuca Community Golf Course

Over the years, Fort Huachuca has evaluated ways to reduce effluent and/or water use at its community golf course. One option considered was to close the Fort Huachuca community golf course and save any unused effluent for recharge or for use at other activities. This option was evaluated as part of this BA; it is not recommended based on the following rationale.

There is only one other golf course in the Sierra Vista area – a commercially operated, semi-private country club. That course uses groundwater for irrigation. Fort Huachuca's golf course is a community recreational activity that is open to the public as well as military patrons. Since it is a community golf course, individuals with no affiliation with the military as well as service personnel, family members, guests, and retirees have access.

[9] This estimated additional groundwater pumping is associated with personnel on Fort Huachuca to meet increased mission requirements in communications and training. An additional 500 personnel are included in the proposed action and discussed in Section 3.

The Army has determined that closing Fort Huachuca's community golf course is not necessary, based in large part, on conservation measures contained in Section Five. Also, over 50,000 rounds of golf are played each year on this community golf course. The Fort Huachuca community golf course is a valuable recreation resource for the entire Sierra Vista region and utilizes effluent for irrigation. If Fort Huachuca's community golf course were to be closed, the Army reasonably believes that a commercial golf course would be constructed to meet the popular public demand and capture the revenue associated with 50,000 rounds of golf played each year. Furthermore, based on potentially available land, it is likely that this commercial golf course would be located closer to the San Pedro River. It is quite likely that a new golf course would use groundwater for irrigation. Depending on the type of course and turf, this would increase pumping by 300 to 800 ac-ft. in the subwatershed.

Due to age and inefficiency of the existing irrigation system, the Army will commit to upgrade the Fort's community golf course irrigation system to reduce the annual effluent use. The existing irrigation system is more than 20 years old, and has limited flexibility. Fort Huachuca will expend more than $1 million to install a state-of-the-art, computer-operated irrigation system that is expected to save 30-35% (or 105 ac-ft) of effluent recharge over the current irrigation system.[10] Fort Huachuca will finance $800,000 to $1.2 million in non-appropriated funds (money dedicated to morale and welfare programs for service members and their families) to upgrade the irrigation system. This irrigation upgrade is scheduled to commence in Fiscal Year 2003.

In addition to upgrading the irrigation system, Fort Huachuca realizes that their successful water conservation program means there will be less effluent available in future years. Effluent availability is fairly constant over the year; irrigation demands are highest in May and June. Consequently, the Army is strongly considering short and long term plans to convert the golf course to a "desert type" course.

Phase II of Effluent Recharge and Reuse Project

Another conservation measure Fort Huachuca commits to is the construction of Phase II of the Effluent Recharge and Reuse Project that will commence in Fiscal Year 2003. This project will extend the Post's existing effluent piping system to irrigate athletic fields that are currently watered with groundwater. An additional 116 ac-ft of effluent will be used to irrigate the athletic fields, thus reducing a like amount of groundwater pumping each year. Existing effluent reuse is metered and will be reported annually to the USFWS.

[10] Unfortunately, Federal law prohibits any use of appropriated funds to "equip, operate, or maintain a golf course at a facility or installation of the DoD." (see 10 USC 2246) This prohibition has effectively stymied past efforts by Fort Huachuca to upgrade the irrigation system at its community golf course. Since traditional sources of funding were not available, the Fort went through a formal loan process approved by the US Army Community and Family Support Center.

As a result of the foregoing conservation measures and projects, Fort Huachuca will reduce its groundwater pumpage by 116 ac-ft (Phase II), while its demand for reuse of treated effluent will remain stable at 373 ac-ft (compared to 362 ac-ft of current effluent reuse).[11]

5.2.3 EFFLUENT RECHARGE

Fort Huachuca's aggressive and innovative use of effluent recharge is key to its goal of reducing its net water consumption in the Sierra Vista subwatershed to zero. Yet the Fort faces an interesting challenge in this regard. As Fort Huachuca's water conservation efforts grow in success, the amount of effluent available for recharge declines.

Fort Huachuca currently recovers approximately 61% of the amount pumped as effluent. This resulted in an estimated 540 ac-ft of effluent recharge in 2001. However, due to water conservation efforts, Fort Huachuca anticipates that the amount of effluent available for recharge will gradually decline and then remain fairly stable after the year 2011. As shown in Appendix N, an estimated 435 ac-ft of effluent will be available for recharge in the year 2011. This amount of effluent recharge is already included in the water budget for the Sierra Vista subwatershed, therefore, it is not included toward the Fort's commitment to reduce 2,784 ac-ft by the year 2011. However, the Fort will continue to meter and monitor effluent recharge through wells at the Effluent Recharge project site. Additional monitoring systems will be installed, as funding becomes available.

In 2001, Fort Huachuca pumped 1,655 ac-ft of groundwater. As noted above, the post currently recovers approximately 61% of the amount pumped as effluent, or approximately 1,013 ac-ft of available effluent. Of this 1,013 ac-ft, the Army reused 362 ac-ft of this effluent to water the Fort's community golf course and the Chaffee Parade Field. The amount of effluent reuse is projected to remain fairly stable in the future. Of the remaining 651 ac-ft of effluent, approximately 540 ac-ft was recharged as the East Range recharge basins came on line during the year.

To facilitate effluent recharge, Fort Huachuca recently completed construction of Phase I of an Effluent Recharge and Reuse Project. This $6 million project included upgrading the wastewater treatment plant to improve effluent quality, and construction of seven effluent recharge basins and one storm water recharge basin. The basins are located on the East Range of Fort Huachuca, where effluent holding/evaporation ponds were previously located.

All basins have received treated effluent for recharge and work well. There has been rapid infiltration with very little evaporative loss. The basins are designed to recharge up to 1,000 ac-ft of water annually. The storm water basin has sufficient capacity to annually recharge at least 250 ac-ft of urban runoff from the built-up areas of Fort Huachuca, depending on precipitation.

[11] In 2001, 350 ac-ft of treated effluent was used to irrigate the Fort Huachuca community golf course (also known as the Mountain View Golf Course). A new irrigation system will likely enhance irrigation efficiency by 30-35% (*see* Mountain View Golf Course, Independent Needs Assessment Study, dated 3 February 1999). Conservatively estimating increased irrigation efficiency to be 30% results in the golf course using 245 ac-ft of effluent. Chaffee Parade Field and Prosser Village landscaping and ball fields used 12 ac-ft in 2001. When this use is combined with the additional 116 ac-ft for athletic fields (from Phase II), use of treated effluent will increase to 373 ac-ft.

Additionally, one of the effluent recharge basins can be converted to accommodate storm water recharge in the event of greater than average precipitation.

5.2.4 CONSERVATION EASEMENTS

Underscoring its innovative approach to meeting its environmental responsibilities within Southeastern Arizona, Fort Huachuca is the first, if not the only, Army installation to use real property easements as a conservation measure. Used in conjunction with its other aggressive water saving measures, the purchase of conservation easements will assist in Fort Huachuca in reducing its net water consumption in the Sierra Vista subwatershed to zero. Fort Huachuca will purchase 1,600 ac-ft in conservation easements by the year 2007.[12]

Leading a multi-agency collaborative effort, Fort Huachuca is working closely with TNC, USFWS, and the BLM to establish conservation easements with a primary objective to reduce irrigation or other large sources of water pumping near the San Pedro River. The process typically begins with the TNC purchasing property from a willing seller for fair market value. This property will normally include irrigation rights or address previous irrigated agriculture activity on the property.

Based on previous pumping records, Fort Huachuca and the USFWS will determine the appropriate water savings credit, in ac-ft, that will accrue to the Army upon purchase of the conservation easement. The "credit" is then calculated toward mitigation of the total amount of water use related to the Fort – whether on-post or to address indirect, interrelated, interdependent, and cumulative effects off-post. Deed restrictions are added to the property to reflect the conservation easement and the TNC resells the property to a private individual or entity.

The conservation easement will usually include restrictions against irrigation for agricultural purposes on the property, or limit the landowner's ability to subdivide the property. Property remains on the tax rolls, and may be used for residential, commercial or agricultural land uses consistent with the terms of the conservation easement. Finally the TNC will transfer the conservation easement to the BLM. The BLM is ultimately responsible for ensuring compliance with the terms of the easement. An alternative method of establishing a conservation easement is to purchase the easement from the existing landowner, and add permanent deed restrictions to the property, with the landowner maintaining possession of the property.

All processes are in place to accomplish this work and the Army has already purchased the initial conservation easement on the Clinton tract near the San Pedro River. Based on previous irrigation records, Fort Huachuca received credit for 630.8 ac-ft, which will be subtracted from the total pumpage associated with Fort Huachuca. In addition to the elimination of pumping for irrigation purposes near the San Pedro River, the property is located in the area between the San Pedro National Riparian Conservation Area (SPRNCA) and the Huachuca Mountains. This area,

[12] Because conservation easements are relatively new, the Fort Huachuca Deputy Staff Judge Advocate recently presented a paper on this innovative concept to the 2002 National Defense Industrial Association's Environmental Symposium. (*please see "Using Conservation Easements to Save the Upper San Pedro River"* by LTC Kevin Luster, at Appendix O)

near the towns of Palominas and Hereford, is referred to as the "Gap," because of a geographic separation in the boundaries of the SPRNCA. Conservation easements in the Gap are also part of a BLM initiative (Gap-Borderlands) that will contribute to the creation of a wildlife corridor between Mexico, the Huachuca Mountains, and the San Pedro River through purchase of selective conservation easements in that area. Currently, Fort Huachuca seeks to establish water-related conservation easements on properties near the southern end of the SPRNCA, in an effort to maintain groundwater flow to the perennial reach of the river between Hereford and Lewis Springs.

Fort Huachuca will continue to work with the TNC, BLM, USFWS, and any other willing partners to aggressively search for conservation easement opportunities. By 2007, Fort Huachuca anticipates acquiring additional conservation easements totaling 1,600 ac-ft in water savings credit (includes the 630.8 ac-ft obtained by the Clinton tract conservation easement). One parcel, Driver, has been purchased by TNC; the easement portion has not been determined but the potential is 500 ac-ft. Six other properties are under consideration which have a potential for 1,104 ac-ft. The total amount of conservation easements which have either been purchased or are under consideration is 2,234 ac-ft.

5.2.5 STORMWATER RECHARGE

As an additional water conservation measure, Fort Huachuca commits to investing and constructing storm water retention projects that will reduce the Post's net water consumption in the Sierra Vista subwatershed to zero. With the below cited projects, Fort Huachuca expects to recharge 1,040 ac-ft of storm water into the Sierra Vista subwatershed. Prior to construction, all applicable permits (Corps of Engineers, ADEQ, ADWR, etc.) will be obtained. The average annual range of precipitation that occurs on or near Fort Huachuca varies between 8-28 inches, depending on elevation and that particular year's precipitation pattern. Within the Fort's urbanized area, impermeable surfaces generate several thousand ac-ft of urban runoff that could be available for recharge with the proper technology. Reducing erosion on Fort Huachuca is another significant conservation measure with the potential for additional recharge at the same time.

One concern of urban runoff or stormwater recharge is that at least some of the flow would reach the river and potentially recharge the shallow aquifer there. Factors considered in analyzing this concern are size of storm, distance from the river to the recharge structure and pattern of rainfall. Small storms are unlikely to generate flow which will reach the river. Data from Walnut Gulch supports this statement. Most of the water in the small storm flows would be used to wet the channel material, evaporation or streamside vegetation. Based on Walnut Gulch research, only 2% of the flow is recharged naturally.

Large storm flows could make it to the river but there is the added chance of a large storm covering several smaller watersheds. In that case, water will flow into the river from other watersheds. Proposed structures will capture and recharge only part of what is flowing over a large area.

Concept is the proposed structures will only affect small storm flows that fall exactly on and above the watershed upstream from the structure. All other storm flows are not altered. Of those small storms, recharge will be greater than would occur naturally. Another consideration is most of the proposed recharge facilities are located between the cone of depression and the Babocomari and San Pedro Rivers. They should improve the groundwater gradient to the river.

In an undisturbed environment, much of this urban runoff would have comprised a part of the natural aquifer recharge process. Capturing this urban runoff and recharging it will help restore a recharge regime closer to the pre-development scheme.

As discussed in Section 5.4.2, the primary focus for Fort Huachuca's erosion controls and storm water recharge efforts will be on the East Range. Measurement of storm water recharge will be based on records maintained for each basin. The method to calculate the storm water recharge savings will be as follows:

For the Graveyard Gulch, Greely Hall, and Hatfield basins, the following procedure will be used. Fort Huachuca will measure the height of water from measuring devices located in each basin. This will be completed weekly after rainfall events and maintained in detailed records. Fort Huachuca will then determine the total volume of storm water (in ac-ft) based on the surface area of the basin. Evaporative losses (depending on month and basin infiltration rates) will then be subtracted out. This net amount is the amount of storm water recharge savings for which Fort Huachuca would receive credit to offset its groundwater pumping elsewhere. For structures designed and constructed after those facilities, weirs will be included as part of the project for future measurement.

Table 15 provides information concerning proposed or completed storm water projects and the amount of estimated annual recharge associated with each project:

5.2.6 WATER MITIGATION POLICY

Fort Huachuca has established a water mitigation policy that will identify mission growth and assist in reducing Fort Huachuca's net water consumption in the Sierra Vista subwatershed to zero. The Fort's requires new activities to fund projects or portions of projects that offset any increased water use associated with their proposed actions. This mitigation policy allows Fort Huachuca to track mission growth and to achieve the water saving goals outlined in the conservation measures described above.

As reflected in Section 3, Fort Huachuca's current employee population baseline is 12,305. This includes permanent party military, government civilians, contractors, and military students who are here on a temporary duty basis. Following the September 11, 2001 terrorist attacks on the Pentagon and the World Trade Center, America's national defense needs have fundamentally and irreversibly changed. The Army is rapidly transforming to protect our citizens and nation's interests throughout the world, to include fighting the war against terrorism. This new world reality will without doubt impact Fort Huachuca's operations, particularly its MI and communications security missions. As a result, Fort Huachuca anticipates that it may be called upon to support additional wartime mission requirements to meet national defense needs.

TABLE 15 PROPOSED OR COMPLETED STORMWATER PROJECTS AND AMOUNT OF ESTIMATED ANNUAL RECHARGE

Project	Status	Estimated Annual Savings
East Range Phase I Stormwater Recharge Basin	Completed 2002	150 ac-ft*
Graveyard Gulch Retention Basing	Under Const. 2002	110 ac-ft**
Hatfield Retention Basin Ph I	Design 2002***	10 ac-ft
Soldier Creek Retention Basing	Design 2003	150 ac-ft
Hatfield Retention Basin Ph II	Design 2003	10 ac-ft
Phase III E Range	Design 2005	150 ac-ft
Hatfield Retention Basin Ph III	Design 2005	10 ac-ft
Phase IV E Range	Design 2007	150 ac-ft
Phase V E Range	Design 2009	150 ac-ft
West Range	Design 2009	150 ac-ft
	Total Storm Water Recharge Savings	**1040 ac-ft**

*Storm water recharge basin is designed to recharge 250 ac-ft; a conservative estimate of 150 ac-ft is used pending validation in 2002 and 2003. Additionally, one of the effluent recharge basins can be converted to accommodate storm water recharge in the event of greater than average precipitation.

**Method utilized for estimating the recharge for Graveyard Gulch was based on watershed area, average distribution of rainfall events, area of basin, and infiltration rates of soils. This data was developed during the design process. Specific data was not available for the other basins listed because design is not completed. The East range estimates are based on similarity to Graveyard Gulch.

*** Typically, projects will be designed one year prior to construction.

For purposes of this consultation, the Army anticipates 12,805 soldiers and employees will be required to meet Fort Huachuca's future mission requirements – an increase of 500 full-time employees over the current baseline of 12,305 personnel. The Fort anticipates these mission requirements will arise over the next few years. By recognizing the need for mission flexibility and providing for an additional 500 personnel in the baseline number, Fort Huachuca can immediately meet new mission requirements as they arise.

Fort Huachuca will balance the need to support additional mission requirements and continue to address groundwater issues through its water mitigation policy (Appendix P).

The Fort calculates the additional water needs associated with this increase to be 208 ac-ft per year of on-post pumping beginning in 2003. Although the Army believes it unlikely that the full 208 ac-ft will be realized in 2003, it adopted an extremely conservative approach to address this issue. This increase is included in the analysis of projected pumping, Appendix M.

The Fort's mitigation policy is an important conservation measure and funding mechanism because it requires all tenants, agencies, and activities to mitigate water use associated with their proposed action. The following are important components of this conservation measure, which are quoted from the policy:

1. To comply with the ESA, and allow for mission requirements, any organization increasing its overall personnel strength in the Fort Huachuca area must mitigate the water use associated with these additional personnel and their family members. This mitigation policy also applies to contract employees who work on the installation.

2. Each employee authorization adds direct, indirect, and interrelated and interdependent water usage for themselves, their families, and within the community. Mitigation will be assessed based on increases from the organization's personnel baseline on 30 September 2001, as reflected in the installation post population planning report.

3. Mitigation for large increases in personnel (over 30 personnel associated with a single project or action), to include civilian contractors who work on post, will occur prior to the personnel increase or hiring action. Otherwise the mitigation fee will be paid by the organization with personnel growth when the annual 30 September post population report is issued. Mitigation may be accomplished by the gaining organization in at least two ways. Either method must be coordinated through the Environmental and Natural Resources Division (ENRD), DIS.

    a. The first mitigation method is on-site. For organizations with large facilities, conservation technology may be installed in their facilities if it will completely mitigate the increased water use of the additional personnel. However, this will be done at the gaining organization's expense.

    b. If the organization increases personnel and cannot reduce water use at their facilities sufficiently on their own, the second method of mitigation requires working with the DIS. Cost for this mitigation method is $1,000 per additional employee. This money will be paid to the DIS and is a one-time fee per position added. The fee applies to all personnel increases, regardless of where the employee or contractor worked or was located prior to the hiring action. The mitigation fee is not an augmentation to the Garrison's appropriated funds budget because it pays to mitigate water consumption resulting from personnel increases that have not been otherwise funded by Department of the Army (DA) in the Garrison's annual budget.

Funds generated from requesting activities will be used to fund specific conservation measures. Principally, these will be water conservation technology, conservation easements, and storm water recharge. Activity funds will be obligated toward conservation measures within 12 months after receiving funding.

5.2.7 SUMMARY OF WATER CONSERVATION MEASURES

As detailed in Section 3, the total groundwater deficit in the Sierra Vista subwatershed is 5,144 ac-ft. Fort Huachuca is responsible for 54% of the groundwater deficit in the Sierra Vista subwatershed, or 2,784 ac-ft.

As part of the proposed action, Fort Huachuca will completely offset 2,784 ac-ft in water usage through the water conservation measures described above. This consists of water conservation savings (437 ac-ft), conservation easements (1,600 ac-ft), and storm water retention (1,040 ac-ft). If these measures should ultimately prove to be less successful than previously projected, Fort Huachuca will identify and implement additional conservation projects to make up the shortfall or reinitiate consultation with the USFWS as appropriate.

By implementing the water mitigation policy, Fort Huachuca will require new activities to fund projects or portions of projects that offset water usage associated with their proposed actions. This will allow Fort Huachuca to stay on track with its conservation measures as outlined above and continue to meet additional mission requirements in the future.

5.3 REGIONAL INITIATIVES THAT ADDRESS CUMULATIVE GROUNDWATER USAGE

By subtracting Fort Huachuca's conservation measures of 2,784 ac-ft from the total groundwater deficit of 5,144 ac-ft, the current groundwater deficit attributable to cumulative effects, not related to Fort Huachuca, is 2,360 ac-ft. The projected population increase of 12,931 people by 2011 would result in a net increase of 1,239 ac-ft of additional groundwater use in the Sierra Vista subwatershed. By taking the existing cumulative groundwater deficit of 2,360 ac-ft and adding 1,239 ac-ft of projected additional water usage, the total cumulative groundwater deficit by 2011 will be approximately 3,599 ac-ft.

Logically, Fort Huachuca cannot commit to a conservation measure that requires the Army to balance all of the cumulative effects contributing to the groundwater deficit in the entire Sierra Vista subwatershed. Such a measure presumes that Fort Huachuca has direct authority and influence over the activities of private citizens, corporations, state agencies, federal agencies, and other entities. Absent martial law or other war authority given by Congress to the military, such a state of affairs is without precedent in American history. However, Fort Huachuca will request that the communities and agencies within the Sierra Vista subwatershed, through the Upper San Pedro Partnership, make a commitment to offset the cumulative effects (3,599 ac-ft) associated with groundwater usage by 2011.

Fort Huachuca can commit as a conservation measure, however, to continue to provide vigorous leadership, technical support, funding, and other resources to assist the efforts of its regional partners (local, State and Federal) to address the impact of cumulative groundwater use in the Sierra Vista subwatershed.

Reducing 3,599 ac-ft of the groundwater deficit related to cumulative effects by the year 2011 is a very achievable accomplishment. Bisbee alone is currently planning to begin construction of an

effluent recharge plant in two years. When constructed in six years the effluent recharge plant is projected to recharge approximately 392 ac-ft which would reduce the cumulative water deficit in 2011 to 3,207 ac-ft. Therefore, not only has Fort Huachuca agreed to zero out all direct, indirect, interrelated and interdependent effects of its proposed action, but Fort Huachuca anticipates that the communities and agencies in the region will also agree to zero out all the cumulative effects associated with groundwater usage in the Sierra Vista subwatershed. The bottom line is that by the year 2011 the groundwater deficit in the Sierra Vista subwatershed will be reduced to zero and there will be no effect on threatened or endangered species or their critical habitat at that time.

Cited below are the major ongoing initiatives which the Army expects will reduce the cumulative effects of groundwater pumping to zero by the year 2011 and support base flow in the San Pedro River.

5.3.1 UPPER SAN PEDRO PARTNERSHIP (USPP)

The USPP is presently the best collaborative regional planning organization for addressing the cumulative effects from all sources on the San Pedro River. Fort Huachuca provides much-needed leadership, direction, and funding in support of the USPP goal to sustain base flows in the San Pedro River.

Fort Huachuca will continue to participate in the USPP and work towards maintenance of base flows in the San Pedro River sufficient to sustain species and habitat protected by the ESA. To attain this goal may require regional partners to acquire and retire water rights in the area, balance water use with conservation and recharge projects, importing water, or any combination of these and other projects to attain a balance between groundwater withdrawals and recharge sufficient to ensure continued base flows. As mentioned above, Fort Huachuca will provide leadership and significant technical or financial resources to help the Partnership accomplish its purpose.

The USPP was formed to facilitate, and implement sound water resource management and conservation strategies in the Sierra Vista subwatershed. It is a consortium of agencies and organizations that own and/or control land or water use in the Sierra Vista subwatershed of the Upper San Pedro River Basin. The USPP was formed through a Memorandum of Understanding (MOU) signed by each member agency. The purpose of the USPP is to “coordinate and cooperate in the identification, prioritization and implementation of comprehensive policies and projects to assist in meeting water needs in the Sierra Vista Sub-watershed of the Upper San Pedro River Basin”.

The USPP established as its first priority the development of an Upper San Pedro Conservation Plan with the goal of “ensuring an adequate long-term groundwater supply is available to meet the reasonable needs of both the area’s residents and property owners (current and future) and the SPRNCA.” The USPP will identify, analyze, prioritize, and recommend feasible, and reasonable, projects and policies to its member agencies that will accomplish the stated goal of the Upper San Pedro Conservation Plan. The USPP hopes to develop a consensus among its members to adopt and implement a comprehensive Upper San Pedro Conservation Plan. The

USPP will then actively support its members in seeking funds and taking action to implement the Upper San Pedro Conservation Plan.

A Partnership Advisory Commission was established to lead the USPP toward reaching its goals. Operational committees have been formed to carry out the purposes of the USPP under the direction of the Partnership Advisory Commission. The Staff Working Group includes an appointed staff representative from each member agency and its purpose is to coordinate USPP activities and advise the Partnership Advisory Commission on the development and implementation of the Upper San Pedro Conservation Plan. The Administrative Committee includes the appointed representatives from each member agency that is funding the Conservation Plan. Its purpose is to manage and direct the expenditure of USPP funds used in the preparation of planning studies and options for the USPP and to provide administrative and policy advice to the Advisory Commission. The other committees include a Public Outreach Committee, and a Technical Committee.

Until recently, the direction of the USPP has been headed toward the development of a Conservation Plan for the Sierra Vista subwatershed. This process of creating a "final" plan has been slated to occur over the next four years, with final plan adoption by the Partnership Advisory Commission scheduled for the summer of 2005. The Coordinating Committee Working Group, member agencies, and interested members of the public, have been wrestling with key issues related to this initiative, to include: How will ongoing or proposed member agency actions fit into this plan? Will or should member agencies wait until 2005 for guidance and recommendations on water conservation activities? Will the public come to expect more timely and tangible results from the work of the Partnership?

These questions gave credence to the idea of a Working Plan – an iterative document that will be completed early in 2003 and reviewed and updated on an annual basis as more information is received by the USPP. To support the development of the Upper San Pedro Conservation Plan a number of studies have been initiated. For example, a study conducted by the Fluid Solutions/BBC consulting firm on reducing human water consumption, reusing water resources, and augmenting water resources is nearing completion. Two other important studies, Storm Water Recharge and SPRNCA Needs, are planned over the next three years and will provide valuable data and guidance towards specific recommendations. In addition, member agencies within the USPP have launched their own water conservation activities in support of USPP water conservation goals. Overall, the purpose of the Working Plan is four-fold:

- To begin synthesizing and consolidating ongoing and completed studies (Fluid Solutions/BBC, Storm water Recharge, SPRNCA needs, etc.)

- To communicate the USPP objectives and the Member Agencies' completed, ongoing and proposed projects to public, Member Agencies, and other specific audiences;

- To assess, on an iterative basis, the effectiveness of Member Agency projects as they relate to overall USPP objectives and studies' results, and make adjustments to objectives and/or recommendations as appropriate;

- To identify gaps in baseline information/projects and recommend future actions and recognize the important milestones to achieving USPP objectives.

An intensive review of the Working Plan will occur annually so as to identify requirements and milestones. As our understanding of the Sierra Vista subwatershed and available technology change over time, so may strategies and recommendations. This raises the question of the Partnership's long term role, beyond 2005, in continuing to provide guidance to member agencies. In essence, the Working Plan may extend the USPP's functionality and purpose beyond the idea of producing a one-time, final document. The proposed outline for the Working Plan is at Appendix Q.

This regional Working Plan will be drafted in October 2002 and evaluated by the Partnership Advisory Commission in February 2003. Completion is scheduled for April 2003. The USPP, through Fluid Solutions, has identified over 54 separate strategies to be evaluated in the areas of public education, recreation, irrigated agriculture, wastewater reuse, and water importation. The USPP will continue to evaluate longer-term water resources planning and develop additional strategies (Fluid Solutions, 2001). Projects currently underway or proposed for the USPP are listed in Appendix L.

5.3.2 CITY OF SIERRA VISTA EFFLUENT RECHARGE PROJECT

The Bureau of Reclamation and the City of Sierra Vista developed an effluent recharge project that is expected to delay negative effects to river base flow and endangered species habitats in and near the San Pedro River. The City of Sierra Vista Effluent Recharge Project will create a mound of groundwater between the city and the San Pedro River. Although the Project does not permanently alleviate the long-term threat to endangered species habitats on the San Pedro River, it will provide valuable time to develop and implement conservation measures that will mitigate long-term threats to the River. The City of Sierra Vista Effluent Recharge Project is near completion, with the grand opening scheduled for July 2002.

While this project was expected to initially recharge between 2,000 and 2,400 ac-ft of treated effluent per year, based on actual effluent flows through the recharge facility, approximately 2,600 ac-ft is being recharged. In 15 to 20 years, the City of Sierra Vista Effluent Recharge Project is expected to recharge up to 4,000 ac-ft of treated effluent per year. The City of Sierra Vista Effluent Recharge Project will sustain base flow in the San Pedro River between Lewis Springs and the Tombstone gauge. Additionally, City of Sierra Vista Effluent Recharge Project will create a sevenfold increase in wetlands habitat at the WRF site and establish a native grass farm in place of existing pasture.

Effluent recharge projects continue to be an important vehicle in the crusade for maintaining base flow in the San Pedro River. Despite the presence of a possible clay deposit, the City of Sierra Vista Effluent Recharge Project is projected to reduce the regional groundwater deficit. The City of Sierra Vista Effluent Recharge Project is expected to delay the effects of groundwater pumping on endangered species and their habitat in the San Pedro River by providing additional, and invaluable, time to develop and implement water management

strategies. These other strategies will emerge from the USPP Regional Plan and each agency acting independently.

5.3.3 BUREAU OF LAND MANAGEMENT

The primary purpose for obtaining real property rights in the Sierra Vista subwatershed is to protect the San Pedro River riparian ecosystem. Land managers have prohibited livestock grazing for at least 15 years. Sand and gravel extraction will also be prohibited in the riparian zone. Within the SPRNCA, motor vehicles and mountain bikes are restricted to designated roads, and campground stays are limited to seven days. To further improve wildlife habitat, BLM land managers will develop ponds and marshes, plant trees and other native vegetation, install nest boxes, and work with others along the San Pedro on water usage and conservation.

Interpretive displays and trails as well as environmental education field study areas will inform the public about these sensitive resources. Three areas designated as *"Areas of Critical Environmental Concern"* will be managed with special care. Developed campgrounds, picnic sites, and historic and archaeological sites for the public to visit will accommodate the growing demands for recreation. With the adoption of these and many other protective measures, BLM land managers hope to preserve the integrity of this critical riparian ecosystem long into the future.

In addition to these management areas, the BLM is also actively seeking land and conservation easements to help protect base flows in the San Pedro River.

5.3.4 US FOREST SERVICE

The USFS manages a significant amount of land at the higher elevations of the Upper San Pedro Watershed. These higher elevation areas receive the most rainfall in the basin. The manner in which they are managed is important to watershed health. Currently, the Forest Service is working on several land management projects, including the Lone Mountain prescribed burn (which aims to protect the watershed and reduce the hazard of catastrophic wildfires), and the Lone Mountain grazing allotment evaluation (which should help define best management practices).

5.3.5 STATE OF ARIZONA LAND EXCHANGES

On February 21, 2001, Governor Jane Hull of Arizona signed the “Growing Smarter Plus” legislation. Sections of the Environmental Planning Element of this legislation addresses environmental issues, policies and strategies germane to the anticipated effects of economic development on air and water quality, water quantity, and natural resources.

Importantly, the water element of this legislation requires communities and counties with populations over 125,000 people to have a water resources section in growth plans. While the regional population according to the 2000 Cochise County census did not cross this threshold, the Cochise County Board of Supervisors has proactively developed a baseline of existing water resources to help assess water use in its County growth plans.

5.3.6 COCHISE COUNTY - SIERRA VISTA

As mentioned above, a baseline of countywide water resources has been completed for Cochise County. Information contained in this inventory will be helpful in water resource management within the Sierra Vista subwatershed (EEC 2002). Cochise County is involved in a mountain front recharge instrumentation program with Sierra Vista to quantify the recharge volumes from basins along Buffalo Solder Trail. Since 1992, the County has actively monitored and participated in the Technical Review Committee to discuss and improve the science and state of hydrology in the region.

In addition, the County is one of the founding partners of the Upper San Pedro Partnership (USPP) and a major sponsor of the Water Wise Program (University of Arizona Extension). There have been several amendments to the Comprehensive Plan to include a conservation goal and policies that address water and its role in sustainable growth for the future. Other initiatives are recommending water conservation techniques in approval of larger-scale developments, enforcing specific provisions of the Arizona Water Efficient Plumbing Act of 1992 (low-flow plumbing) in designated building code areas around Benson and Sierra Vista, proposing waterless urinals in all new commercial development, front loading or high efficiency washers in all new commercial developments, etc.

Included in the current budget and expected to be funded are several initiatives which demonstrate commitment of the County to addressing water issues. A Water Conservation Office for the Sierra Vista subwatershed will be funded ($100K). Office will be part of Planning and Zoning. Cochise County is in the process of creating a Water Resource Conservation Area for the Sierra Vista subwatershed. This innovative initiative includes Joint Development Agreements which have been developed with Tombstone, Huachuca City, Bisbee and Sierra Vista. These agreements have been under consideration for eighteen months and are expected to be completed by the end of July. This framework provides the basis for similar zoning and enforcement within the subwatershed and a solid mechanism for achieving goals of the Upper San Pedro Partnership. Cochise County also plans to fund $ 50K per year in rebates for water conservation and will fund a similar rural water measurement project as is currently underway in Santa Cruz County.

The City of Sierra Vista has also implemented the Sierra Vista Watershed Protection Program to provide for the sustainable future of the Sierra Vista community while protecting the unique habitat of the SPRNCA. Additionally, a San Pedro River informational booklet and video, formation of an environmental affairs commission, establishment of a successful Water Wise Program, and creation of a school programming initiative have been generated locally. A surface water plan is in place where a series of storm water detention/retention basins throughout Sierra Vista will be established that would help alleviate flooding and increase recharge opportunities.

The City has also formed a staff Water Management Team that has implemented a toilet rebate program, a home retrofit program, enrolled the City in the EPA WAVE program, is partnering with the Chamber of Commerce to assist the business community in improving water conservation practices, is monitoring and recording water used by local charity car washes, established an internal “Water Watch” program to evaluate and manage municipal water use, and implemented an extensive marketing campaign under the new “Water Tight” umbrella program.

Further, the City is participating in a cooperative recharge project with Cochise County and Fort Huachuca. Low-flow fixtures, recirculating hot water heaters and on-site retention- recharge ordinances have improved the local development code by mandating low water flow fixtures in all new construction and retention of surface flows to pre-construction conditions. Other recent code changes that have been adopted by the city include requirements that commercial car washes recycle 75% of their water; commercial establishments that have urinals must use waterless urinals, including remodels and retrofits of those facilities; all artificial lakes, ponds, and other water features are limited to 500 square feet; use of turf is prohibited in new governmental, commercial and industrial developments; multi-family turf is limited to 20% of the landscaped area, and new single family residences are limited to 200 square feet in front yard; all landscape plants must be from city-approved low water use plant list, or developer must prove that plants used are low-water use and drought tolerant; native plants salvage is required for commercial and residential developments of one acre or more in size; and new irrigation standards for steep slopes, narrow medians and adjacent to curbs have been established.

In addition, more development code initiatives and changes are currently being considered for adoption and implementation as well. The City has obtained voter approval to own and operate two local water companies. Should this occur, the City will obtain the authority to better employ conservation and recharge measures among its citizenry.

5.3.7 ARIZONA DEPARTMENT OF WATER RESOURCES

The ADWR is active in the rural watershed initiative, chairs the USPP and is engaged in a monitoring program to determine water level changes in the region. The University of Arizona Agriculture Extension Service has been contracted by Fort Huachuca, Cochise County and the Sierra Vista to conduct a Water Wise Program encouraging more school education, water audits, etc.

5.3.8 SAN PEDRO ALLIANCE

The San Pedro Alliance, a non-governmental entity, was recently created with the objective of providing information and plans for reducing water usage and sustaining the river in the long term. The Alliance has filed a petition in November 2000 with the ADWR to designate the Upper San Pedro River Basin as an AMA. The ADWR Tucson office is currently reviewing this petition.

5.3.9 STREAMFLOW GAUGING AND EDUCATION

Both Cochise County and Fort Huachuca provided funding to establish and maintain USGS flow gauges at the Charleston, Palominas, Babocomari, and Greenbush Draw locations. Fort Huachuca provided a majority of the funding for the Babocomari gage, two stream flow sites in the Huachuca Mountains and three meteorological sites along the San Pedro River. The County had provided classes at Cochise College on San Pedro water issues, and studying urbanization effects on ephemeral stream channel geometry although this effort is not currently underway. The County participated in an ephemeral stream recharge study with Agricultural Research

Service to quantify the recharge volumes from the ephemeral stream on the Walnut Gulch experimental watershed.

5.3.10 SAN PEDRO FOUNDATION

A non-profit organization, the San Pedro Foundation, was recently formed. Its mission is to provide a funding mechanism to achieve sustainable water resource management practices within the San Pedro River Basin that are well integrated with regional economic and cultural goals and also contribute to the integrity of riparian habitat. Through active stakeholder involvement, the Foundation aims to fund actions necessary to meet balanced goals and improve the likelihood of long-term environmental sustainability in the Basin.

5.3.11 NATURE CONSERVANCY AND UDALL CENTER

TNC has been active in local forums, and in public education and acquisitions of land and easements. To determine stream flow in the San Pedro during the dry summer months, members of the local community voluntarily conduct a survey of the river in mid-June each year. Volunteers hike or horseback ride along 43 miles of the river within the SPRNCA.

The Udall Center for Studies in Public Policy has also been working in the subwatershed to inspire and enable community members to contribute to water-wise planning and management activities in the upper San Pedro River basin.

5.3.12 INTERNATIONAL AGREEMENT BETWEEN MEXICO AND THE UNITED STATES ON PROTECTING THE SAN PEDRO RIVER

On June 22, 1999, Interior Secretary Bruce Babbitt and Mexican Ambassador Jesus Reyes-Heroles signed a joint declaration to improve and conserve the natural and cultural resources of the upper San Pedro River basin, including the river and riparian corridor. The declaration creates a partnership to share funds, information, and conservation expertise between land and resource managers in both countries. Planned activities include reprogramming of Land and Water Conservation Funds for purchase from willing sellers of fee titles and conservation easements near Palominas, which should help protect the river from agricultural pumping.

5.3.13 ALTERNATIVE FUTURES STUDY

Several years ago, the Harvard School of Graphics completed an Alternative Futures Study which modeled the impact and effects of several pro-growth and conservation scenarios in the USPB. One scenario included the closure of Fort Huachuca. This scenario revealed a short-term population decline within the Sierra Vista subwatershed region.

Significantly, however, this short-term drop in population numbers was followed by increased, permanent, and uncontrolled population growth in the subwatershed. Hence, by the end of the Harvard School's modeling period, population within the San Pedro River region would be greater than the alternatives where Fort Huachuca remained an active military installation.

The Harvard School study suggests that loss of Fort Huachuca would result in a greater threat to endangered and threatened species within the San Pedro River basin area.

5.4 OTHER CONSERVATION MEASURES

5.4.1 INTERAGENCY AGREEMENT

The Interagency Agreement between the Forest Service, Fort Huachuca, state of Arizona and regional fire departments is another significant regional conservation measure. Fort Huachuca also has a real estate agreement with Department of Agriculture for maintaining a tanker base at Libby Army Air Field. Although this activity uses moderate amount of water, it directly supports fire fighting efforts that frequently protect listed species and critical habitat on Fort Huachuca and the Sierra Vista subwatershed.

5.4.2 EROSION CONTROL

Although watershed conditions on the post are generally good to very good, Fort Huachuca is committed to minimizing the effects of erosion. Fort Huachuca has taken several actions to identify, monitor and improve watershed conditions across the installation. These actions include: mesquite root-plowing, upland re-vegetation, gabions, erosion control structures, soils mapping, cooperative efforts with other federal land managers, working with the Natural Resources Conservation District, and plant inventories. To reduce erosion, all off road vehicle traffic is also prohibited on the installation. Any disturbance of more than one acre requires a Storm Water Pollution Prevention Plan. Most plan components include silt fencing, water bars, and other best management practices. Fort Huachuca is also retiring unnecessary roads and fire breaks.

Fort Huachuca will direct its initial erosion control efforts mainly toward improvements on the East Range. Certain areas are more prone to erode because of soil properties and less vegetation. Projected work will lower sediment loads, provide recharge, reduce velocity of storm water flows, and protect archeological sites on the East Range.

East Range. Based on the East Range Watershed Improvement Plan, the following work is underway or scheduled:

- Graveyard Gulch – Retention Structure - Under Construction. Awarded in 2002 for $ 344K ($ 58K Design in 01)
- Soldier Creek – Similar Work is Projected for 2004
- Phase III – Similar Work is Projected for 2006
- Phase IV – Similar Work is Projected for 2007
- Phase V – Similar Work is Projected for 2008

- East Range road closures – 81 miles

Cantonment Area. There are also projects within the cantonment area which will reduce the potential impact of erosion. Status of these efforts is as follows:

- Greely Hall Detention Basin – Complete This was a conservation measure incorporated to reduce impacts from increased pavement for parking near Greely Hall.

- Hatfield Detention Basin – Design Complete – Construction will begin in 2002.

West Range. The post is also planning on a West Range Project retention structure for 2010.

5.4.3 ENVIRONMENTAL FUNDING SOURCES AND PROCESS

Each year for the last 12 years, Fort Huachuca has invested $3.5 to $5.5 million in environmental, natural resources, and cultural projects. In the last few years, funding emphasis has shifted toward water conservation efforts. In the past four years alone, over $10 million has been spent for conservation work (not including the $6 million Effluent Recharge Project initiated in March 2001). Important projects completed during the last few years include geophysics (mapping of groundwater reserves), purchase of conservation easements, vegetative mapping of the SPRNCA, water conservation programs, and surveys/research on Threatened and Endangered species. Programmed funding for the next four years is expected to remain at $10 million. Planned projects include additional vegetative mapping and trend analysis, purchase of conservation easements, water conservation programs, and capture/recharge of urban storm water runoff.

The primary funding source to implement conservation measures is the Environmental Compliance Achievement Program (ECAP). This type of funding must be obligated between October 1 and September 30 of each fiscal year and is programmed through the Environmental Program Requirements (EPR) process. Except for salaries, ECAP funding is based on individual projects. As an example, project HUAS91-020, Comply with BO (Monitor Spotted Owl/Peregrine Falcon), is the funding mechanism to meet the monitoring conservation measure for these species. A completed BO constitutes a compliance agreement and projects in support of the BO are placed in the “must fund” category. All EPR project submissions are reviewed by the environmental attorney, the Staff Judge Advocate, and then approved by the Commanding General at Fort Huachuca. Legal and technical reviewers at higher headquarters and Department of Army closely scrutinize project narratives and justification. Approved projects for Fort Huachuca are shown in Table 16 and project printouts are contained in Appendix R.

TABLE 16 APPROVED PROJECTS FOR FORT HUACHUCA

		PROJECT FUNDING $(000)							
EPR #	Project Name	FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10
HUAF010002	Comply with BO (Water Mgt. Plan)	50	50	50	50	50	50	50	50
HUAF010003	Comply with BO (USPP)	500	500	500	150	150	150	150	150
HUAF010004	Comply w/BO (Monitor Umbel & Flycatcher in SPRNCA)	55	100	140	60	60	110	140	70
HUAF980014	Comply w/BO (Agave GMT)	50	90	90	50	50	30	30	30
HUAF980015	Comply w/BO (Aquatic Species MGT.)	35	85	85	90	90	90	90	90
HUAF980016	Comply w/BO Implement ESMP (Cand sp)	30	30	30	30	30	30	30	30
HUAF980018	Comply with BO (Protect SWWF)	300	325	325	325	325	325	325	325
HUAF980020	Implement INRMP (Invasive Species)	100	50	50	50	50	50	50	50
HUAS91-020	Comply with BO (MSO/pereg)	40	60	60	60	60	60	60	60
HUAS960002	Comply w/BO (Water Conservation)	308	300	300	500	400	200	200	200
HUAS960003	Comply w/BO (Fire MGT.)	120	160	160	160	170	170	170	170
HUAS960010	Comply w/BO (MOA w/Forest Service)	25	30	30	30	30	30	30	30
HUAS960011	Comply w/BO (LLNB MGT.)	50	50	40	40	40	40	40	40
HUAS960012	Implement ESMP (BA)	10	10	10	10	10	10	10	10
HUAS960014	Implement ESMP (Subsurface Survey)	100	100	100	100	100	100	100	100
HUAS010001	Prepare/Update ESMP	25	25	25	25	25	25	25	25
HUAS030005	Implement INRMP (EA)	30	30	30	30	30	30	30	30
HUAS950025	Implement ESMP (Spotted Owl)	50	60	60	60	60	60	60	60
HUAS96	Implement ESMP (Mountain Front Recharge)	150	500	150	150	100	100	100	100
	PROJECT TOTAL	2028	2555	2235	1970	1830	1660	1690	1620
HUAS020005	Program Management (CNS)	430	452	458	458	458	458	458	458
	ECAP TOTAL	2458	3007	2693	2428	2288	2118	2148	2078

Funding for two biologists and one ecologist is also obtained through the EPR process. However, salaries are not broken out separately for endangered species compliance. Program management (salaries, supplies and vehicles) is broken out by pillars (compliance, conservation, and pollution prevention). Project HUAS020005 is used to program funding for Fort Huachuca's conservation program (endangered species, NEPA, cultural resources, and natural resources). These are "must fund" requirements for the Army.

There are other Army funding sources for conservation measures. One is the MCA program. Approximately $12 million has been approved for Phase I and Phase II, Effluent Recharge and Reuse Project. Military pay is funded separately and active Army individuals who expend significant time in support of endangered species compliance include the commanding general, garrison commander, Staff Judge Advocate, the Deputy Staff Judge Advocate, and the Public Affairs Officer. There are other civilian and contractor employees that provide important technical and legal support to the compliance program. Currently, the Army Corps of Engineers provides a half man-year of support through the Installation Support Office.

Another source of revenue comes from the water mitigation policy. Organizations that have an increased mission or new organizations coming to Fort Huachuca are required to pay a mitigation fee to offset the water usage associated with any increase in personnel numbers. Funding received for this mitigation will be used for water conservation, conservation easements, or storm water retention.

5.4.4 MONITORING AND SURVEYING OF LISTED AND CANDIDATE SPECIES

Fort Huachuca has monitored listed, candidate and sensitive species and conducted surveys on a recurring basis. Funding has been requested through the EPR budget process for future years. Specifics are not included for annual surveys based on existing protocols since this process is well established. Additional detail for different monitoring periods or detailed requirements is in Section 5.5 which addresses these species on an individual basis.

5.4.5 PROTECTION OF LISTED AND CANDIDATE SPECIES

Fort Huachuca has implemented several actions to protect federally listed threatened and endangered as well as candidate species and their habitat across the installation. These include, but are not limited to the following measures:

a. Off road travel and pyrotechnics are prohibited in agave management areas.

b. Off road travel is prohibited.

c. Warning signs and physical protection (i.e. boulders, fencing, etc.) have been completed and are being maintained.

d. Annual reports have been submitted and current year work plans developed. Fort Huachuca will continue to report and jointly develop work plans with the Service.

5.4.6 INTEGRATED TRAINING ARMY MANAGEMENT (ITAM)

The US Army ITAM program is designed to provide sustainable training lands. There are four main components to the ITAM program. These are Land Condition Trend Analysis, Environmental Awareness, Land Rehabilitation and Maintenance (LRAM), and Training Requirements and Integration. An ITAM coordinator was hired in 2001 and works in the Range Scheduling Office. Support includes Geographic Information Systems, fire planning, environmental awareness, adherence to training restrictions, monitoring training areas, and projected funding for erosion control/watershed improvement and other training lands enhancement projects on the installation. Close coordination and a good working relationship exists with ENRD. Project funding is anticipated in 2003 and will be accomplished through the Natural Resources Conservation District.

5.4.7 FIRE MANAGEMENT

During fire suppression, prescribed fire, and managed natural fire activities on the installation, the following measures shall be implemented:

a. One of the objectives of fire activities shall be protection of agave, LLNB, Huachuca water umbel, Mexican spotted owl and Sonora tiger salamander populations. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

b. A Resource Advisor(s) shall be on the fire during all activities. Resource Advisors shall be qualified biologists designated to coordinate listed and sensitive species and serve as an advisor to the fire boss. They shall also serve as field contact representatives responsible for coordination with the Service. They shall monitor fire activities to ensure the protective measures endorsed by the fire boss are implemented. Resource Advisors shall be on call 24 hours a day during the fire season.

c. Off-road vehicle activity shall be kept to a minimum. Vehicles shall be parked as close to roads as possible, and vehicles shall use wide spots in roads or disturbed areas to turn around. If off-road travel is necessary, local fire-fighting units should go off-road first because of their knowledge of the area.

d. Use of tracked vehicles shall be restricted to improving roads or constructing lines where a short distance of line might save a large area from fire.

e. The Fort shall, to the extent possible, obliterate vehicle tracks made during the fire, especially those of tracked vehicles.

f. Areas disturbed for crew camps, landing strips, staging areas, and any other new areas of disturbance created during the fire shall be kept to the minimum area possible and shall be located in previously disturbed sites whenever possible.

g. The Fort in coordination with the Service shall develop a mitigation/monitoring plan or each prescribed fire, managed natural fire, or fuels treatment that may adversely affect listed species. The mitigation/monitoring plan shall ensure that adverse effects to listed species and their habitat are minimized. The effects of prescribed fire and fuels treatment on listed species and its habitat shall also be monitored. Mitigation/monitoring plans shall be approved by the Service prior to implementing prescribed fire or fuels management. Mitigation and monitoring for managed natural fire that has the potential to affect listed species shall be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

h. The Fort shall develop and implement a Fire Management Plan to address suppression and prescribed fire. As part of the planning effort, the Fort shall establish a schedule and implement as soon as possible prescribed burns and/or fuels management to reduce fuel loading in Fort Huachuca woodlands, thereby reducing the potential for stand-replacing fires.

i. The Fort Huachuca Fire Department will black line or burn out from Alpha Break into the area where ignitions are most prominent from Range 6 to Range 10. A line will be burned out along the north side of Range 6, the south side of Range 10, and along Alpha Break One which is located up canyon from where most ignitions occur on Range 9. In a normal year, a black line would be burned in the Spring and in the Fall if needed. The width of the line would vary with fuel type, topography, and with risk of escape beyond the break, but the goal will be to establish a black line of 100 feet in width.

j. The Fort Huachuca Fire Department will be present on small arms firing ranges whenever tracer rounds are fired and will confine and contain any fires that are ignited in front of the black line to Alpha Break under appropriate conditions. All fires ignited west of Alpha Break will be managed as a suppression action.

k. Additional information is contained in specific species conservation measures and the project listing.

5.4.8 RECREATION MANAGEMENT

Since September 2001, Fort Huachuca has been a closed post with access only by authorized personnel. At lower threat levels, recreational access is permitted with vehicle registration and proof of insurance. Night travel is prohibited on secondary roads including Huachuca and Garden Canyons. Recreation management measures that have been implemented include:

- Boulder Placement and warning signs around known populations of Huachuca water umbel;

- Warning signs and Boulder Placement to Protect Upper Garden Canyon Pond, Tinker Pond and riparian areas;

- Recreational restrictions to protect MSO and critical habitat;
- Seasonal Closure and protection of LLNB roost sites;
- Closure of Gate 7 to all vehicles;
- Restricted vehicle access to include no off road vehicle use;
- Additional restriction on the use of live bait as outlined in the Fort's fishing fact sheet;
- Other measures are contained in the project list at the end of this section.

5.4.9 ENVIRONMENTAL AWARENESS EDUCATION

The Fort shall continue to provide information and education (including protected resource identification) to military units, civilians, contractors and the general public. Range Scheduling, the ITAM coordinator and ENRD will ensure that units training on the installation become familiar with environmental policies and operational requirements. Personnel training in the Huachuca Mountains shall, through the environmental awareness training, be made aware of the protected status of listed species and these terms and conditions, but specific locations of listed species shall not be revealed unless absolutely necessary to protect the species.

Also, information shall be provided through the Newcomer's Briefing, Fort Huachuca 40-Hour Resource Conservation and Recovery Act (RCRA) course, Pre-Commander's Course, Fort Huachuca Conservation Committee, Environmental Quality Control Committee, and unit/organization briefings.

5.4.10 INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (INRMP)

The Fort Huachuca INRMP was completed in November 2001 in compliance with Public Law 105-85, Sikes Improvement Act of 1997 (16 USC 670 *et seq*). This plan provides the basis and criteria for protecting and enhancing natural resources using watershed, landscape, and ecosystem perspectives, consistent with the military mission. At a regional scale, the INRMP guides Fort Huachuca cooperation in renewable natural resources conservation at a landscape scale. The USFWS and AGFD have concurred with the plan and it is currently being implemented.

5.4.11 AGAVE MANAGEMENT PLAN

The Fort will continue to implement this plan in order to maintain self-sustaining natural populations of *Agave palmeri*. The preferred method if the proposed construction site impacts more than 25 agave plants is to move the construction site. If unable to do so, the Fort shall explore methods of transplanting agave that would otherwise be destroyed by construction activities. Previous efforts (primarily mitigation for training damage) have not been successful. Additional protection is required and the Fort shall experiment with different methods.

Recommended methods that emerge from the experiment should be cost effective and exhibit reasonable long-term success (survival of at least 50% of wild plants of similar age classes in similar habitats).

The agave management plan will be revised in 2003.

5.5 SPECIES SPECIFIC CONSERVATION MEASURES

5.5.1 HUACHUCA WATER UMBEL (ENDANGERED) WITH CRITICAL HABITAT

1. Fort Huachuca will conduct an inventory of all potential umbel habitat on the installation every three years with frequency transects conducted at documented umbel populations in the other two years.

2. On the SPRNCA, Fort Huachuca will conduct an inventory of all potential umbel habitats every three years. No frequency transects are required. All inventory and monitoring activities will be conducted from September 15 through October 31 of each year.

3. The Fort shall maintain rock barriers around Huachuca water umbel populations.

4. The Fort shall initiate prescribed fire and fuel management in the Huachuca Mountains.

5. The Fort shall maintain the barrier to vehicle travel at Gate No. 7.

6. General fire coordination shall be accomplished as specified in Section 5.4.7.

7. The Fort shall fund water umbel habitat management or restoration where habitat has been degraded or lost, or where potential exists for creating water umbel habitat. Assistance shall take the form of funding and/or technical assistance. Projects funded should include both off-post and on-post projects. On-post activities could include restoration and protection of cienega conditions in Garden Canyon and other wet sites. Off-post, the Fort could assist BLM, the Coronado National Forest, or other land owners/managers of water umbel habitat potentially affected by the proposed action. Off-post projects that the Fort should consider funding include cienega restoration or protection in Scotia Canyon or elsewhere in the Huachuca Mountains, if approved by and coordinated with the Coronado National Forest, and restoration or protection of cienega conditions on the San Pedro RNCA, if approved by and coordinated with the BLM. All plans and agreements for funded projects shall be coordinated with and approved by the Service.

8. The Fort shall monitor and document any disturbance of umbel or habitat. This and other monitoring required here will be reported to the Service pursuant to the "reporting requirements" described below.

9. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out direct, indirect, interdependent and interrelated effects. Cumulative effects will be balanced by regional efforts, chiefly the USPP.

10. Complete a Huachuca Water Umbel Endangered Species Management Plan in 2003.

11. All maintenance activities in Garden Canyon will occur within the existing roadbed or catch basins and will only occur during the day. Silt fencing will be used where there is the potential for sediment to enter Garden Canyon Creek. No vegetation will be removed outside of the existing roadbed and no invasive plant or animal species will be introduced. No water will be used from Garden Canyon Creek. Contractors will be trained to recognize Huachuca water umbel and instructed to follow these conservation measures.

5.5.2 LESSER LONG-NOSED BAT (ENDANGERED)

1. The Fort shall ensure that construction, upgrading, or maintenance of roads does not increase or facilitate public access to Manila Mine, Pyeatt Cave, or other day roosts identified during the life of the project.

2. The Fort is in the process of installing a new surveillance system because the previous system was unreliable. The system shall be operational by July 2002. Access routes at the closures and the mine/cave sites are posted with the following information: no vehicle access, no entry into mines or caves, explanations that the closures are needed to protect sensitive species, and warnings that entry into the mines/caves could represent a violation of the ESA. Fort Huachuca will continue to maintain the signs. Current access control will continue with no access from July 1 to October 31unless bats are present which would expand the closure period.

3. Monitoring shall be conducted per Section 5.4.4.

4. The Fort shall prohibit low-level helicopter flights within 350 feet of Pyeatt Cave, Manila Mine, or other day roosts identified during the life of the project from July 1 to October 31, unless bats are present which would expand the prohibition.

5. Prior to construction activities, pre-construction surveys shall be conducted for paniculate agaves that may be directly affected by construction activities. If agaves are found during pre-construction surveys, the following measures shall be implemented:

    a. Disturbance shall be limited to the smallest area practicable, damage to agaves shall be avoided where possible, and projects shall be located in previously disturbed areas whenever possible.

b. Vehicle use shall be limited to existing routes and areas of disturbance except as necessary to access or define boundaries for new areas of construction or operation.

c. All workers shall strictly limit their activities and vehicles to designated areas. Construction workers shall be informed of these terms and conditions.

6. No seeding/planting of nonnative grasses or other plants shall occur at Fort Huachuca that may alter fire frequencies in wildland areas. However, seeding with hybrid sterile seeds in disturbed construction sites is authorized to establish a temporary ground cover for erosion control. This is only authorized during fall and spring when it is not feasible to seed with native species.

7. General fire coordination shall be accomplished as specified in Section 5.4.7. Also, the following measures will be implemented:

   Prescribed fire and managed natural fire shall be planned to minimize adverse effects to lesser long-nosed bat forage plants and roosts. Measures shall be developed to ensure the following:

   1) The fire kills no more than 20% of agaves that are burned during prescribed fire or managed natural fire.

   2) Fires in agave management areas shall be actively suppressed unless the area is approaching its natural fire return interval of 10 years.

   3) Prescribed fire shall be prohibited in agave management areas where greater than half of those agaves are young age classes (agaves with four or fewer spiral courses of leaves).

   4) A mitigation plan shall be developed by the Fort in coordination with the Service for each prescribed or managed natural fire within 0.5 mile of a lesser long-nosed bat roost or in areas that support paniculate agaves. The mitigation plan shall ensure those effects to lesser long-nosed bat roosts and forage plants are minimized and shall include monitoring of effects to forage plants. The Service shall approve the plan. Mitigation and monitoring for managed natural fire shall be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

   5) A schedule for prescribed burns shall be established and followed to reduce fuel loading in Fort Huachuca grasslands and woodlands, thereby reducing the potential for major wildfires in lesser long-nosed bat foraging and roosting habitat. This schedule shall be coordinated and approved by the Service.

6) Nighttime training shall not occur in agave management areas from July 1 through October 31.

8. No nighttime use and no tracer fire shall occur on live fire ranges 2, 3, and 4 from July 1 through October 31.

9. From July 1 - October 31, all nocturnal UAV operations at the Rugge-Hamilton and Pioneer sites will be above 500 feet agl, except for take-off and landings. Take-off and landing approaches at Rugge-Hamilton will be confined to the east and north and approaches at Pioneer will be confined to the north and west, away from agave management areas. Nocturnal rocket-assisted take-offs of UAVs from the Black Tower site shall only occur from November through June. Rocket-assisted take-offs shall be attended by fire crews due to the high probability of fire and potential adverse effects to agave communities.

10. Off-road vehicle travel shall not occur in protected agave management areas or any other part of the West Range or South Range.

11. Pyrotechnics shall not be used within 0.25 miles of protected agave management areas.

12. The Fort shall develop an endangered species management plan for the lesser long-nosed bat by June 2003.

13. The Fort shall conduct monitoring of Palmer's agave populations on the West and South Ranges every five years. The objective of the monitoring shall be to establish trends in bat forage resources.

14. Fort Huachuca shall continue to monitor around the Bergey wind turbine and wind data towers. If LLNB are found dead at the base of these structures, the Fort will initiate formal consultation.

15. The Fort shall monitor take of lesser long-nosed bats, document any disturbance of roost sites, and document acres burned on the West or South ranges and whether such fire burned in agave management areas. The results of this monitoring shall be reported to the Service pursuant to the "reporting requirements" below.

5.5.3 SONORA TIGER SALAMANDER (ENDANGERED)

1. Fort Huachuca shall conduct annual monitoring of the upper Garden Canyon pond in June or early July (pre-monsoon) of each year to determine condition of the habitat and presence of aquatic salamanders according to protocol approved by the Service.

2. General fire coordination shall be accomplished as specified in Section 5.4.7. One of the objectives of fire suppression activities shall be protection of salamanders and the

aquatic habitat at upper Garden Canyon pond, in Scotia Canyon, or other salamander localities possibly affected by fire at Fort Huachuca. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

3. The Fort shall meet the objectives contained in the Endangered Species Management Plan for the Sonora tiger salamander.

4. The Fort will maintain boulders placed around the pond's perimeter at upper Garden Canyon Pond to prevent vehicles from driving through the habitat.

5. A closure to vehicle travel shall be maintained at Gate No. 7.

6. The Fort has amended the Fort Huachuca Fishing Fact Sheet and the Fort Huachuca web site to read, "Live fish and salamanders may not be transported or used as bait on Fort Huachuca. Capture, transport, or release of salamanders is strictly prohibited." This appears in bold.

7. The Fort shall maintain the permanent all-weather sign posted at upper Garden Canyon pond. The sign contains the following information: 1. Fishing, use of nets, and capture or release of salamanders or fish is prohibited, and 2. Off-road vehicle use is prohibited.

8. The Fort shall monitor take of Sonora tiger salamanders and document any disturbance of salamanders or salamander habitat. Results of this and other monitoring required herein shall be reported to the Service pursuant to the "reporting requirements" below.

9. The Fort shall establish a schedule and implement, as soon as possible prescribed burns and/or fuels management to reduce fuel loading in Fort Huachuca woodlands.

5.5.4 SOUTHWESTERN WILLOW FLYCATCHER (ENDANGERED)

1. The Fort shall maintain existing fire breaks on the East Range.

2. The Fort shall vigorously suppress any fire on the eastern third of the East Range, except in the impact area, and implement all portions of the proposed action and proposed conservation measures relevant to fire suppression.

3. If surveys confirm presence of southwestern willow flycatchers on Fort Huachuca, the Fort shall take action to ensure that fire ignited on the training ranges does not spread to flycatcher habitat and shall work with the Service to develop and implement a plan to prevent any take of flycatchers.

4. The Fort has assessed habitat suitability for flycatchers at Research, Development, Testing, and Evaluation (RDTE) survey points along the San Pedro River and none exists. Further habitat assessments will be conducted on a periodic basis, as needed.

5. Monitoring shall be conducted per Section 5.4.4. This includes habitat on Fort Huachuca, at the Babocomari Cienega, if permission is obtained, and throughout the SPRNCA in cooperation with the BLM. Surveys shall adhere to Service protocol (Sogge *et. al.* 1997). Surveys shall include documenting flycatcher population size and distribution; identity of nesting birds (if banded); number of nesting attempts, clutch sizes, hatching success, fledgling success; causes of nest loss or failure; breeding season length; and habitat use.

6. The Fort shall monitor habitat conditions in the SPRNCA and habit acquired or for which easements/permission to enter are obtained. Aerial photos (1"=500 feet) were taken in 2000 and shall be taken of the riparian corridor in 2004 and 2008. Vegetation maps were developed in 2001and will be constructed from photo series within one year of obtaining the photographs. Resolution of the maps shall be sufficient to map vegetation patches as small as 10 acres. Vegetation typing shall be by plant species composition and vertical structure/foliage density. Sufficient ground-truthing shall be conducted to assure reasonable accuracy of the mapping effort. Vegetation mapping in 2005 and 2009 shall be accompanied by a trend analysis to determine gains or losses in flycatcher habitat.

7. The Fort shall assist BLM or other land owners/managers of habitat on the Upper San Pedro River with flycatcher habitat management, or restoration on retired agricultural lands, grazed areas, and in other areas where flycatcher habitat has been degraded or lost. Assistance shall take the form of funding and/or technical assistance. All plans and agreements for projects funded shall be coordinated with and approved by the Service.

8. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out direct, indirect, interdependent and interrelated effects. Cumulative effects will be balanced by regional efforts (communities and agencies), through the USPP and other collaborative efforts.

5.5.5 CANELO HILLS LADIES' TRESSES (ENDANGERED)

1. General fire coordination shall be accomplished as specified in Section 5.4.7. Historically, fires have been more likely to burn onto the West Range than to spread from Fort Huachuca property.

2. Fort Huachuca will maintain roads around the northwestern boundary of the installation, which act to inhibit the spread of fire.

3. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out direct, indirect,

interdependent and interrelated effects. Cumulative effects will be balanced by regional efforts, chiefly the USPP.

5.5.6 JAGUAR (ENDANGERED)

General fire coordination shall be accomplished as specified in Section 5.4.7.

5.5.7 SPIKEDACE (THREATENED) WITH CRITICAL HABITAT

1. General fire coordination shall be accomplished as specified in Section 5.4.7.

2. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out direct, indirect, interdependent and interrelated effects. Cumulative effects will be balanced by regional efforts, chiefly the USPP.

3. Erosion control measures will be implemented as described in Section 5.4.2.

5.5.8 MEXICAN SPOTTED OWL (THREATENED) WITH CRITICAL HABITAT

1. Fort Huachuca shall conduct annual monitoring of currently known PAC's and surveys of potential MSO habitat at Fort Huachuca in accordance with Service survey protocol.

2. The Fort shall complete the endangered species management plan for the MSO that conforms to and complements the MSO Recovery Plan by July 2003.

3. General fire coordination shall be accomplished as specified in Section 5.4.7.. Also, the following measures will be implemented:

    a. Areas within PACs treated to reduce occurrence of wildfire, prescribed fire or fuels management shall be monitored, as described in the Recovery Plan, to determine effects of the treatment on known owl habitat components. If adverse effects are detected, treatments shall be modified to reduce those effects as much as possible while still reducing the risk of wildfire.

    b. One of the objectives of fire suppression activities in the Huachuca Mountains shall be protection of MSO PACs. This objective will not in any way constrain the fire boss from taking any action as needed to protect life or property.

    c. If a MSO is encountered during the fire, the Resource Advisor shall be advised immediately. The Resource Advisor shall assess potential harm to the owl and advise the fire boss of methods to prevent harm. The Resource Advisor shall maintain a record of any Mexican spotted owls encountered during suppression activities. The information shall include for each owl the

location, date, and time of observation and the general condition of the owl, and response to the fire and fire activities.

d. All fire suppression actions in PACs will occur, to the maximum extent possible, using "light on the land" methods, including not removing trees over 9 inches diameter at breast height (dbh) unless it is deemed necessary by the fire boss to prevent the fire from effecting additional PAC acres, or to protect life or property.

e. Patches of unburned vegetation within burned areas in the Huachuca Mountains shall not be burned out as a fire suppression measure, except as needed to secure the fire perimeter or provide for fire fighter safety.

f. The Fort in coordination with the Service shall develop a mitigation/monitoring plan for each prescribed fire, managed natural fire, or fuels treatment that may adversely affect the MSO. Prescribed fire and fuels treatment shall be designed to protect MSOs and their habitat.

g. Treatments/prescribed fire shall not occur within a 100 acre area around spotted owl nest sites. This area shall include habitat that resembles the structural and floristic characteristics of the nest site. The 100 acre area will be protected by using topographic and other barriers, or through line construction. All line construction in PACs will occur outside the MSO breeding season, will not remove any trees larger than 9 inches dbh unless they pose a threat to the safety of fire fighters, and will only occur with a wildlife biologist from the Fort on-site.

h. Treatments shall enhance or retain owl habitat components, such as downed large logs greater than 12 inches in midpoint diameter, hardwoods, grasses, forbs, and shrubs, while still reducing the chance of wildfire. In regard to downed logs, this shall be achieved by protecting 80-90% of the downed logs 12 inches diameter or larger, and hand-lining snags 18 inches dbh or larger for all managed natural fire actions within PACs.

i. Treatments shall produce a mosaic of habitat components within PACs.

j. Prescribed or managed natural fire shall be introduced in PACs in blocks of 100-acres or less, and only between September 1 and February 28, outside the MSO breeding season.

k. Prescribed or managed natural fire shall be introduced into potential MSO nest/roost habitat only if at least two years of surveys, in accordance with Service protocol has been conducted, and for which one year of follow-up survey (four visits) has been conducted, if more than one breeding season has elapsed since the last survey to protocol and the action. Furthermore, introduction of fire into PACs shall only occur if the nest/roost site is known

the year of the action, or for which nest/roost site information is less than three years old. If nest/roost information for a PAC is three years old or more, a 200-acre nest buffer shall be deferred from treatment until such a time, as the nest/roost can be located again.

l. All prescribed or managed natural fire shall be suppressed if it is anticipated that the fire may burn out of prescription in the following 24 hours. The Fort may choose to suppress actions prior to this.

m. For prescribed or managed natural fire, the Fort shall ensure that no more than 10% of the canopy of each PAC will be affected by gaps created by single or groups of trees crowning. Groups of trees that "crown out" shall not exceed two acres in size.

n. The Fort shall ensure that no more than two PACs per year on Fort Huachuca are affected by prescribed or managed natural fire. A PAC is considered affected if one or more acres of the PAC are burned to any degree. If prescribed or managed natural fires in one year are located in PAC(s) outside of the nest buffer, and are 1-10 acres in size, the Fort will discuss with the Service the option of allowing prescribed or managed natural fire to occur in one additional (or the same) PAC.

o. The effects of prescribed fire, managed natural fire, and fuels treatment on the owl and its habitat shall be monitored. Such monitoring shall include quantifying acres of 100-acre activity centers, PACs, and potential habitat affected by these activities.

p. The Service shall approve Mitigation/monitoring plans. Such plans shall be developed prior to implementation of prescribed fire. Mitigation and monitoring for managed natural fire that may adversely affect the MSO shall be coordinated with and approved by the Service as soon as possible after a decision is made to let a natural fire burn under controlled conditions.

q. Areas of significant human activity during fire suppression operations, prescribed fire, or managed natural fire in the Huachuca Mountains such as fire crew camps, landing strips, and equipment staging areas, shall be located outside of PACs. Areas disturbed during fire suppression activities in the Huachuca Mountains such as fire lines, crew camps, and staging areas shall be rehabilitated. Including the obliteration of fire lines to prevent their use by vehicles or hikers.

4. Within canyons containing active MSO nests, or in canyons where occupancy or reproductive status is unknown, the Fort shall minimize low-level helicopter flights within 1.0 mile of the nest, or the site of the last previously known nest. Helicopter flights closer than 0.25 mile to active nests shall be prohibited from March 1-August 31.

5. If MSOs are found nesting in Garden Canyon within 0.25 mile of the rappelling cliffs, rappelling shall be halted or moved at least 0.25 mile from the active nest from March 1 through August 31, or until nestlings fledge.

6. The Fort shall maintain the permanent all-weather sign near the Scheelite Canyon trailhead (but not visible from the Garden Canyon Road) that informs visitors of the following:

    a. The Canyon is home to sensitive species.

    b. Visitors should stay on the trail and be as quiet and unobtrusive as possible.

    c. Groups of visitors are limited to 12 or less.

    d. Calling, hooting, or playing of taped recordings to elicit responses from or to locate owls is prohibited in Scheelite Canyon without special permit from the US Fish and Wildlife Service.

    e. Smoking is prohibited.

7. All maintenance activities in Garden Canyon will occur within the existing roadbed or catch basins and will only occur during the day. Silt fencing will be used where there is the potential for sediment to enter Garden Canyon Creek. No vegetation will be removed outside of the existing roadbed and no invasive plant or animal species will be introduced. No water will be used from Garden Canyon Creek. Contractors will be trained to recognize Mexican spotted owls and instructed to follow these conservation measures.

8. The Fort shall monitor take of MSOs and document any disturbance of owls or owl habitat. This and other monitoring required here will be reported to the Service pursuant to the "reporting requirements" described below.

5.5.9 BALD EAGLE (THREATENED)

1. Fort Huachuca shall continue to monitor around the Bergey wind turbine and wind data towers. If bald eagles are found dead at the base of these structures, the Fort will initiate formal consultation.

2. Records of sightings on Fort Huachuca shall be maintained by ENRD.

5.5.10 LOACH MINNOW (THREATENED) WITH CRITICAL HABITAT

1. General fire coordination shall be accomplished as specified in Section 5.4.7.

2. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out direct, indirect, interdependent and interrelated effects. Cumulative effects will be balanced by regional efforts, chiefly the USPP.

3. Erosion control measures will be implemented as described in Section 5.4.2.

5.5.11 RAMSEY CANYON LEOPARD FROG (CONSERVATION AGREEMENT)

1. Fort Huachuca shall continue to meet obligations in the Conservation Agreement.

2. General fire coordination shall be accomplished as specified in Section 5.4.7.

3. Erosion control measures will be implemented as required to protect habitat.

4. Fort Huachuca will maintain existing habitat protection measures (signs, boulder placement, etc.).

5.5.12 HUACHUCA SPRING SNAIL (CANDIDATE)

1. General fire coordination shall be accomplished as specified in Section 5.4.7.

2. Species monitoring is scheduled for 2002 and will be conducted periodically as needed.

3. Erosion control measures will be implemented as required to protect habitat.

4. Habitat protection measures (i.e. fencing, boulders, etc.) will be installed as needed.

5.5.13 YELLOW-BILLED CUCKOO (CANDIDATE)

1. General fire coordination shall be accomplished as specified in Section 5.4.7.

2. Fort Huachuca's water conservation, effluent recharge, purchase of conservation easements and storm water recharge efforts will balance out direct, indirect, interdependent and interrelated effects. Cumulative effects will be balanced by regional efforts, chiefly the USPP.

3. Erosion control measures will be implemented as described in Section 5.4.2.

5.6 REPORTING REQUIREMENTS

For the duration of the proposed action, the Fort will prepare and deliver to the USFWS annual reports documenting progress/results in implementation of all conservation measures. These will include actions taken, problems encountered, any take of listed species documented, copies of reports and data sheets for habitat monitoring and species surveys, effectiveness of the

conservation measures, and recommendations on how to modify the measures to enhance protection of listed species or reduce needless hardship on the Fort or its contractors. Reports shall be due January 31st of each year.

As discussed in Section 5.4.3, each year after Fort Huachuca receives approved funding, an annual meeting will be held with the USFWS to discuss development of an annual work plan. The annual work plan will contain all proposed actions the Fort plans to implement in the upcoming year to meet the requirements in its biological opinion. The annual meeting, work plan and report will serve as a key check and balance to ensure that Fort Huachuca is fulfilling its obligations under the Endangered Species Act.

5.7 MANAGEMENT RESPONSIBILITIES

The US Army is responsible for managing all military and civilian activities on the Fort Huachuca military reservation. Fort Huachuca is currently under the management of TRADOC. Effective October 1, 2002, however, Fort Huachuca's installation management functions, including environmental management, will fall under the Southwest Regional Office of the new Army Installation Management Agency, located in San Antonio, Texas.

Fort Huachuca is home to several military organizations including the USAIC (comprised primarily of the111th and 112th MI Brigades), Headquarters for the US Army Signal Command, the 11th Signal Brigade, the EPG, the Joint Interoperability Test Center, and other partner activities. As the management and scheduling authority for all military activities on Fort Huachuca, the Army is responsible for adherence to all conservation measures set forth in this BA and compliance with the resulting BO.

To ensure that operations will be conducted in compliance with environmental requirements that come from this consultation, a management representative (point of contact) will be designated from the Range Control Operations office. This management representative has the authority to halt activities that are inconsistent with the BO. The management representative will routinely coordinate with Fort Huachuca's ENRD. The ENRD will in turn coordinate with the designated USFWS representative on matters concerning this consultation.

All military units, agencies, and organizations using Fort Huachuca ranges and training areas are required to submit a range/training request to Range Scheduling, including information regarding the requested use, number, and types of troops and vehicles, and duration of training. Unit commanders will ensure that unit personnel are adequately trained in natural resource protection procedures, that the unit has adequate fire suppression capabilities, and that all restrictions or guidelines for training or testing are followed. Both the Range Control Operations Office and the ENRD will oversee unit activities and training in this regard. Failure to follow all range procedures could result in loss or limitation of range privileges at the discretion of the Range Control Officer.

The Range Control Officer is responsible for reviewing range/training area requests; maintaining a database of range usage and training man-hours; performing scheduled or unscheduled checks

of ranges and training areas to ensure compliance with range use procedures; and limiting use of ranges as required by environmental conditions.

5.8 TIMELINE TO IMPLEMENT CONSERVATION MEASURES

The below timeline establishes, by year and project, Fort Huachuca's commitment to accomplish the conservation measures detailed in this BA. As noted at the outset of this section, Fort Huachuca's on-post water use will be reduced to zero by the year 2007. Even more significantly, by the year 2011, Fort Huachuca commits to balancing on-post and off-post water use that is attributable to it (2,784 ac-ft). In doing so, the Fort will offset the potential effects of the Fort's water use on all listed species, and achieve a "no effect" on listed species by the year 2011. Consequently, for planning purposes only, the below timeline extends only through 2011 because that is when Fort Huachuca will reduce its water consumption in the Sierra Vista subwatershed to zero.

While net water conservation, recharge and reuse are an important part of the proposed action, other projects to support threatened and endangered species and their habitat are also important. Some individual project flexibility is intended in order to take specific advantage of opportunities in a given year. For example if an opportunity arose to purchase a conservation easement which significantly reduced agricultural pumping near the San Pedro River, funds could be reprogrammed from other projects to take advantage of that previously unforeseen opportunity.

Proposed projects for each year will be included in the annual work plan and discussed during the annual meeting with the USFWS. The status of projects, additions or deletions, and any revision to this timeline will be coordinated with the USFWS through the annual work plan, annual meetings, annual reporting, or informal or formal consultation – as appropriate.

TABLE 17 CONSERVATION MEASURES ACCOMPLISHED ON AN ANNUAL BASIS

Project	EPR	Estimated Cost	COMMENT
Comply with BO Water Management Plan (Annual Update)	HUAF010002	$ 50K	Assess progress and identify new technology
Comply with BO (USPP)	HUAF010003	$ 150-500K Contract	Fort Huachuca also provides substantial support (civilian and military employees)
Comply with BO (Agave Management)	HUAF980014	$ 30 - 50K	Burn mortality, inventory, etc.
Comply with BO Aquatic Species	HUAF980015	$ 35 - 90K	Inventory,, habitat protection, etc.
Implement ESMP Candidate Species	HUAF980016	$ 30K	Inventory,, habitat protection, etc.
Comply with BO Protect SWFFL	HUAF980018	$ 300 - 325K	Erosion control, fire protection, etc.
Comply with BO Peregrine/MSO	HUAS91-020	$ 40 -$60K	Survey, habitat protection, etc.
Comply with BO Fire Management	HUAS960003	$ 120 -170K	Burn plan, prescribed burn, thinning, etc.
Comply with BO MOA with Forest Service	HUAS960010	$ 20 – 30K	Provide funding for support
Meteorological Stations and Stream Gauging	HUAF010003 HUAF980015	$25 - $ 50K	Real time data and weather information
Comply with BO (LLNB)	HUAS960011	$ 40 - 50K	Monitor, maintain surveillance equipment, etc.
Implement INRMP Invasive Species	HUAF980020	$ 50 - 100K Contract	Inventory, prescribed burn, etc.
Implement ESMP Biological Assessments	HUAS960012	$ 10K	If required for supporting mission
Implement ESMP Subsurface Survey	HUAS960014	$ 100K	Normally with USGS
Update ESMP	HUAS010001	$ 25K	
Implement INRMP Environmental Awareness	HUAS030005	$ 30K	Posters, materials, GIS support
Implement ESMP MSO	HUAS950025	$ 50 – 60K	Habitat improvement, research, etc.
Implement ESMP Mountain Front Recharge	HUAS96	$ 100 - 150K	Detention basins, design, etc.
Manpower, Supplies, GSA Vehicles	HUAS020005	$ 306K	In house management efforts
Comply with BO (Umbel Flycatcher in SPRNCA)	HUAF010004	$ 55K	Survey, report, etc.
Implement INRMP	HUAS96011	$ 125K	Nuisance wildlife, habitat improvement, etc.

TABLE 18 PROJECTS SCHEDULED FOR FISCAL YEAR 2002

Project	EPR or Other Funding Source	Estimated Cost	Comment
Complete AWRMP	HUAF010002	$ 182K	Phase I completed
Construct Retention Basin Graveyard Gulch	HUAF980018	$ 373K	Construction Ongoing
Provide Bat Roost Video Monitoring and Tie Into Military Police	HUAS960011	$ 100K	Project In Progress
Horizontal Axis Washers	HUAS960002	$ 100K	Purchased
Begin Construction of Urban Run Off Basin Hatfield Street			Design Revision at 90% June 2002
Increase Effluent Convert 19th Hole to Sanitary Sewer			Design Ongoing
Complete Phase I Effluent Recharge	Military Construction	$ 6M	Basins 99% Complete
Increase Effluent Inspect and Clean Wastewater Collection	HUAS960002	$ 45.7K	Complete
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Fire Management Thin Oaks Burn Slash Black Line Alpha Break Maintain Fire Breaks Support Research Plot Burns	HUAS960003	$ 158K	
Xeriscape	HUAS960002	$ 78K	Complete

TABLE 19 PROJECTS SCHEDULED FOR FY 2003

Project	EPR or Other Funding Source	Estimated Cost	Comment
Upgrade Irrigation System at Golf Course	Non-Appropriated Funds	$ 1.2M	Project requires Fort profitability – Illegal to fund with ECAP
Design Soldier Creek Detention Basin	HUAS96	$ 80K	
Increase Effluent Convert Main Gate to Sanitary Sewer			
Geophysics Survey	HUAS960014	$ 100K	
Begin Phase II Effluent Reuse	Military Construction	$ 6M	Repair Collection System Extend Effluent Piping for Irrigation
Increase Effluent Inspect and Clean Wastewater Collection	HUAS960002	$ 50K	Final Phase
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Fire Management Maintain Fire Breaks Black Line Alpha Break Support Research Plot Burns	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Horizontal Axis Washers	HUAS960002	$ 100K	MWR Facilities AAFES Laundromat
Xeriscape	HUAS960002	$ 45K	
Design Ph II Hatfield Basin	HUAS96	$ 50K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	
Rooftop Capture For Irrigation	HUAS96002	$ 75K	
Xeriscaping	HUAS960002	$ 80K	LAAF Ops

TABLE 20 PROJECTS SCHEDULED FOR FY 2004

Project	**EPR or Other Funding Source**	**Estimated Cost**	**Comment**
Xeriscaping	HUAS960002	$ 45K	Main Chapel
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Construct Soldier Creek Detention Basin	HUAF980018	$ 400K	
Increase Effluent Convert Black Tower to Sanitary Sewer			
Fire Management Maintain Fire Breaks Black Line Alpha Break Support Research Plot Burns	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	
Project	EPR or Other Funding Source	Estimated Cost	Comment
Project	EPR or Other Funding Source	Estimated Cost	Comment
Aerial Photos Riparian Corridor	HUAF980018	$ 75K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	

TABLE 21 PROJECTS SCHEDULED FOR FY 2005

Project	EPR or Other Funding Source	Estimated Cost	Comment
Xeriscaping	HUAS960002	$ 45K	
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Design Phase III E Range Detention Basin	HUAS96	$ 80K	
Vegetative Mapping Riparian Corridor	HUAF980018		
Fire Management Maintain Fire Breaks Black Line Alpha Break Support Research Plot Burns	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	

TABLE 22 PROJECTS SCHEDULED FOR FY 2006

Project	EPR or Other Funding Source	Estimated Cost	Comment
Xeriscaping	HUAS960002	$ 45K	
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Construct Phase III E Range Detention Basin	HUAF980018	$ 400K	
Fire Management Maintain Fire Breaks Black Line Alpha Break	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	
Construct Hatfield Ph III Basin	HUAS96	$ 50K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	

TABLE 23 PROJECTS SCHEDULED FOR FY 2007

Project	EPR or Other Funding Source	Estimated Cost	Comment
Continue to Seek Conservation Easements	HUAS96002	$ 300K	
Project	EPR or Other Funding Source	Estimated Cost	Comment
Design Phase IV East Range Detention Basin	HUAS96	$ 80K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	
Fire Management Maintain Fire Breaks Black Line Alpha Break	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	

TABLE 24 PROJECTS SCHEDULED FOR FY 2008

Project	EPR or Other Funding Source	Estimated Cost	Comment
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Fire Management Maintain Fire Breaks Black Line Alpha Break	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Construct Phase IV East Range Detention Basin	HUAF980018	$ 400K	
Aerial Photos Riparian Corridor	HUAF980018	$ 75K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	

TABLE 25 PROJECTS SCHEDULED FOR FY 2009

Project	EPR or Other Funding Source	Estimated Cost	Comment
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Fire Management Maintain Fire Breaks Black Line Alpha Break	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Vegetative Mapping Riparian Corridor	HUAF980018		
HUAS96	$ 80K	$ 250K	
Project	EPR or Other Funding Source	Estimated Cost	Comment
Rooftop Capture For Irrigation	HUAS960002	$ 75K	

TABLE 26 PROJECTS SCHEDULED FOR FY 2010

Project	EPR or Other Funding Source	Estimated Cost	Comment
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Fire Management Maintain Fire Breaks Black Line Alpha Break	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS96002	$ 150K	
Construct Phase V East Range Detention Basin	HUAF980018	$ 425K	
Grey Water Housing Areas and Barracks	HUAS960002	$ 250K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	
Construct West Range Detention Basin	HUAF980018	$ 425K	

TABLE 27 PROJECTS SCHEDULED FOR FY 2011

Project	EPR or Other Funding Source	Estimated Cost	Comment
Continue to Seek Conservation Easements	HUAS960002	$ 300K	
Fire Management Maintain Fire Breaks Black Line Alpha Break	HUAS960003	$ 160K	
Replace Evap Cooling with A/C	HUAS960002	$ 150K	
Rooftop Capture For Irrigation	HUAS960002	$ 75K	

SECTION 6
REFERENCES

Abbate, D. 1998. Arizona Game and Fish Department. 1997. Sonora tiger salamander surveys. Presentation to the Fourth Annual Meeting of the Southwestern Working Group of the Declining Amphibian Populations Task Force, Phoenix, AZ.

Advisory Panel on the Upper San Pedro Initiative. 1998. Advisory Panel report on the Upper San Pedro River Initiative, recommendations and findings presented to the Commission for Environmental Cooperation. Http://cec.org/english/new/spagre.cfm?format=1.

ADWR (Arizona Department of Water Resources) 1988. Water resources of the upper San Pedro basin, Arizona. Phoenix, AZ: Arizona Department of Water Resources, Hydrology Division. 158 pp.

ADWR 1990. Water Resources of the Upper San Pedro Basin, Arizona, 1998: Arizona Department of Water Resources, Hydrology Division. 158 p. Revised 1990.

ADWR 1991. Nov. Hydrographic survey report for the San Pedro River watershed. Volume 1: general assessment, in re the general adjudication of the Gila River system and source. Phoenix, AZ: ADWR. Filed with the Court, November 20, 1991, 548 pgs.

ADWR 1994. Upper San Pedro River case study. Pages 147-208 in Arizona riparian protection program, legislative report, July 1994.

ADWR 1995. Water Resources of the Upper San Pedro River Basin, AZ. Hydrology Division, July.

ADWR 1996. Groundwater Flow Model Scenarios of Future Groundwater and surface Water conditions: Sierra Vista Subwatershed of the Upper San Pedro Basin - Southeastern Arizona. Modeling Report No. 10, August; Supplement, November.

Affolter, J.M. 1985. A Monograph of the Genus *Lilaeopsis* (Umbelliferae). Systematic Botany Monographs Volume 6: 1-140.

AGFD (Arizona Game and Fish Department) 1993. *Pyrgulopsis thompsoni*. Unpublished abstract compiled and edited by the Heritage Data Management System. Arizona Game and Fish Department, Phoenix, Arizona. 3 pp.

AGFD 1995. *Rana subaquavocalis*. Unpublished abstract compiled and edited by the Heritage Data Management System. Arizona Game and Fish Department, Phoenix, Arizona. 2 pp.

AGFD 1996. Wildlife of special concern in Arizona, public review draft. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, Arizona.

AGFD 1997. *Lilaeopsis schaffneriana* ssp. *recurva*. Unpublished abstract compiled and edited by the Heritage Data Management System. Arizona Game and Fish Department, Phoenix, Arizona. 4 pp.

AGFD 1998. *Coccyzus americanus occidentalis*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. Xpp.

AGFD 1999. The Black tailed Prairie Dog Conservation Assessment and Strategy. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program. Phoenix, Arizona. 9 September 1999.

AGFD 2000. *Spiranthes delitescens.* Unpublished abstract compiled and edited by the Heritage data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4pp.

AGFD 2001a. *Rana chiricahuensis.* Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 5pp.

AGFD 2001b. *Rana subaquavocalis*. Unpublished abstract compiled and edited by the heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4pp.

AGFD 2001c. Heritage Data Management System. *Pelecanus occidentalis californicus* species account for Cochise County. 28 August 2001.

AGFD 2001d. *Glaucidium brasilianum cactorum*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4pp.

AGFD 2001e. *Crotalus willardi obsurus* Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4pp.

AGFD 2001f. *Gila intermedia*. Unpublished abstract complied and edited by the Heritage Data Management System, Arizona Game and Fish Department Phoenix, AZ. 6pp.

AGFD 2001g. *Tiaroga cobitis.* Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 5pp.

AGFD 2001h. *Media fulgida.* Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 3pp.

AGFD 2002. Arizona's Nongame News. Arizona Game and Fish Department, WMNG, Phoenix, Arizona.

Anable, M.E., M.P. McClaran, and G.B. Ruyle. 1992. Spread of introduced Lehmann lovegrass (*Eragrostis lehmanniana* Nees.) in southern Arizona, USA. Biological Conservation 61:181-188.

Anderson, R.M. 1978. The distribution and aspects of the life history of *Meda fulgida* in New Mexico. New Mexico State University, Las Cruces, New Mexico. 62 pp.

Anderson, D.E., O.J. Rongstad, and W.R. Mytton. 1989. Response of nesting red-tailed hawks to helicopter overflights. Condor 91:296-299.

Anderson, D.E., O.J. Rongstad, and W.R. Mytton. 1990. Home range changes in post-breeding raptors exposed to increased human activity levels in southeastern Colorado. Wildlife Society Bulletin. 18:134-142.

Anderson, A.A., and D. Hendrickson. 1994. Geographic variation in morphology of spikedace, *Meda fulgida,* in Arizona and New Mexico. The Southwestern Naturalist 39(2):148-155.

Anderson, B.W. 1995. Salt cedar, revegetation, and riparian ecosystems in the Southwest. *In* J. Lovitch, J. Randall, and M. Kelley (eds), Proceedings of the California Exotic Pest Control Council.

Arizona Rare Plant Committee. 2001. Arizona Rare Plant Field Guide. A Collaboration of Agencies and Organizations.

ASL (ASL Hydrologic and Environmental Services) 1994. Sierra Vista subwatershed hydrology primer. Report to the City of Sierra Vista, Bella Vista Water Company, Inc., and Pueblo Del Sol Water Company.

ASL 1995. Report on the feasibility of groundwater recharge and sewage effluent reuse in the Sierra Vista subwatershed. Report to the City of Sierra Vista and the US Bureau of Reclamation, Boulder City, NV.

ASL 1998. Monitoring program design report and groundwater modeling evaluation for Sierra Vista Water Reclamation facility. Report to the City of Sierra Vista, Arizona.

AZ ARNG (Arizona Army National Guard) 1997. Biological assessment for the proposed upgrade of training areas at Fort Huachuca. Phoenix, AZ.

AUAVPO (US Army Unmanned Aerial Vehicle Project Office). 1991. Life Cycle Environmental Assessment for Unmanned Aerial Vehicle - Close Range. Requirements, System Integration and System Engineering Branch, Technical Management Division, Army Unmanned aerial Vehicle Project Office. November.

AWC 1974 (Arizona Water Commission). Status report of a study of the adequacy of the water supply of the Fort Huachuca area, Arizona. In: COE. 1974 Mar. Report on the water supply, Fort Huachuca and vicinity, Arizona. Appendix 2. Los Angeles, CA: US Army Corps of Engineers, Los Angeles District March. 53 pp.

Bahre, C.J. 1991. A Legacy of Change: Historic human impact on vegetation of the Arizona borderlands. University of Arizona Press, Tucson. 231 pp.

Barber, W.E. and W.L. Minckley. 1966. Fishes of Aravaipa Creek, Graham and Pinal Counties, Arizona. The Southwestern Naturalist 11(3):313-324.

Barber, W.E., D.C. Williams, and W.L. Minckley. 1970. Biology of the Gila spikedace, *Meda fulgida*, in Arizona. Copeia 1970(1):9-18.

Barber, W.E. and W.L. Minckley. 1983. Feeding ecology of a southwestern Cyprinid fish, the spikedace, *Meda fulgida* Girard. The Southwestern Naturalist 28(1):33-40.

Barrett, P.J., W.G. Kepner, J.E. Burton, and M.D. Jakle. 1985. Upper Verde River aquatic study. US Fish and Wildlife Service, Phoenix, AZ. 17 pp.

Bartlett, J.R. 1854. Personal narrative in 2 volumes. D. Appleton & Co., New York, NY

Barrowclough, G.F., and R.J. Gutierrez. 1990. Genetic variation and differentiation in the spotted owl (*Strix lucidus occidentalis*). Auk 107:737-744.

Beatty, G. 1997a. Arizona Game and Fish Department. Personnel communication with Kath Strickler (SAIC). June 1997.

Beatty G. 1997b. Arizona Game and Fish Department. Personnel communication with Laura Valutis (SAIC). 8 August 1997.

Bednarz, J. C. 1988. The Mexican wolf: biology, history, and prospects for reestablishment in New Mexico. Prepared for the USFWS, purchase order no. 20181-87-00570.

Behler, J.L., and F.W. King. 1980. The Audubon Society field guide to North American reptiles and amphibians. Alfred A. Knopf, New York, NY 719pp.

Belnap, J. 1992. Potential role of cryptobiotic soil crusts in semiarid rangelands. Paper presented at the Symposium on Ecology, Management, and Restoration of Intermountain Annual Rangelands, Boise, Idaho, May 18-22, 1992.

Belsky, A.J., and D.M. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the interior west. Conservation Biology 11(2):315-327. Bryan, K. 1925. Date of channel trenching (arroyo cutting) in the arid southwest. Science 62:338-344.

Benson, L. and R.A. Darrow. 1982. Trees and shrubs of the Southwestern deserts. University of Arizona Press, Tucson.

Bestgen, K.R. 1985. Results of identification of collections of larval fish made in the upper Salt and Gila Rivers, Arizona. US Fish and Wildlife Service, Albuquerque, NM. 7 pp.

BISON 2000. Biota Information System of New Mexico. *Rana chiricahuensis* species account version 1/2000. New Mexico Department of Game and Fish, Sante Fe, NM.

BISON 2002. Biota Information System of New Mexico. *Grus americana* species account version 3/2002. New Mexico Department of Game and Fish, Sante Fe, NM.

Biswell, H.H., H.R. Kallander, R. Komarek, R.J. Vogel, and H. Weaver. 1973. Ponderosa fire management. Tall Timbers Research Station. Misc. Publ. No. 2. Tall Timber Research Station, Florida.

Blackburn, W.H. 1984. Impacts of grazing intensity and specialized grazing systems on watershed characteristics and responses. Pp. 927-983. In: Developing strategies for rangeland management. National Research Council/National Academy of Sciences. Westview Press. Boulder, CO.

BLM (Bureau of Land Management) 1987. Assessment of water conditions and management opportunities in support of riparian values: BLM San Pedro River properties, Arizona Project Completion Report, BLM, Denver, Colorado.

BLM 1989 Jun. San Pedro River riparian management plan and environmental impact statement. Final. Safford, AZ: US Department of the Interior, BLM. 381 p.

BLM 1996. Biological evaluation: Safford District Grazing Program. Bureau of Land Management, Safford Field Office, Safford, AZ.

BLM 1998. The upper San Pedro River Basin of the United States and Mexico, A resource directory and an overview of natural resource issues confronting decision-makers and natural resource managers. Arizona State Office, Bureau of Land Management, Report No. BLM/AZ/PT-98/021. 110 pp.

Bock, J.H. an C.E Bock. 1992. Vegetation Responses to Wildfire in Native Versus Exotic Arizona Grassland. J. of Vegetation Science 3:39-446.

Bowles, A.L. 1995. Responses of wildlife to noise. In R.L. Knight and K.J. Gutzwiler (eds), Wildlife and Recreationists, Coexistence Through Management and Research. Island Press, Washington, DC

Braun, D.P., T. Maddock III, and W.B. Lord. 1992. Waterbud, a spreadsheet-based model of the water budget and water management systems of the upper San Pedro River basin, Arizona. Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ.

Britt, K.D. 1982. The reproductive biology and aspects of the life history of *Tiaroga cobitis* in southwestern New Mexico. New Mexico State University, Las Cruces. 56 pp.

Brittingham, M. C. and S. A. Temple. 1993. Have cowbirds caused forest songbirds to decline? *Bioscience* 33:31-35.

Brown, H.E., M.B. Baker, Jr., J.J. Rogers, W.P. Clary, J.L. Kovner, F.R. Larson, C.C. Avery, and R.E. Campbell. 1974. Opportunities for increasing water yields and other multiple use values on ponderosa pine forest lands. US Forest Service Rocky Mountain Forest and Range Experiment Station, Research Paper RM-129, Ft. Collins, CO. 1-36 pp.

Brown, D.E. 1982. Biotic communities of the American southwest--United States and Mexico. Desert Plants 4: 123-181.

Brown, D.E. and R.A. Minnich. 1986. Fires and Changes in Creosote Bush Scrub of the western Sonoran Desert, California. The Am. Midland. Nat. 116:411-422.

Brown, B.T. 1988. Monitoring bird population densities along the Colorado River in Grand Canyon: 1987 breeding season. Final Report to the Glen Canyon Environmental Studies. Bureau of Reclamation, Salt Lake City, Utah. 26 pp.

Brown, L. and D. Amadon. 1989. Eagles, hawks, and falcons of the world. The Wellfleet Press, Secauscas, New Jersey.

Brown, David E. 2000. Professor, Department of Biology, Arizona State University, Tempe, Arizona. Personal communication with Joanne Kirchner, EEC. 30 November 2000.

Brown, David E, Carlos A. Lopez Gonzalez. 2001. Borderland Jaguars. The University of Utah Press. Salt Lake City, Utah.

Browning, M.R. 1993. Comments on the taxonomy of *Empidonax trailli* (willow flycatcher). Western Birds 24:241-257.

Bryan, K. 1925. Date of channel trenching (arroyo cutting) in the arid southwest. Science 62:338-344.

Buffington, L.C. and C.H. Herbel. 1965. Vegetational changes on a semidesert grassland range from 1858 to 1963. Ecological Monographs 35(2):139-164.

Burnham, William, J. Peter Jenny, William R Heinrich, Grainger Hunt, Angel B Montoya, Brian D. Mutch, and Cal E. Sandfort. 2002. Proposal: Restoration of the Northern Aplomado Falcon in New Mexico. The Peregrine Fund, Boise, Idaho. www.peregrinefund.org.

Burton, J.A., Editor. 1973. Owls of the world. E.P. Dutton, Inc. New York, New York.

Busby, F.E., and G.F. Gifford. 1981. Effects of livestock grazing on infiltration and erosion rates measured on chained and unchained pinyon-juniper sites in southeastern Utah. Journal of Range Management 34:400-405.

Busch, D.E., N.L. Ingraham, and S.D. Smith. 1992. Water uptake in woody riparian phryeatophytes of the southwestern United States: a stable isotope study. Ecological Applications 2:450-459.

Cable. 1965. Damage of mesquite, Lehmann lovegrass, and black grama by a hot June fire. J. of Range Mgmt. 18:326-329.

Campbell, R.E., M.B. Baker, Jr., P.F. Ffolliott, R.R. Larson, and C.C. Avery. 1977. Wildfire effects on a ponderosa pine ecosystem: an Arizona case study. USDA For. Serv. Res. Pap. RM-191. 12 pp.

Census 2000. US Bureau of the Census. Census of Population and Housing.

Chase, T. 1997. University of Colorado, Boulder, Colorado, graduate student. Personal communication with Chuck Burt, ecologist, SAIC, Albuquerque, New Mexico, July 25, 1997.

Cockrum, E.L., and Y. Petryszyn. 1991. The lesser long-nosed bat. *Leptonycteris*: an endangered species in the Southwest? Occasional Papers of the Museum, Texas Tech University, Number 142: Page 32.

Coffman and Associates. 1995. Sierra Vista Municipal Airport, Airport Master Plan.

Cole, D.N., and P.B. Landres. 1995. Indirect effects of recreation on wildlife. Chapter 11 *in* Wildlife and Recreationists. Island Press, Washington, D.C

Collins, J.P., and T.R. Jones. 1987. Report on the status of the Sonora tiger salamander, *Ambystoma tigrinum stebbinsi* Lowe. Department of Zoology, Arizona State University, Tempe, Arizona. 66 pp.

Collins, J.P., T.R. Jones, and H.J. Berna. 1988. Conserving genetically distinctive populations: the case of the Huachuca tiger salamander (*Ambystoma tigrinum stebbinsi* Lowe). Pages 45-53 In R.C. Szaro, K.E. Severson, and D.R. Patton (tech. coords.). Management of amphibians, reptiles and small mammals in North America. USDA Forest Service General Technical Report RM-166.

Collins, J.P. 1996. Final report: A status survey of three species of endangered/sensitive amphibians in Arizona. Report to Arizona Game and Fish Department, Phoenix, AZ. Heritage Fund - IIPAM #I92014.

Cooke, P. St. G. 1938. Cooke's journal of the march of the Mormon Battalion, 1846-1847. Pages 63-240 in Exploring Southwest Trials, 1846-1854. Southwest History Series, Volume 7. Arthur H. Clark Company, Glendale, CA.

Corell, S.W. 1996. Groundwater flow model scenarios of future groundwater and surface water conditions: Sierra Vista subwatershed of the upper San Pedro basin-southeastern Arizona. Arizona Department of Water Resources, Hydrology Division, Phoenix, AZ. Supplement to Modeling Report No. 10.

Corell, S.W., F. Corkhill, D. Lovvik, and F. Putman. 1996. A groundwater flow model of the Sierra Vista subwatershed of the upper San Pedro basin-southeastern Arizona. Arizona Department of Water Resources, Hydrology Division, Phoenix, AZ. Modeling Report No. 10.

Corman, T. E. 1992. Evaluation of ten potential northern aplomado falcon reintroduction areas in southeastern Arizona. Nongame and Endangered Wildlife Program Final Report. Arizona Game and Fish Department Publication, Phoenix, Arizona. 47 pp.

Corman, T.E., and R.T. Magill. 2000. Western yellow-billed cuckoo in Arizona: 1998 and 1999 survey report. Nongame and Endangered Wildlife Program Technical Report 150. Arizona Game and Fish Department, Phoenix, Arizona.

Cross, A.F. 1991. Vegetation of two southeastern Arizona desert marshes. Madrono 38(3):185-194.

Dalton, V.M., and D.C. Dalton. 1993. Assessment of the impacts of low level military aircraft on *Leptonycteris curasoae*, an endangered bat, at Organ Pipe Cactus National Monument, Arizona. Report to Luke Air Force Base, AZ and Organ Pipe Cactus National Monument, Ajo, AZ.

Dalton, V.M., and D.C. Dalton, and S.L. Schmidt. 1994. Roosting and foraging use of a proposed military training site by the long-nosed bat, *Leptonycteris curasoae*. Contract No DACA65-94-M-0831 and DACA65-94-M-0753. Report to the Luke Air Force Natural Resources Program. 34 pp.

Danzer, S. 1997. A pilot study of fuel loads on the Fort Huachuca Military Reservation. Appendix H in Robinett, D., R.A. Abolt, and R. Anderson, Fort Huachuca Fire Management Plan. Report to Fort Huachuca, AZ

Danzer, S.R., C.H. Baisan, and T.W. Swetnam. 1997. The influence of fire and land-use history on stand dynamics in the Huachuca Mountains of southeastern Arizona. Appendix D in Robinett, D., R.A. Abolt, and R. Anderson, Fort Huachuca Fire Management Plan. Report to Fort Huachuca, AZ.

Davis, W.A. and S.M. Russell. 1995. Finding birds in southeast Arizona. Tucson Audubon Society, Tucson, Arizona.

DeBano, L.F., and L.J. Schmidt. 1989. Interrelationship between watershed condition and riparian health. Pages 45-52 in: Practical approaches to riparian resource management. US Bureau of Land Management, Billings, MT.

DeBano, L.F., and D.G. Neary. 1996. Fire severity effects on riparian systems. Pages 69-76 in Ffolliott *et al.* (eds), Effects of Fire on Madrean Province Ecosystems, A Symposium Proceedings. USDA Forest Service, General Technical Report RM-GTR-289.

DeLaney, D.K., T.G. Grubb, and L.L. Pater. 1997. Effects of helicopter noise on nesting Mexican spotted owls. A report to US Air Force 49 CES/CEV, Holloman Air Force Base. Project order No. CE P.O. 95-4. 49 pp.

DeLaney, D.K., T.G. Grubb, P. Beier, L.L. Pater, M. Hildegard Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63(1):60-76.

DeLoach, C.J. 1991. Saltcedar, an exotic weed of western North American riparian areas: a review of its taxonomy, biology, harmful and beneficial values, and its potential for biological control. Report to the Bureau of Reclamation, Boulder City, NV, Contract No. 7-AG-30-04930.

DES 2002 (Arizona Department of Economic Security). Arizona Unemployment Statistics Program for Cochise County. Phoenix, Arizona www.de.state.az.us/links/economic/webpage/eaweb/spec02.html

Dobyns, H.F. 1981. From Fire to Flood: Historic Human Destruction of Sonoran Desert Riverine Oases. Ballena Press, Socorro, New Mexico. 222 pp.

Douglas, M.E., P.C. Marsh, and W.L. Minckley. 1994. Indigenous fishes of western North America and the hypothesis of competitive displacement: *Meda fulgida* (Cyprinidae) as a case study. Copeia 1994(1):9-19.

Drost, C.A., M.K. Sogge, and E. Paxton. 1998. Preliminary diet study of the southwestern willow flycatcher. USGS, Colorado Plateau Field Station report. 26 pp.

DRM 1998 (Directorate of Resource Management). Annual Economic Impact Statement for Fiscal Year 1997, Fort Huachuca, Arizona.

DRM 1999 (Directorate of Resource Management). Annual Economic Impact Statement for Fiscal Year 1998, Fort Huachuca, Arizona.

DRM 2000 (Directorate of Resource Management). Annual Economic Impact Statement for Fiscal Year 1999, Fort Huachuca, Arizona.

DRM 2001 (Directorate of Resource Management). Annual Economic Impact Statement for Fiscal Year 2000, Fort Huachuca, Arizona.

DRM 2002 (Directorate of Resource Management). Annual Economic Impact Statement for Fiscal Year 2001, Fort Huachuca, Arizona.

DuBois, S.M., and A.W. Smith. 1980. The 1887 earthquake in the San Bernardino Valley, Sonora: historic accounts and intensity patterns in Arizona. Bureau of Geology and Mineral Technology, University of Arizona Special Paper 3:1-112.

Duncan, R. B. 1991. 1991 Fort Huachuca Mexican spotted owl inventory. Prepared for US Army Garrison, Environmental and Natural Resources Division, ATZS-EHB (Game Management), Fort Huachuca, Arizona. 15 August 1991.

Duncan, R.B., S.M. Speich, and J.D. Taiz. 1993. Banding and blood sampling study of Mexican spotted owls in southeastern Arizona - 1993 Annual Report. Report to the Coronado National Forest, Tucson, AZ.

Earhart, C. M. and N. K. Johnson. 1970. Size dimorphism and food habits of North American owls. Condor 72:251-264.

Eccleston, R. 1950. Overland to California on the southwestern trail, 1849, diary of Robert Eccleston. G.P. Hammond and E.H. Howes (eds), University of California Press, Berkeley, CA.

EEC (Engineering and Environmental Consultants, Inc) 2000a. Final Year 2000 Huachuca Water Umbel Monitoring and Inventory Fort Huachuca and San Pedro Riparian NCA. Prepared for Directorate of Installation Support, US Army Garrison, Fort Huachuca, Arizona.

EEC 2000b. Southwestern Willow Flycatcher Survey of the San Pedro Riparian National Conservation Area and Adjacent Fort Huachuca. Prepared for Directorate of Installation Support, US Army Garrison, Fort Huachuca, Arizona.

EEC 2000c. Comprehensive Unmanned Aerial Vehicle Testing and Training at Fort Huachuca, Arizona. Environmental Assessment. Prepared for Directorate of Installation, US Army Garrison, Fort Huachuca, Arizona.

EEC 2001. Army Water Resources Management Plan for Fort Huachuca, Arizona – Phase 1. Fort Huachuca, AZ.

EEC 2001a. Final Report Huachuca Water Umbel Surveys, Cienega Creek Preserve, Bingham Cienega Preserve, La Cebadilla Property, Pima County, Arizona. Prepared for Pima County Flood Control District, Tucson, Arizona.

EEC 2001b. Final 2001 Huachuca Water Umbel Fort Huachuca Monitoring and San Pedro Riparian NCA Inventory Reports. Prepared for Directorate of Installation Support, US Army Garrison, Fort Huachuca, Arizona.

EEC 2001c. Southwestern Willow Flycatcher 2001 Surveys of the San Pedro Riparian National Conservation Area. Prepared for US Army Garrison, Fort Huachuca, Arizona.

EEC 2001d. Mexican Spotted Owl Monitoring and Inventory Report for Year 2001. Prepared for Directorate of Installation Support, US Army Garrison, Fort Huachuca, Arizona.

EEC 2002. Cochise County Water Resources Inventory. Cochise County Board of Supervisors, Bisbee, AZ.

EIFS (Economic Impact Forecasting System) 2002. Model Run by Army Environmental Policy Institute. June 2002.

Ellis, D.H. 1981. Responses of raptorial birds to low level military jets and sonic booms. Institute of Raptor Studies, Oracle AZ. 59 pp.

Ellis, D.H., C.H. Ellis, and D.P. Mindell. 1991. Raptor responses to low-level jet aircraft and sonic booms. Environmental Pollution 74: 53-83.

ENRD (Environmental and Natural Resources Division) 1997. Fort Huachuca East Range watershed improvement plan. Report to the Environment and Natural Resources Division, Fort Huachuca, AZ.

ENRD 2001. Integrated Natural Resources Management Plan (INRMP), Fort Huachuca, Arizona 2001-2005. Prepared by Gene Stout and Associates for the Environmental and Natural Resources Division, Directorate of Installation Support, Fort Huachuca, Arizona. 287 pp.

Enriquez-Rocha, P., J. L. Rangel-Salazar, and D. W. Holt. 1993. Presence and distribution of Mexican owls: a review. J. Raptor Res. 27:154-160.

EPA (Environmental Protection Agency) 1997. San Pedro River - a landscape approach to community-based environmental protection. US EPA, National Exposure Research Laboratory, Las Vegas, NV. 2pp

ESWR (Endangered Species and Wetlands Report) 1996. September 1996. No-listing agreement signed for rare frog in Arizona. 11 pp.

Evans, R.C. 1945. The Pima uprising of 1751: A study of Spanish-Indian relations on the frontier of New Spain. Greater American Essays in Honor of Herbert Eugene Bolton. University of California Press, Berkeley, CA.

Fenske, J. P. 1998. July 1, 1998, memorandum for the record: subject: compilation and analysis of April 1995 to April 1998 water-level data at monitoring and test wells, Fort Huachuca, AZ. US Army Corps of Engineers.

Finberg, K.O. 1994. Community structure changes in a grassland after a wildfire and a dry season. MS Thesis, Arizona State University, Tucson, Arizona. 95 pp.

Flather, C.H., and H.K. Cordell. 1995. Outdoor recreation: historical and anticipated trends. Chapter 1 *in* R.L. Knight and K.J. Gutzwiller (eds), Wildlife and Recreationists. Island Press, Washington, DC

Fleming, T.H. 1995. Lesser long-nosed bat recovery plan. US Fish and Wildlife Service. Albuquerque, New Mexico. Page 29.

Fletcher, K.W. 1990. Habitats used, abundance, and distribution of the Mexican spotted owl, *Strix lucidus occidentalis*, on National Forest system lands. USDA Forest Service, Southwestern Region, Albuquerque, NM. 55 pp.

Fluid Solutions. 2001. Project SP0002 – Reduce Water Consumption/Reclaim Water Resources. Upper San Pedro Partnership. Sierra Vista, AZ.

Folliott, P.F. and D.A. Bennett. 1996 peak Fire of 1988: its effects on Madrean oak trees in Madrean type ecosystems: Southwestern United States in Effects of Fire on Madrean Province Ecosystems, US Forest Service, Rocky Mountain Forest and Range Experiment Station, Gen. Tech. Rep. RM-GTR-289.

Fredlake, M. 1996. Biological evaluation for re-establishment of beaver into the San Pedro Riparian National Conservation Area. Bureau of Land Management, Sierra Vista, AZ.

Freethey GW. 1982 Jul. Hydrologic analysis of the upper San Pedro basin from the Mexican-United States international boundary to Fairbank, Arizona. Tucson, AZ: US Geological Survey. Open File Report 82-752. 64 p.

Ganey, J.L., and R.P. Balda. 1989. Distribution and habitat use of Mexican spotted owls in Arizona. Condor 91:355-361.

Ganey, J.L. 1998. Spotted owl. Pages 170-174 in R.L. Glinski (ed), The Raptors of Arizona. University of Arizona Press, Tucson, AZ.

General Wildlife Services. 1999. Garden Canyon Watershed, A Vision. General Wildlife Services, Chino, Valley, AZ. 140 pp.

Gentry, H.S. 1982. Agaves of Continental North America. University of Arizona Press, Tucson, Arizona. Pages 443-447 and 538-545.

Geraghty and Miller, Inc. 1995. Historical flows and conditions in the San Pedro River. Report to the Water Action Task Force, Sierra Vista Economic Development Foundation, Project No. AZ0473.001. 33pp +figures.

Gifford, G.F., and R.H. Hawkins. 1978. Hydrologic impact of grazing on infiltration: a critical review. Water Resources Research. 14:305-313.

Gilman, M. F. 1909. Some owls along the Gila River in Arizona. Condor 11:145-150.

Girmendonk, A.L. 1994. Ocelot, jaguar, and jaguarundi sighting reports: Arizona and Sonora, Mexico. Nongame and Endangered Wildlife Technical Report 35. Arizona Game and Fish Department, Phoenix, Arizona.

Goodrich, D.C., *et al.* 1998. An overview of the 1997 activities of the Semi-Arid Land-Surface-Atmosphere (SALSA) program. Presented at the American Meteorological Society, Special Symposium on Hydrology, Phoenix, AZ, 11-16 Jan. 1998. Http://www.tucson.ars.ag. gov/salsa/archive/publi.../ams_papers_table_of_contents_pdf.htm

Gori, D.F., P.L. Warren, and L.S. Anderson. 1990. Population studies of sensitive plants of the Huachuca, Patagonia, and Atascosa Mountains, Arizona. Unpublished report. Coronado National Forest, Tucson, Arizona. 114 pp.

Groebner, D.J., A.L. Girmendonk, and T.B. Johnson. 1995. A proposed cooperative reintroduction plan for the Mexican gray wolf in Arizona. Nongame and Endangered Wildlife Technical Report 56. Arizona Game and Fish Department, Phoenix, Arizona.

Groebner, D.J. and T.B. Johnson. 1995. Mexican wolf surveys in Arizona and Mexico. Nongame and Endangered Wildlife Technical Report 78. Arizona Game and Fish Department, Phoenix, Arizona.

Grubb, T.G., and R.M. King. 1991. Assessing human disturbance of breeding bald eagles with classification tree models. Journal of Wildlife Management 55(3): 500-511.

Grubb, T.G., and W.W. Bowerman. 1997. Variations in breeding bald eagle response to jets, light planes, and helicopters. Journal of Raptor Research 31.

Gruberg, E.R., and R.V. Stirling. 1972. Observations on the burrowing habits of the tiger salamander (*Ambystoma tigrinum*). Herpetological Review 4:85-89.

Gutierrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted owl. In A. Poole. P. Stettenheim, and F. Gill (eds). The birds of North America. Academy of the Natural Sciences and American Ornithological Union. Washington, DC

Gutierrez, R.J., A.B. Franklin, and W.S Lahaye. 1995. The Birds of North America, N0.179. Birds of North America, Inc. Philadelphia, Pa.

Gutzwiller, K.J. 1995. Recreational disturbance and wildlife communities. Chapter 10 in R.L. Knight and K.J. Gutzwiller (eds), Wildlife and Recreationists. Island Press, Washington, DC

Haas, S.K, and R.J. Frye. 1997. Hydrology and water quality effects on *Lilaeopsis schafffneriana* ssp. *recurva.* Report to Arizona Department of Agriculture and Fort Huachuca.

Hammitt, W.E., and D.N. Cole. 1987. Wildland recreation: ecology and management. John Wiley and Sons, New York, NY

Hanna, W.C. 1928. Notes on the dwarf cowbird in southern California. Condor 30:161-162.

Harrington, J.A.,Jr., R. Cerveny, and R. Balling Jr. 1992. Impact of the Southern Oscillation on the North American Southwest Monsoon. Physical Geography 13:318-330.

Harris, J.H., S.D. Sanders, and M.A. Flett. 1987a. The status and distribution of the willow flycatcher (*Empidonax traillii*) in the Sierra Nevada. California Department of Fish and Game Wildlife Management Branch Administrative Report 87-2., .

Harris, J.H., S.D. Sanders, and M.A. Flett. 1987b. Willow flycatcher surveys in the Sierra Nevada. *Western Birds* 18:27-36.

Harris, J.H. 1991. Effects of brood parasitism by brown-headed cowbirds on willow flycatcher nesting success along the Kern River, California. *Western Birds* 22:13-26.

Harshbarger and Associates. 1974 Mar. Report on water development in the Ft. Huachuca area, Arizona. In: COE. 1974 Mar. Report on the water supply, Fort Huachuca and vicinity, Arizona. Appendix 1. Los Angeles, CA: US Army Corps of Engineers, Los Angeles District. 35 p.

Hastings, J.R. and R.M. Turner. 1980. The Changing Mile. University of Arizona Press, Tucson. 317 pp.

Hector, D. P. 1985. The diet of the aplomado falcon (*Falco femoralis*) in eastern Mexico. Condor 87:336-342.

Hendrickson, D.A., and W.L. Minckley. 1984. Cienegas - vanishing climax communities of the American Southwest. Desert Plants 6(3):131-175.

Hereford R. 1993. Entrenchment and widening of the upper San Pedro River, Arizona. Boulder, CO: Geological Society of America. Special Paper 282. 46 p.

Hereford, R. 1993. Geomorphic evolution of the San Pedro River channel since 1900 in the San Pedro Riparian National Conservation Area, southeast Arizona. USDI, Geological Survey, Open File Report 92-339. 71pp.

Hessil, J. 1998. Fort Huachuca Game Management Branch, US Department of Army, Fort Huachuca Arizona. Personal communication with Laura Valutis (SAIC) 17 February 1998.

Hoffmeister, D.F 1986. The mammals of Arizona. The University of Arizona Press and the Arizona Game and Fish Department. 602 pp.

Horner, M.A., T.H. Fleming, and M.D. Tuttle. 1990. Foraging and movement patterns of a nectar feeding bat: Leptonycteris curasoae. Bat Research News, Winter 1990:81.

Houser, B. 1998. 26 May 1998 letter from Brenda Houser, US Geological Survey, Tucson, AZ, to Jim Rorabaugh, US Fish and Wildlife Service, Phoenix, AZ.

Howell, D.J. 1974. Acoustic behavior and feeding in glossophagine bats. Journal of Mammalogy 55:293-308.

Howell, D.J. 1992. The effects of UAV testing on *Leptonycteris curasoae* at Fort Huachuca, Arizona. Report to Fort Huachuca, Arizona. Contract No. DATM01-91-C-0002. 13pp + appendices.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press, New York, New York. 851 pp.

Howell, D.J., and D.G. Robinett. 1995. Agave management plan. Report to the Environment and Natural Resources Division, Fort Huachuca, AZ.

Howell, D.J. 1996. Agave palmeri on Fort Huachuca: five years of research on natural history and response to fire. Report to Fort Huachuca, AZ.

Huckleberry, G., 1996, Historic Channel Changes on the San Pedro River, Southeastern Arizona: Arizona Geological Survey Open-File Report96-15, 35 pp.

Irvine, L. 1991. Disturbance and small mammals: effects of prescribed fire on white-footed mice (*peromyscus*). MS Thesis. Northern Arizona University.

Jackson, W., T. Martinez, P. Cuplin, W.L. Minckley, B. Shelby, P. Summers, D. McGlothlin, and B. Van Haveren. 1987. Assessment of water conditions and management opportunities in support of riparian values: BLM San Pedro River Properties, Arizona. US Department of Interior, Bureau of Land Management. 180 pp.

Jahrsdoerfer, Sonja. January 24, 1995. Endangered Species Coordinator, Ecological Services Office, US Fish and Wildlife Office. Albuquerque, New Mexico.

Jakle, M. 1992. Memo Feb. 26, 1992 - Summary of fish and water quality sampling along the San Pedro River from Dudleyville to Hughes Ranch near Cascabel, Oct. 24 and 25, 1992, and the Gila River from Coolidge Dam to Ashurst/Hayden Diversion Dam, Oct. 28-31, 1991. US Bureau of Reclamation, Phoenix, AZ. 11 pp.

Jancovich, J.K., E.W. Davidson, J.F. Morado, B.L. Jacobs, and J.P. Collins. 1998. Isolation of a lethal virus from the endangered tiger salamander, *Ambystoma tigrinum stebbinsi* Lowe. Abstract in programs and abstracts, Fourth Annual Meetings of the Southwestern United States Working Group of the Declining Amphibian Populations Task Force. Phoenix, AZ.

Jennings, R. D. and N. J. Scott, Jr. 1993. Ecologically correlated morphological variation in tadpoles of the leopard frog, *Rana chiricahuensis*. Journal of Herpetology. Vol. 27(3):285-293.

Johnsgard, P. A. 1988. North American owls. Smithsonian Institution Press, Washington, D. C. 295 pp.

Johnsgard, P.A. 1988. North American Owls. Smithsonian Institute Press, Washington, D.C. 295 pp.

Johnson, T. B. 1997. Arizona Game and Fish Department, Nongame Field Notes, southwestern willow flycatcher. Internet WWW page, at <http://www.gf.state.az.us/fishwild/ngame i.htm>.

Johnson, T.B. and W.E. Van Pelt. 1997. Conservation assessment and strategy for the jaguar in Arizona and New Mexico. Nongame and Endangered Wildlife program Technical Report 105. Arizona Game and Fish Department, Phoenix, Arizona.

Jones, T.R., J.P. Collins, T.D. Kocher, and J.B. Mitton. 1988. Systematic status and distribution of *Ambystoma tigrinum stebbinsi* Lowe (Amphibia:Caudata). Copeia 1988(3):621-635.

Jones, T.R., E.J. Routman, D.J. Begun, and J.P. Collins. 1995. Ancestry of an isolated subspecies of salamander, *Ambystoma tigrinum stebbinsi* Lowe: the evolutionary significance of hybridization. Molecular Phylogenetics and Evolution 4(2):194-202.

Jones, Kenley, E. 2002 Center for Economic Research's Assessment of the Economic Impact of Activity on Fort Huachuca as it Relates to Statements Made by the Center for Biological Diversity. Cochise College Center for Economic Research, Sierra Vista, Arizona.

Kerrigan, M. 1998. Forester, Sierra Vista Ranger District, Coronado National Forest, US Forest Service, Sierra Vista, AZ. Unpublished data/personal communication with Laura Valutis, February 1998.

King, J.A. 1955. Social behavior, social organization, and population dynamics in a black-tailed prairie dog town in the Black Hills of South Dakota. Contrib. Lab. Vet. Biol. University of Michigan 67.

Kino, E.F. 1919. Kino's historical memoir of Pimeria Alta, Vols. I-II. H.E. Bolton (ed.). A.H. Clark, Cleveland, Ohio.

Knight, R.L., and S.A. Temple. 1986. Why does intensity of avian nest defense increase during the nesting cycle? Auk 103:318-327.

Knight, R.L., and D.N. Cole. 1995. Wildlife responses to recreationists. Chapter 4 *in* R.L. Knight and K.J. Gutzwiller (eds), Wildlife and Recreationists. Island Press, Washington, DC.

Knight, R.L., and K.J. Gutzwiller. 1995. Wildlife and recreationists - coexistence through management and research. Island Press, Washington, DC.

Knight, R.L., and S.A. Temple. 1995. Origin of wildlife responses to recreationists. Chapter 6 *in* R.L. Knight and K.J. Gutzwiller (eds), Wildlife and Recreationists. Island Press, Washington, DC.

Knowles, G.W. 1994. Fisheries survey of the Apache-Sitgreaves National Forests, third trip report: Eagle Creek, June 05-07 and August 02, 1994. Arizona State University, Tempe, AZ. 6 pp.

Knowles, G.W. 1995. Fisheries survey of the Apache-Sitgreaves National Forests, trip reports July-August 1994, July 1995. Arizona State University, Tempe, AZ. 8 pp.

Koehler, R., and G. Ball. 1998. A statistical analysis of low flows on the San Pedro River, Arizona. Presentation to the September 1998 Symposium of the Arizona Hydrological Society, Tucson.

Krueper, D. J. 1993. Effects of land use practices on western riparian ecosystems. In Status and Management of Neotropical Migratory Birds, General Tech. Rep. RM-229, U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Landye, J.J. 1993. Huachuca springsnail populations located on the Fort Huachuca Army Post. 1 pp.

Leach, J.B. 1858. Itinerary of the El Paso and Fort Yuma wagon road expedition. National Archives File Microcopies M95, roll 3.

Lefcourt, H., K.A. Hancock, K.M. Maur, and D.C. Rostal. 1997. The effects of used motor oil, silt, and the water mold *Saprolegnia parasitica* on the growth and survival of mole salamanders (Genus *Ambystoma*). Archives of Environmental Contamination and Toxicology 32:383-388.

Lesh, T. D. and T. E. Corman. 1995. Cactus ferruginous pygmy-owl surveys in Arizona: 1993 - 1995. Nongame and Endangered Wildlife Program Technical Report 76. Arizona Game and Fish Department, Phoenix, Arizona. 23 pp.

Lowe, C.H. 1954. A new salamander (genus *Ambystoma*) from Arizona. Proceedings of the Biological Society of Washington 67:243-246.

Lowe, P.O., P.F. Ffolliott, J.H. Dieterich, and D.R. Patton. 1978. Determining potential wildlife benefits from wildfire in Arizona ponderosa pine forests. Gen. Tech. Rep. RM-52. Rocky Mountain Forest and Range Experiment Station.

MacNish, R.D. 1998. An analysis of the diminishment of baseflow of the San Pedro River in the Sierra Vista sub-watershed, Cochise County, Arizona (draft). Arizona Research Laboratory for Riparian Studies, University of Arizona, Tucson, AZ.

Maddock, T. 1994. Letter to Mr. George P. Michael, Jr., Director of Public Works, City of Sierra Vista, AZ, dated February 25, 1994. Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ.

Marsh, P.C., F.J. Abarca, M.E. Douglas, and W.L. Minckley. 1989. Spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*) relative to introduced red shiner (*Cyprinella lutrensis*). Arizona Game and Fish Department, Phoenix, AZ. 116 pp.

Marsh, P.C., J.E. Brooks, D.A. Hendrickson, and W.L. Minckley. 1990. Fishes of Eagle Creek, Arizona, with records for threatened spikedace and loach minnow (Cyprinidae). Journal of the Arizona-Nevada Academy of Sciences 23(2):107-116.

Martin, S.C. 1975. Ecology and management of southwestern semidesert grass-shrub ranges: The status of our knowledge. US Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 39 pp.

Martin, S.C. 1983. Responses of semi-desert grasses and shrubs to fall burning. Journal of Range Management 36:604-610.

Mayfield, H.F. 1977. Brown-headed cowbird: agent of extermination? American Birds 31:107-113.

McBride, R. T. 1980. The Mexican wolf (*Canis lupus baileyi*): A historical review and observations on its status and distribution. A Progress Report to the US Fish and Wildlife Service. Contract No. 14-16-0002-3728.

McCarthey, T.D., C.E. Paradzick, J.W. Rourke, M.W. Sumner, and R.F. Davidson. 1998. Arizona partners in flight southwestern willow flycatcher 1997 survey and nest monitoring report. Report to the Bureau of Reclamation, Phoenix, AZ.

McClaran, M.P. and P.C. Sundt. 1992. Population dynamics of the rare orchid, *Spiranthes delitescens*. The Southwestern Naturalist 37:299-333.

McDonald, C.B., J. Anderson, J.C. Lewis, R. Mesta, A. Ratzlaff, T.J. Tibbitts, and S.O. Williams. 1991. Mexican spotted owl (*Strix lucidus occidentalis*) status report. USDI Fish and Wildlife Service, Albuquerque, NM.

McLaughlin and Bowers, 1982. Effects of wildfire on a Sonoran Desert community. Ecology: 63:246-248.

McPherson, G. 1995. The role of fire in desert grasslands. Pages 130-151 in M.P. McClaran and T.R. Van Devender (eds), The Desert Grassland. University of Arizona Press, Tucson. 346 pp.

Menges, E.S. and D.M. Waller. 1983. Plant strategies in relation to elevation and light in floodplain herbs. American Naturalist.

Miller, R.R. 1961. Man and the changing fish fauna of the American southwest. Papers of the Michigan Academy of Science, Arts, and Letters XLVI:365-404.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, AZ. 293 pp.

Minckley, W.L. 1981. Ecological studies of Aravaipa Creek, Central Arizona, relative to past, present, and future land uses. Final contract report to the Bureau of Land Management.

Moir, W.H., J.L. Dick, Jr., W.M. Block, J.P. Ward, Jr., R. Vahle, F.P. Howe, and J.L. Ganey. 1995. Conceptual framework for recovery (17 pp), *in* Recovery Plan for the Mexican spotted owl. Vol. II. USDI Fish and Wildl. Serv., Albuquerque, NM.

Montoya, A. B., P. J. Zwank, and M. Cardenas. 1997. Breeding biology of aplomado falcons in desert grasslands of Chihuahua, Mexico. J. Field Ornithol. 68(1):135-143.

National Wildlife Coordinating Group. 1979. Prescribed fire job qualification guide: wildland fire management. USDI National Park Service. Washington DC.

Newman, D. 1991. Status Report: *Spiranthes delitescens*. US Fish and Wildlife Service, Ecological Services State Office, Phoenix, Arizona. 10 pp.

NGS (National Geographic Society) 1987. Field Guide to the Birds of North America, 2nd Edition. National Geographic Society, Washington D.C.

NMDGF (New Mexico Department of Game and Fish) 1996. Species Accounts. Internet WWW page, at BISON-M: http://www.fw.vt.edu/fixhex/nmex main/nm4.htm.

Nowak, R.M. 1991. Walker's mammals of the world. The Johns Hopkins University Press, Baltimore. 1629 pp.

NPS (National Park Service) 1994. Report to Congress: report on the effects of aircraft overflights on the National Park system. USDI, National Park Service, Washington DC 187pp.

NRCS (Natural Resource Conservation Service) 1997. Soil Survey of the San Pedro River Valley, Arizona, An interim report from the Soil Survey of Cochise County, Douglas - Tombstone Part.

NWR (National Wildlife Refuge) 1997. Internet WWW page, at <http://refuges.fws.gov/NWRSFiles/WildlifeMgmt/SpeciesAccounts/Birds/CactusFerruginousPygmyOwl.html>.

Palmer, R. S. 1988. Handbook of North American Birds, Vol. 5. Yale University Press, New Haven and London. Pp. 315-322.

Paradzick, C.E., R.F. Davidson, J.W. Rourke, M.W. Sumner, and T.D. McCarthey. 1999. Southwestern willow flycatcher 1998 survey and nest monitoring report. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, AZ, Technical Report 141.

Paradzick, C.E., R.F. Davidson, J.W. Rourke, M.W. Sumner, Angela M. Wartell, and T.D. McCarthey. 2000. Southwestern willow flycatcher 1999 survey and nest monitoring report. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, AZ, Technical Report 151.

Parke, J.G. 1857. Report of explorations for railroad routes. In Explorations and surveys to ascertain the most practical and economical route for a railroad from the Mississippi to the Pacific Ocean. US 33rd Congress, 2nd session, Senate Executive Document 78, Volume 7:1-469.

Parsons, D. 1997. Mexican wolf recovery program coordinator, USFWS, Albuquerque, NM. Personal communication with Laura Valutis (SAIC). 15 July 1997.

Patton, P.W.C., C.J. Zabel, D.L. Neal, G.N.Steger, N.G. Tilgham, and B.R Noon. 1991. Effects of radio tags on spotted owls. J. Wildl. Manage. 55(4):617-622.

Patton, D.R., and J. Gordon. 1995. Fire, habitats, and wildlife. Final Report submitted to USDA Forest Service, Coconino National Forest. 85 pp.

Paxton, E., J. Owen, and M. Sogge. 1996. Southwestern willow flycatcher response to catastrophic habitat loss. USG.S. Colorado Plateau Research Station/Northern Arizona University report. 12 pp.

Peterson, R.T. 1990. A field guide to western birds. 3rd ed. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington DC 587 pp.

Petranka, J.W., A.W. Rushlow, and M.E. Hopey. 1998. Predation by tadpoles of *Rana sylvatica* on embryos of *Ambystoma maculatum*: implications of ecological role reversals by *Rana* (predation) and *Ambystoma* (prey). Herpetologica 54(1):1-13.

Phillips, A.R. 1948. Geographic variation in *Empidonax traillii*. *The Auk* 65:507-514.

Platt, J.B. 1977. The breeding behavior of wild and captive gyrfalcons in relation to the environment and human disturbances. Ph.D. Thesis, Cornell University, Ithica, New York. 164 pp.

Platz, J. E. and J. S. Mecham. 1979. *Rana chiricahuensis*, a new species of leopard frog (*Rana pipiens* complex) from Arizona. Copeia. 3: 383-390.

Platz, J. E. 1993. *Rana subaquavocalis*, a remarkable new species of leopard frog (*Rana pipiens* complex) from southeastern Arizona that calls under water. Journal of Herpetology. Vol. 27(2): 154-162.

Pool, D. R. and A. L. Coes. 1999. Hydro-geologic Investigations of the Sierra Vista subwatershed of the Upper San Pedro Basin, Cochise County, Southeast Arizona, US Geological Survey Water-Resources Investigations Report 99-4197.

Porter, R.D., C.M. White and R.J. Erwin. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. Brigham Young University, Bulletin of Biological Science. 18:1-74.

Postovit, H.R. and B.C. Postovit. 1987. Impacts and mitigation techniques. Pages 183-213 in B.A. Giron Pendleton, B.A. Mildsap, K.W. Cline, and D.M. Bird, eds. Raptor management techniques manual. Scientific Technical Series 10. National Wildlife Federation, Washington, DC.

Pratt, Jerome J. 1996. The Whooping Crane. North America's Symbol of Conservation. Tallahassee, Florida.

Propst, D.L., K.R. Bestgen, and C.W. Painter. 1986. Distribution, status, biology, and conservation of the spikedace (*Meda fulgida*) in New Mexico. Ed. 15. US Fish and Wildlife Service, Endangered Species Reports, 93 pp.

Propst, D.L., K.R. Bestgen, and C.W. Painter. 1988. Distribution, status, biology, and conservation of the loach minnow (*Tiaroga cobitis*) Girard in New Mexico. US Fish and Wildlife Service Endangered Species Report 17, Albuquerque, NM. 75 pp.

Propst, D.L. and K.R. Bestgen. 1991. Habitat and biology of the loach minnow, *Tiaroga cobitis*, in New Mexico. Copeia 1991(1):29-38.

Proudfoot, G. A. and S. L. Beasom. 1996. Responsiveness of cactus ferruginous pygmy-owls to broadcasted conspecific calls. Wildl. Soc. Bull. 24:294-297.

Putman, F., K. Mitchell, and G. Bushner. 1988. Water resources of the upper San Pedro basin, Arizona. Arizona Department of Water Resources, Hydrology Division.

Qi, J., M.S. Moran, D.C. Goodrich, R. Marsett, R. Scott, A. Chehbouni, S. Schafer, J. Schieldge, D. Williams, T. Keefer, D. Cooper, L. Hipps, W. Eichinger, and W. Ni. 1998. Estimation of evapotranspiration over the San Pedro Riparian Area with remote and in situ measurements. Presented at the American Metereorological Society, Special Symposium on Hydrology, Phoenix, AZ, 11-16 Jan. 1998.

Richardson, S. 1997. Arizona Game and Fish Department, Tucson, Arizona. Personal communication with Katherine Strickler (SAIC). 19 June 1997.

Ridgely, R.S. and G. Tudor. 1994. The Birds of South America: Suboscine Passerines. University of Texas Press, Austin, Texas.

Rinne, J.N. and E. Kroeger. 1988. Physical habitat used by spikedace, *Meda fulgida*, in Aravaipa Creek, Arizona. Proceedings of the Western Association of Fish and Wildlife Agencies Agenda 68:1-10.

Rinne, J.N. 1989. Physical habitat use by loach minnow, *Tiaroga cobitis* (Pisces: Cyprinidae), in southwestern desert streams. The Southwestern Naturalist 34(1):109 – 117.

Rinne, J.N. 1996. Short-term effects of wildfire on fishes and aquatic macroinvertebrates in the southwestern United States. North American Journal of Fisheries Management 16:653-658.

Rinne, J.N. and D.G. Neary. 1996. Fire effects on aquatic habitats and biota in Madrean-type ecosystems: Southwestern United States. Pages 135-145 in P.F. Ffolliott *et al.* (eds), Effects of Fire on Madrean Province Ecosystems, A Symposium Proceedings. USDA Forest Service, General Technical Report RM-GTR-289.

Robinett, D. and S. Baker. 1996. Fire effects on Sonoran grasslands. In Effects of Fire on Madrean Province Ecosystems, US Forest Service, Rocky Mountain Forest and Range Experiment Station, Gen. Tech. Rep. RM-GTR-289.

Robinett, D., R.A. Abolt, and R. Anderson. 1997. Fort Huachuca fire management plan. Report to Fort Huachuca.

Roby, K.B., and D.L. Azuma. 1995. Changes in a reach of a Northern California stream following fire. Environmental Management 19(4):591-600.

Roeske RH, Werrell WL (US Geological Survey). 1973, Mar. Hydrologic condition in the San Pedro River valley, Arizona, 1971. Phoenix, AZ: Arizona Water Commission. Bulletin 4. 76 p.

Rogers, W.M. 1965. Historical land occupance of the upper San Pedro River valley since 1870. Unpublished Masters Thesis, University of Arizona, Tucson, AZ.

Ruyle, G.B., B.A. Roundy, and J.R. Cox. 1988. Effects of burning on germinability of Lehmann lovegrass. Journal of Range management 41:404-406.

SAIC 1997a (Science Application International Corporation). Increasing Recharge from Mountain Front Precipitation and Runoff Final Report July 1997.

SAIC 1997b (Science Application International Corporation). Range Utilization Survey, Phoenix, AZ. August.

SAIC 1998a. Programmatic biological assessment for Fort Huachuca, Arizona. Report to Directorate of Engineering and Housing, Environmental and Natural Resources Division, US Army Garrison, Fort Huachuca, AZ.

SAIC 1998b. 29 January 1998 letter to Jackie Record, US Fish and Wildlife Service, Phoenix, AZ. A report of southwestern willow flycatcher surveys on the San Pedro River in 1997.

SAIC 1999. 1999 Fort Huachuca Demographic Survey. Report to Directorate of Installation Support, Fort Huachuca, Arizona September 1, 1997.

San Pedro Expert Study Team. 1999. Sustaining and enhancing riparian migratory bird habitat on the upper San Pedro River. Report to the Secretariat of the Commission for Environmental Cooperation.

Scheibe, D. 1997. Air Traffic Chief. Libby Army Airfield, Fort Huachuca, Arizona. Written Communication with Brenda Ostrom (SAIC). August 14.

Schreiber, D.C. 1978. Feeding interrelationships of fishes of Aravaipa Creek, Arizona. MS Thesis, Arizona State University, Tempe, AZ. 312 pp.

Schueler, T. 1994. Feature Article. Watershed Protection Techniques 1(3):104.

Schwartzman, P.N. 1990. A hydrogeologic resource assessment of the lower Babocomari watershed, Arizona. Masters Thesis, Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ.

Scott, R.L., W.J. Shuttleworth, and D.C. Goodrich. 1998. Water use of two dominant riparian vegetation communities in southeastern Arizona. Presented at the American Meteorological Society, Special Symposium on Hydrology, Phoenix, AZ, 11-16 Jan. 1998. Http://www. tucson.ars.ag.gov/salsa/archive/publi.../ams_papers_table_of_contents_pdf.htm.

SDCP (Sonoran Desert Conservation Plan) 1999. Education Session #2, Arizona-Sonora Desert Museum, Tucson Arizona. http://www.co.pima.az.us/cmo/sdcp/sdcp2/ses/ses2.html.

Semlitsch, R.D. 1983. Burrowing ability and behavior of salamanders of the genus *Ambystoma.* Canadian Journal of Zoology 61:616-620.

Sevellita LTER. 1996. The Sevilleta Long-Term Ecological Research Project, Internet WWW page, at <http://sevilleta.unm.edu/animal/mammal/mexican_wolf.html>.

SFB (Southwestern Field Biologists) 1996a. Baseline and history of six wildlife species federally listed as threatened or endangered in the San Pedro River Watershed, Arizona. Prepared for the Department of the Army, Directorate of Engineering and Housing, Fort Huachuca, Arizona by Southwestern Field Biologists, Tucson, Arizona.

SFB 1996b. *Coryphantha robbinsorum* web page. Internet WWW page, at <http://www.internet.com/www/swfbtucs/hp/cactus/coro.htm>.

Sferra, S.J., Corman, T.E., C.E. Paradzick, J.W. Rourke, J.A. Spencer, and M.W. Sumner. 1997. Arizona Partners in Flight, southwestern willow flycatcher survey 1993-1996 summary report. Technical Report. Nongame and Endangered Wildlife Program. Arizona Game and Fish Department, Phoenix, AZ. 97 pp.

Shafer, C.L. 1990. Nature Reserves, Island Theory and Conservation Practice. Smithsonian Institution Press, Washington DC 189 pp.

Sharma, V., R.D. Mac Nish, and T. Maddock III. 1997. Analysis of hydrologic data collected by the US Bureau of Land Management 1987-1995 and recommendations for future monitoring programs. Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ. HWR No. 97-060. 61pp.

Sheridan, T.E. 1986. Los Tucsonenses: The Mexican Community in Tucson, 1854-1941. University of Arizona Press, Tucson. 327 pp.

Sheviak, C.J. 1990. A New *Spiranthes* (Orchidaceae) from the cienegas of southernmost Arizona. Rhodora 92:213-231.

Sidner, R. 1993. Fourth annual monitoring of potential roost sites of the lesser long-nosed bat (*Leptonycteris curasoae*) on the Fort Huachuca Military Reservation, Cochise County, Arizona. Report to Fort Huachuca, AZ. Contract #DABT63-93-P-0597.

Sidner, R. 1994. Bat inventory of riparian areas of the Fort Huachuca Military Reservation 1993-1994. Report to Arizona Game and Fish Department Heritage Fund (IIPAM Project #I92019), 12 Dec 1994. 47pp.

Sidner, R. 1996. Sixth annual monitoring of potential roost sites of the lesser long-nosed bat (*leptonycteris curasoae*) and other bat species on the Fort Huachuca Military Reservation, Cochise County, Arizona. Report to Fort Huachuca, AZ. Contract #DABT63-95-P-1083).

Sidner, R. 1999. Ninth annual monitoring report of bats, especially the lesser long-nosed bat (*Leptonycteris curasoae*), with emphasis upon roostsites on the Fort Huachuca Military Reservation, Cochise County, Arizona, May - October 1998. Report to Fort Huachuca, AZ. Contract #DABT63-98-T-0093.

Sidner, Ronnie 2000. Eleventh Annual Monitoring of Endangered Lesser Long-Nosed Bats on the Fort Huachuca Military Reservation, Cochise County, Arizona. July-November 2000. EEC Project 99190.37.

Sierra Vista Economic Focus. 2001-2002. Cochise College Center for Economic Research. Sierra Vista, Arizona

Silvey, W. and M.S. Thompson. 1978. The distribution of fishes in selected streams on the Apache-Sitgreaves National Forest. Completion report to USDA Forest Service. Arizona Game and Fish Department, Phoenix, AZ. 49 pp.

Skagen, S. 1995. The importance of riparian corridors and oases to migrating birds: a research, inventory, and monitoring project. Report to the Arizona Game and Fish Heritage Fund and National Fish and Wildlife Foundation. 35pp + figures and appendices.

Skinner, Tom 2002. Coronado NF Supervisor's Office,Tucson, Arizona 85701. Personal communication with Joanne Kirchner, EEC. 17 May 2002.

Slauson, L. 1996. Pollination ecology of *Agave chrysantha* and *Agave palmeri*. Pages 154-203. In Amorphametric and Pollination Ecology Study of *Agave chrysantha* Peebles and *Agave palmeri* Englem. (Agavaceae). Ph.D. Dissertation. Arizona State University. Tempe, Arizona.

Smith, Alexander B, Charles E. Paradzick, April A Woodward, Patrick E.T. Dockens, Tracy D. McCarthey. 2002. Southwestern Willow Flycatcher 2001 Survey and Nest Monitoring Report. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, AZ, Technical Report 191.

Snyder, J.D., T.J. Maret, and J.P. Collins. 1998. Species' interactions and drying frequency determine extinction and colonization rates in metapopulations of the Huachuca tiger salamander, introduced fish, and introduced bullfrogs in the San Rafael Valley, AZ. Abstract in program and abstracts, Fourth Annual Meeting of the Southwestern United States Working Group of the Declining Amphibian Populations Task Force, Phoenix, AZ.

Sogge, M. K., R. M. Marshall. S. J. Sferra, and T. J. Tibbitts. 1997. A southwestern willow flycatcher natural history summary and survey protocol. Tech. Rep. NPS/NAUCPRS/NRTR-97/12, USGS Colorado Plateau Research Station/Northern Arizona State University. 39 pp.

Spangle,Steve 2002. USFWS Office Supervisor and MSORP Liaison. Endangered Species Suboffice, Flagstaff, Arizona.

Spencer, C.N., and F.R. Hauer. 1991. Phosphorus and nitrogen dynamics in streams during a wildfire. Journal of the North American Benthological Society 10(1):24-30.

Stacey, P.B., and A. Hodgson. 1995. Impact of a large natural fire on the Mexican spotted owl. Department of Environmental and Resource Science, University of Nevada, Reno, NV.

Stalmaster, M. V. 1987. The bald eagle. Universe Books, New York.

Stebbins, R.C., and N.W. Cohen. 1995. A natural history of amphibians. Princeton University Press. Princeton, New Jersey. 316 pp.

Steidl, R.J. 2001. Relationship between Agaves and Lesser long-nosed bats on Fort Huachuca. University of Arizona, School of Renewable Natural Resources, Tucson, Arizona.

Stiles, F.G. and A.F. Skutch. 1989. A guide to the birds of Costa Rica. Comstock, Ithaca, New York. 364 pp.

Stoleson, S.H., and D.M. Finch. 1998. Reproductive success of the southwestern willow flycatcher in the Cliff-Gila Valley, summary report for the 1997 field season. USDA, Rocky Mountain Research Station, Albuquerque, NM. 14 pp.

Storfer, A., J. Collins, and J. Snyder. 1999. February 4, 1999, letter to Mr. Sheridan Stone, Fort Huachuca, AZ.

Stromberg, J.C., R. Tiller, and B. Richter. 1996. Effects of groundwater decline on riparian vegetation of semiarid regions: the San Pedro River, Arizona. Ecological Applications 6(1):113-131.

Stromberg, J.C., and M.K. Chew. 1997. Herbaceous exotics in Arizona's riparian ecosystems. Desert Plants 1997(2):11-17.

Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico. 393 pp.

Sumrall, L.B., B.A. Roundy, J.R. Cox, and V.K. Winkel. 1991. Influence of canopy removal by burning or clipping on emergence of *Eragrostis lehmanniana* seedlings. International Journal of Wildland Fire 1:35-40.

Svetlic, W. 1994. Soil survey of U.S. Army, Fort Huachuca, Cochise County, Arizona. Interim report. Fort Huachuca, AZ; U.S. Department of Agriculture, Natural Resources Conservation Service.

Swetnam, T.W., and J.L. Betancourt, 1998: Mesoscale disturbance and ecological response to decadal climatic variability in the American Southwest. Journal of Climate 11:3128-3147.

Tandy, M. 1997. Fort Huachuca plant community interpretation (vegetation community type map). University of Arizona, Tucson.

Taylor, R.C. 1995. A birder's guide to southeastern Arizona. American Birding Association, Inc., Colorado Springs, CO.

Tewes, M. 1982. Study of the endangered ocelot occurring in Texas. Year-end report to the Caesar Kleberg Wildlife Research Institute, Texas A&I University, Kingsville, TX.

Tewes, M. 1997. Texas A&I University, Kingsville, TX. Personal communication with Kate Barts (SAIC). July 1997.

Thomas, P.A. and P. Goodson. 1992. Conservation of succulents in desert grasslands managed by fire. Biological Conservation 6: 91-100.

Tibbets, C.A. 1992. Allozyme variation in populations of the spikedace, *Meda fulgida* and the loach minnow *Tiaroga cobitis*. Proceedings of the Desert Fishes Council 24th:37.

Tibbitts, T.J., M.K. Sogge, and S.J. Sferra. 1994. A survey protocol for the southwestern willow flycatcher (*Empidonax traillii extimus*). National Park Service, Colorado Plateau Research Station, Technical Report NPS/NAUCPRS/NRTR-94/04.

TPF (The Peregrine Fund) 1994. Northern aplomado falcon restoration. Progress report: 1994. The Peregrine Fund, World Center for Birds of Prey, Boise, Idaho. December 15, 1994.

Tschakert, P., R. Carter, and B. Morehouse, 1999, “Assessing the sensitivity of the Southwest's urban water sector to climatic variability: Case studies in Arizona”, CLIMAS Report Series No. CL1-00, Institute for the Study of Planet Earth, University of Arizona, Tucson, AZ.

Unitt, P. 1987. *Empidonax traillii extimus*: An endangered subspecies. *Western Birds* 18:137-162.

USACHPM (US Army Center for Health Promotion). 1997. Environmental Noise Management Plan and Installation Compatible Use Zone Study. Directorate of Environmental Health Engineering, Aberdeen Proving Ground, Maryland.

USAIC&FH (US Army Intelligence Center and Fort Huachuca) 1991. Environmental Assessment for Short Range Unmanned Air Vehicle Tests. Directorate of Engineering and Housing, US Army Garrison, Fort Huachuca, Arizona. February.

USAIC&FH 1992. Environmental Assessment for US Army Electronics Proving Ground Communication-Electronic Testing and use of Test Sites in Southern Arizona and Fort Huachuca. US Army Electronics Proving Ground, Fort Huachuca, Arizona. May

USAIC&FH 1993a. Comprehensive Unmanned Aerial Vehicle Environmental Assessment. Directorate of Engineering and Housing, US Army Garrison, Fort Huachuca, Arizona. March.

USAIC&FH 1993b. Environmental Assessment for Military Training and Communications-Electronic Testing at Fort Huachuca. Directorate of Engineering and Housing, US Army Garrison, Fort Huachuca, Arizona. January.

USAIC&FH 1997. Range Control Training Range Data.

USDC (US District Court of Arizona). 1995. Lawsuit - Southwest Center for Biological Diversity vs. William J. Perry, et. al.

USFS (US Forest Service) 1996. Mexican spotted owl inventory protocol. USDA Forest Service, Southwest Region. Albuquerque, New Mexico.

USFS 2000. Special Status Species list on Sierra Vista Ranger District, Coronado National Forest. Sierra Vista Office, April 25, 2000.

USFWS (US Fish and Wildlife Service) 1980. Selected vertebrate endangered species of the seacoast of the United States - the ocelot. Biological Services Program FWS/OBS-80/01.9. March 1980.

USFWS 1986. Endangered and threatened wildlife and plants; determination of threatened status for *Corphantha robbinsorum*. Federal Register January 9, 1986. pp 953-955.

USFWS 1990a. Spikedace recovery plan. Albuquerque, New Mexico. 38 pp.

USFWS 1990b. Loach minnow recovery plan. Albuquerque, New Mexico. 38 pp.

USFWS 1990c. Northern aplomado falcon recovery plan. US Fish and Wildlife Service. Albuquerque, Mew Mexico. 56 pp.

USFWS 1990d. Listed cats of Texas and Arizona recovery plan (with emphasis on the ocelot). Edited by A.M. Shull, S. Van Riper, S.P. Thompson, and S.E. Jahrsdoerfer.

USFWS 1993. Desert pupfish recovery plan. Phoenix, Arizona. 67 pp.

USFWS 1994a. Endangered and threatened wildlife and plants; designation of critical habitat for the threatened spikedace (*Meda fulgida*). Federal Register 59(45):10906-10915.

USFWS 1994b. Notice of 90-day and 12-month findings on a petition to reclassify spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*) from threatened to endangered. Federal Register 59(131):35303-35304.

USFWS 1994c. Lesser long-nosed bat recovery plan. US Fish and Wildlife Service, Albuquerque, NM. 30 pp.

USFWS 1995a. Endangered and threatened wildlife and plants; determination of endangered status for the southwestern willow flycatcher. Federal Register 60:10694-10715.

USFWS 1995b. Recovery plan for the Mexican spotted owl (*Strix occidentalis lucida*). US Fish and Wildlife Service, Southwest Region, Albuquerque, NM.

USFWS 1995c. Recovery Plan for the Mexican spotted owl: Vol. I, Part II. Albuquerque, New Mexico (2, 11, 26 pp).

USFWS 1995d. Whooping Crane *(Grus americana*) Species Account. Division of Endangered Species, Albuquerque, New Mexico.

USFWS 1995e. Reintroduction of the Mexican wolf within its historic range in the southwestern United States. Draft Environmental Impact Statement, June 1995.

USFWS 1995f. Huachuca springsnail conservation agreement. Briefing statement to the regional director of AGFD. 18 May 1995.

USFWS 1997. *Pyrgulopsis thompsoni*. Unpublished abstract complied and edited by the US Fish and Wildlife Service. Phoenix Field Office, Phoenix, AZ. 3 pp.

USFWS 1997a. Endangered and threatened wildlife and plants; determination of endangered status for three wetland species found in southern Arizona and Northern Sonora, Mexico. Federal Register 62(3):665-689.

USFWS 1997b. Endangered and threatened wildlife and plants, final determination of critical habitat for the southwestern willow flycatcher. Federal Register 62(140):39129-39146.

USFWS 1997c. Endangered and Threatened Wildlife and Plants, Final Rule to Extend Endangered Status for the Jaguar in the United States. Federal Register50 CFR 17 (39147-3915). 22 July 1997.

USFWS 1997d. Final rule determining endangered species status for the jaguar. Federal Register 62:140 (July 22, 1997).

USFWS 1997e. Final rule determining endangered species status for the cactus ferruginous pygmy-owl. Federal Register 62:46 (March 10, 1997).

USFWS 1999a. Programmatic Biological Opinion (PBO) for US Army Intelligence Center and Fort Huachuca; Final Non-jeopardy Rule USFWS Regional Office, Albuquerque, NM.

USFWS 1999b. Endangered and threatened wildlife plants; Designation of Critical Habitat for Huachuca Water Umbel. A plant. Final rule. 50 CFR Part 17. July 12, 1999. Federal Register 64 (132); 37441-37453.

USFWS 1999c. Sonora tiger salamander (*Ambystoma tigrinum stebinsi*) draft recovery plan. US Fish and Wildlife Service, Phoenix, Arizona. Section I.

USFWS 1999d. Endangered and threatened wildlife and plants; final rule to remove the American peregrine falcon from the Federal list of endangered and threatened wildlife, and to remove the similarity of appearance provision for free-flying peregrines in the conterminous United States; final rule. Federal Register 64(164):46542-46558.

USFWS 2000a. Endangered and threatened wildlife and plants; notice of 90 day finding for a petition to list the yellow-billed cuckoo as endangered and commencement of a status review. Federal Register 65:8104-8107.

USFWS 2000b. Endangered and threatened wildlife and plants; Final Designation of Critical Habitat for the Spikedace and the Loach Minnow. Federal Register 64:69323-69355.

USFWS 2000c. Endangered and Threatened Wildlife and Plants; Reopening of Comment Period, Notice of Public Hearins, and Clarification of Special Rule on Proposed Threatened Status for Chiricahua Leopard Frog. 27 September 2000.

USFWS 2001. United States Department of Interior Fish and Wildlife Service. Federal Register 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Species That Are Candidates or Proposed for Listing as Endangered or Threatened, Annual Notice of Findings on Recycled Petitions, and Annual Description of Progress on Listing Actions. 30 October 2001.

USGS (US Geological Survey) 1998. Letter from Nick Melcher, USGS, to Jim Rorabaugh, USFWS, review of the effects analysis within the Draft Biological Opinion on the Huachuca Water Umbel of the San Pedro River Basin, Arizona, dated August 28, 1998. USGS Tucson, Arizona.

USPP (Upper San Pedro Partnership) 2001. Open Space Subcommittee Hydrologic Protection Areas Final Report. Sierra Vista, AZ

Uyehara, J.C., Mary J. Whitfield, Lloyd Goldwasser. 2000. The Ecology of Brown-headed Cowbirds and Their Effects on Southwestern Willow Flycatchers in Status and Conservation of the Southwestern Willow Flycatcher for USDA Rocky Mountain Research Station. General Technical Report RMRS-GTR-60.

Velasco, A.T. 1994. Fish population sampling: Aravaipa Creek, Graham and Pinal Counties, Arizona, 1991-1992. The Nature Conservancy, Tucson, AZ. 154 pp.

Vionett, L.B., and T. Maddock III. 1992. Modeling of ground-water flow and surface/ground-water interaction for the San Pedro River basin, Part I, Mexican border to Fairbank, Arizona. Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ. HWR No. 92-010.

Vives, S.P. and W.L. Minckley. 1990. Autumn spawning and other reproductive notes on loach minnow, a threatened cyprinid fish of the American southwest. The Southwestern Naturalist 35(4):451-454.

W&EST, Inc. (Water and Environmental Systems Technology, Inc.) 1994. San Pedro hydrologic system model, US Bureau of Reclamation scenarios, November, 1994. Report to the Bureau of Reclamation, Phoenix, AZ.

W&EST, Inc. 1996. Upper San Pedro basin model, progress report to Gila River Indian Community. Report to the Gila River Indian Community, Sacaton, AZ.

Wallace, E. 1998. Herpetologist, AZ Game and Fish Department, Phoenix, AZ. Personal communication with Laura Valutis, February 1998.

Wang, L., J Lyons and R Gatti, 1997, Influences of watershed land use on habitat quality and biotic integrity in Wisconsin streams, Fisheries 22(6) 6-12.

Ward, L.Z. and M.A. Ingraldi. 1994. Grassland raptor / Aplomado falcon survey. Nongame and Endangered Wildlife Program Technical Report 27. Arizona Game and Fish Department, Phoenix, Arizona. 12 pp.

Ward, J.P., Jr., and W.M. Block. 1995. Mexican spotted owl prey ecology. Chapter 5 *in* US Fish and Wildlife Service, Mexican spotted owl recovery plan. Volume II, Albuquerque, NM.

Warren, P.L., L.S. Anderson, and P.B. Shaffroth. 1989. Population studies of sensitive plants of the Huachuca and Patagonia Mountains, Arizona. Unpublished report. Coronado National Forest, Tucson, Arizona. 99 pp.

Warren, P.L., D.F. Gori, L.S. Anderson, and B.S. Gebow. 1991a. Status report for *Lilaeopsis schaffneriana* ssp. *recurva*. US Fish and Wildlife Service, Arizona Ecological Services State Office, Phoenix, Arizona. 30 pp.

Warren, P.L., and F.R. Reichenbacher. 1991b. Sensitive plant survey of Fort Huachuca, Arizona. Unpublished report for the US Army, Fort Huachuca, Arizona.

Warren, P.L., B.S. Gebow, D.F. Gori, and J. Malusa. 1991c. Erigeron Lemmonii: Status Report Arizona Nature Conservancy, submitted to the USFWS.

Warren, P. L. 1998. The Nature Conservancy, Tucson, Arizona. Personal communications with Laura Valutis, SAIC, on 24 February 1998.

Watson, J.W. 1993. Responses of nesting bald eagles to helicopter surveys. Wildlife Society Bulletin 21:171-178.

Wauer, R. H., P. C. Palmer, and A. Windham. 1993. The ferruginous pygmy-owl in south Texas. American Birds 47(5):1071-1076.

Webb, R.H. and J.L. Betancourt. 1992. Climatic variability and flood frequency of the Santa Cruz River, Pima County, Arizona. US Geological Survey Water-supply Paper 2379.

White, C.M., and S.K. Sherrod. 1973. Advantages and disadvantages of the use of rotor-winged aircraft in raptor surveys. Raptor Research 7:97-104.

White, G.C., A.B. Franklin, and J.P. Ward, Jr. 1995. Population biology. Chapter 2. In Mexican spotted owl recovery plan, Volume II, USDI Fish and Wildlife Service, Albuquerque, NM.

White, L.D. 1969. Effects of a Wildfire on Several Desert Grassland Shrub Species. J. Range Manage. 22:284-285.

Whitfield, M.J., K.M. Enos, and S.P. Rowe. 1998. Reproductive response of the southwestern willow flycatcher (*Empidonax traillii extimus*) to the removal of brown-headed cowbirds. Report to the US Army Corps of Engineers, Sacramento, CA, and the California Department of Fish and Game, Sacramento, CA. 21 pp.

Wiesenborn, B. 1995. Sierra Vista wetlands and reuse study. Bureau of Reclamation, Boulder City, NV.

Wilcox, B.A., and D.D. Murphy. 1985. Conservation strategy: the effects of fragmentation on extinction. American Naturalist 125:879-887.

Williams, J.E., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye. 1985. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona-Nevada Academy of Science 20(1):1-62.

Windsor, J. 1977. The response of peregrine falcons (Falco peregrinus) to aircraft and human disturbance. Mackenzie Valley Pipeline Investigations, Report for Environmental Social Programs. Canadian Wildl. Serv. 87 pp.

Wright, H.A., and A.W. Bailey. 1982. Fire ecology, United States and Canada. John Wiley and Sons, New York. Pages 297-303.

Wynn, J., and M. Gettings. 1997. A preliminary interpretation of the 1997 airborne electromagnetic (EM) survey over Fort Huachuca, Arizona, and the upper San Pedro River basin (draft). USDI, Geological Survey, Reston, VA.

Ziemba, R.E., A.T. Storfer, J. Warren, and J.P. Collins. 1998. Genetic variation among populations of the Sonora tiger salamander (*Ambystoma tigrinum stebbinsi* Lowe). Report to the Arizona Department of Game and Fish, Heritage Fund Program Grant #I96046.

Zillgens (Hermann Zillgens and Associates). 1991. Fort Huachuca land use plan. Report to Fort Huachuca.

APPENDIX A
PREVIOUS CONSULTATION ON ARMY ACTIVITIES AT OR NEAR FORT HUACHUCA

Consultation No	Date of Correspondence	Project	Species Addressed	Findings
2-21-98-F-266	25 Jan 2002	Conservation Easements	N/A	The Service concurred with water credit amounts for Clinton Ranch and with method used to determine water savings and credit.
CL 11-0030	14 Nov 2001	Fort Huachuca Integrated Natural Resources Management Plan	Huachuca water umbel, southwestern willow flycatcher, Mexican spotted owl, lesser long-nosed bat, Sonora tiger salamander, spikedace, loach minnow and Canelo Hills ladies' tresses and designated critical habitat	The Service commented on the INRMP.
2-21-01-I-413 CL2001637	24 Aug 2001	Wind Data Towers	lesser long-nosed bat and bald eagle	The Service concurred with may affect determinations.
2-21-98-F-266R4	9 May 2001	Garden Canyon Road Maintenance Project	Mexican spotted owl, Huachuca water umbel and critical habitat for each species	The Service concurred with may affect determinations.
2-21-98-F-266R3	17 Apr 2001	Grassland Fire Research Project	lesser long-nosed bat	The Service concurred with may affect determination.
2-21-01-I-192	15 Mar 2001	Grassland Fire Research Project	lesser long-nosed bat, Huachuca water umbel, Mexican spotted owl and Sonora tiger salamander	The Service concurred with effect determinations
2-21-95-I-421	8 Dec 2000	203 acre land transfer	Huachuca water umbel, southwestern willow flycatcher, lesser long-nosed bat, bald eagle, spikedace and loach minnow and designated critical habitat.	The Service concurred with effect determinations.
2-21-98-F-266R2	29 Nov 2000	East Range effluent reuse program	Huachuca water umbel, southwestern willow flycatcher, Mexican spotted owl, lesser long-nosed bat, Sonora tiger salamander, spikedace, loach minnow and Canelo Hills ladies' tresses	Activities will not jeopardize the continued existence of the umbel, flycatcher, owl, bat or salamander or destroy or adversely modify designated critical habitat. The Service concurred with may affect determinations for the other species.
2-21-98-F-266R1	29 Sep 2000	UAV Program expansion and critical habitat designated for the spikedace and loach minnow	Huachuca water umbel, southwestern willow flycatcher, Mexican spotted owl, lesser long-nosed bat, Sonora tiger salamander, Canelo Hills ladies' tresses, spikedace and loach minnow	Activities will not jeopardize the continued existence of the umbel, flycatcher, owl, bat or salamander or destroy or adversely modify designated critical habitat. The Service concurred with may affect determinations for the other species.

Consultation No	Date of Correspondence	Project	Species Addressed	Findings
2-21-00-I-345	28 Jul 2000	Bergey Wind Turbine	Lesser long-nosed bat and bald eagle	The Service concurred with may affect determinations.
2-21-00-I-183	3 Jul 2000	Veteran's Cemetery	Lesser long-nosed bat, Huachuca water umbel, southwestern willow flycatcher, loach minnow and spikedace	The Service concurred with may affect determinations.
2-21-98-F-266	27 Oct 1999	Programmatic Biological Opinion on Ongoing and Future Programmed Military Operations and Activities at Fort Huachuca, Arizona	Lesser long-nosed bat, Sonora tiger salamander, Mexican spotted owl, southwestern willow flycatcher, Huachuca water umbel, Canelo Hills ladies' tresses, loach minnow and spikedace	Activities will not jeopardize the continued existence of any species or destroy or adversely modify designated critical habitat. The Service issued take statements for the owl, bat and salamander and concurred with may affect determinations for other species.
2-21-98-I-310	16 Jun 1998	Fire management activities - South Range	Lesser long-nosed bat	The Service concurred that proposed actions may affect, but are not likely to adversely affect the bat
2-21-96-I-147	08 Jan 1998	Programmatic - all activities	Mexican spotted owl, peregrine falcon, southwestern willow flycatcher, lesser long-nosed bat, Sonora tiger salamander, Huachuca water umber, Canelo Hills ladies tresses	The Service requested that the Army request initiation of formal consultation
2-21-96-I-147	08 Oct 1997	Programmatic - all activities	Same as Above	The Service provided comments to the Fort on the draft Biological Assessment
2-21-96-I-127	18 Aug 1997	AZ Army National Guard activities at Fort Huachuca	Same as Above plus jaguar, ocelot, jaguarundi, Mexican gray wolf, cactus ferruginous pygmy-owl	The Service provided comments to the Guard on the Dec 1996 draft Biological Assessment on Guard activities
No Number	14 Jul 1997	AZ Army National Guard activities at Fort Huachuca	Not Specified	The Service requested environmental assessment and mitigation of Guard activities at Fort Huachuca and elsewhere
2-21-96-I-127	No Date	AZ Army National Guard activities at Fort Huachuca	Mexican spotted owl, peregrine falcon, southwestern willow flycatcher, lesser long-nosed bat, Sonora tiger salamander, Huachuca water umber, Canelo Hills ladies tresses, Cactus ferruginous pygmy-owl, spikedace, and others	The Service provided comments on the 22 July 1996 draft Biological Assessment on Guard activities
2-21-96-I-127	09 Jun 1997	AZ Army National Guard activities at Fort Huachuca	Not Specified	The Service requested an update on consultation scheduling
2-21-97-I-196	04 Feb 1997	Regionalization of civilian personnel administrative functions	Mexican spotted owl, peregrine falcon, southwestern willow flycatcher, Cactus ferruginous pygmy-owl, bald eagle, lesser long-nosed bat, spikedace, Sonora tiger salamander, Huachuca water umber, Canelo Hills ladies tresses, jaguar, ocelot, jaguarundi, Mexican gray wolf, Gila topminnow	The Service agreed with no effect determination for subject species

Consultation No	Date of Correspondence	Project	Species Addressed	Findings
2-21-96-I-147	18 Jun 1996	Preliminary draft Master Plan EIS	Same as Above plus Chiricahua dock	The Service provided comments on the preliminary draft EIS
2-21-96-I-142	13 Feb 1996	J-STARS EA	Mexican spotted owl, Huachuca water umbel, Sonora tiger salamander	The Service did not concur with the Fort's finding that the proposed action would not affect listed species
2-21-94-I-473	22 Sep 1995	Programmatic consultation on the draft master Plan EIS	Huachuca water umbel, San Pedro species	The Service suggested measures for mitigating possible adverse effects to San Pedro species
2-21-94-I-473	21 Jun 1995	Endangered species issues at the Fort	Southwestern willow flycatcher, Huachuca water umbel, spikedace, loach minnow, razorback sucker, desert pupfish, lesser long-nosed bat, Mexican spotted owl, peregrine falcon	Service comments on endangered species, especially in regard to the San Pedro River
2-21-95-I-087	21 Dec 1994	Sensitive species management Plan for the Fort	Aplomado falcon, San Pedro species	The Service forwarded a species list to the Fort and commented on concerns in regard to listed species
2-21-94-I-609	13 Oct 1994	EA for M1 tank operation	Mexican spotted owl	The Service commented on draft EA
2-21-94-I-473	14 Sep 1994	Possible base realignment	All listed species in the area	The Service provided the Fort's consultant with a species list for Fort Huachuca and surrounding areas
2-21-94-I-473	22 Aug 1994	Possible base realignment	All listed species in the area	The Service provided the Fort's consultant with a species list for Fort Huachuca and surrounding areas
No Number	25 Feb 1994	8th of the 40th tank training	Lesser long-nosed bat	The Service conditionally concurred with the Fort's no effect determination on the bat
2-21-92-I-146	04 Jan 1994	Proposed gas station and mini-mall	None	The Service determined that no listed species were present in the project area
No Number	28 Dec 1993	M1 tank maneuvers/firing	Mexican spotted owl	The Service expressed concerns over possible adverse effects to spotted owls
No Number	17 Dec 1993	Draft EA M1 tank operations	Mexican spotted owl, lesser long-nosed bat	The Service commented on the draft EA
2-21-94-I-054	03 Dec 1993	EA for renovation of Greely Hall	None	The Service concurred with a no effect determination to listed species
No Number	07 May 1993	EA for restricted airspace over South Range	Lesser long-nosed bat, Mexican spotted owl	The Service found that no additional effects to listed species would occur as a result of the action
No Number	01 Apr 1993	EA for comprehensive unmanned air vehicle (UAV)	Lesser long-nosed bat, Mexican spotted owl	The Service provided comments on the draft EA
No Number	04 Nov 1992	EA for Applied Instructional Building for UAVs	Not specified	The Service provided comments on the draft EA
2-21-92-I-742	02 Oct 1992	EA for renewal of leases at Willcox Playa and Sands Ranch	Lesser long-nosed bat	The Service concurred on the Fort's determination of no affect to the lesser long-nosed bat
No Number	24 Aug 1992	EA for Applied instructional Building for UAVs	Not specified	The Service provided comments on the draft EA
No Number	11 Aug 1992	Comprehensive EIS on Fort Huachuca activities and missions	Lesser long-nosed bat, Mexican spotted owl	The Service commented on the need for a comprehensive EIS and Biological Assessment

Consultation No	Date of Correspondence	Project	Species Addressed	Findings
No Number	2 Jun 1992	EA for Fort Huachuca Installation Asbestos Management Plan	Lesser long-nosed bat	The Service concurred on the Fort's determination of no affect to the lesser long-nosed bat
No Number	14 Apr 1992	EA for 79 Army Security Agency (ASA) points near and on the Fort	Lesser long-nosed bat	The Service provided comments on the draft EA
No Number	19 Mar 1992	Draft FONSI for Vehicle Magnetic Signature Duplicator test	None specified	The Service found that no listed species would be affected
2-21-92-I-153	12 Mar 1992	EA for Test and Experimental Command (TEXCOM), Unmanned Air Vehicle-Short Range (UAV-SR)	Lesser long-nosed bat	The Service provided comments on the draft EA
2-21-90-I-257	10 Mar 1992	Request to extend the UAV-SR Program to June 30, 1992	Lesser long-nosed bat	The Service provided no objection to the time extension
No Number	26 Feb 1992	EA for continuation of Join Terminal Information Distribution System (JTIDS)	None specified	The Service provided comments on the draft EA
No Number	11 Feb 1992	Advanced Airlift Tactics Training Center (AATTC)	Lesser long-nosed bat	The Service provided comments on mitigation measures
No Number	17 Dec 1991	Dec 1991 and Jan 1992 test of the JTIDS	None specified	The Service found that no listed or proposed species would be affected
2-21-92-I-193	07 Jan 1992	Proposed expansion of Black Tower UAV compound Fort Huachuca Base Realignment	Not specified	The Service provided comments on the project
2-21-92-I-146	12 Dec 1991	Fort Huachuca Base Realignment	Lesser long-nosed bat, Mexican spotted owl	The Service provided a species list for BRAC 91
No Number	02 Dec 1991	Draft EA for Development of a Forward Operating Base for the Advanced Airlift Tactics Training Center, Joint Operations Training	Lesser long-nosed bat	The Service provided comments on the draft EA
No Number	02 Dec 1991	Draft FONSI for TEXCOM test of TOPHUNTER tactical communication Intelligence direction finding system	Lesser long-nosed bat	The Service provided comments on the draft FONSI
No Number	02 Dec 1991	EA for Electronic Proving Ground JTIDS on 24 sites within 40 mi. of Fort Huachuca	Lesser long-nosed bat	The Service provided comments on the draft EA
2-21-92-I-053	08 Nov 1991	UAV tests by TEXCOM	Lesser long-nosed bat, peregrine falcon, Gila topminnow, Mexican spotted owl	The Service provided a species list for the subject project
2-21-91-I-534 2-21-91-I-442	02 Oct 1991	Exercises of the 11th Signal Brigade	Not specified	The Service found that consultation on individual exercises is not necessary under specified conditions
No Number	23 Sep 1991	EA for Fire Department Training Academy	Lesser long-nosed bat	The Service found that the action would not affect the lesser long-nosed bat
No Number	23 Sep 1991	UAV Projects	Lesser long-nosed bat	The Service concurred with the Fort's determination of no effect to listed species
2-21-91-I-534	20 Sep 1991	EA for 11th Signal Brigade Exercises, Nov 1991	Not specified	The Service concurred with the Fort's determination of no effect to listed or proposed species

Consultation No	Date of Correspondence	Project	Species Addressed	Findings
2-21-90-I-257	06 Sep 1991	UAVs	Lesser long-nosed bat	The Service conditionally concurred with the Fort's determination that the project would not likely adversely affect to the lesser long-nosed bat
2-21-91-I-477	27 Aug 1991	EAs for renewal of leases at Willcox Playa and Gila Bend	Lesser long-nosed bat, Whooping crane, Tumamoc globeberry	The Service concurred with the Fort's determination of no effect to listed species
No Number	09 Jul 1991	8th of the 40th Army Reserve Unit Training, fires in agave areas, etc.	Lesser long-nosed bat	The Service commented on issues involving listed species and discussed the need for a comprehensive consultation on all activities at the Fort
No Number	1991	8th of the 40th Army Reserve activities	Not specified	Compliance of the 8th of the 40th with conditions/environmental regulations
2-21-90-I-257	30 May 1991	UAV activities over Canelo Hills and Patagonia Mountains	Lesser long-nosed bat	The Service conditionally concurred with the Fort's determination that the project would not likely adversely affect to the lesser long-nosed bat
2-21-91-I-207	19 Mar 1991	Prescribed fire on Area W	Lesser long-nosed bat	The Service provided comments on the proposed fire and identified a need for a comprehensive Fire Management Plan
2-21-91-F-083	18 Jan 1991	Prescribed fire and fire breaks on South Range	Lesser long-nosed bat	Biological Opinion, in which the Service found that the action would not jeopardize the continued existence of the lesser long-nosed bat
2-21-91-F-083	18 Dec 1990	Prescribed fire and fire breaks on South Range	Not specified	The Service acknowledged receipt of request for formal consultation
2-21-91-I-041	14 Nov 1990	Tank firing at Fort Huachuca	Lesser long-nosed bat, peregrine falcon	The Service provided a list of species in the project area
No Number	04 Jun 1990	EA for UAV runway	Lesser long-nosed bat	The Service concurred with the Fort's determination that the project would not affect the lesser long-nosed bat
No Number	23 May 1990	Base realignment	Lesser long-nosed bat	The Service concurred with the Fort's determination that the project would not affect the lesser long-nosed bat
No Number	27 Mar 1990	UAV Runway	Lesser long-nosed bat	The Service provided comments on the first draft of the EA
No Number	20 Mar 1990	NEPA, ESA issues, prescribed fire	Lesser long-nosed bat	The Service provided comments on the NEPA and ESA processes
No Number	21 Dec 1989	EA/scoping letter for High Frequency Test Facility at Site Sibil	Lesser long-nosed bat	The Service provided comments on the draft EA/scoping letter
No Number	11 Sep 1989	Relocation of High Frequency Radio Transmitter from Blacktail Canyon to Site Sibil	Lesser long-nosed bat, peregrine falcon	The Service requested an opportunity to comment on the draft EA

Consultation No	Date of Correspondence	Project	Species Addressed	Findings
No Number	24 Sep 1989	EA for High Frequency Test Facility	Lesser long-nosed bat	The Service provided comments on the draft EA
No Number	15 Mar 1990	EA for Base Realignment	Lesser long-nosed bat	The Service commented on the draft EA and stated that Section 7 consultation may be required
No Number	29 Aug 1989	EA for UAV	Not specified	The Service concurred with the Fort's FONSI
No Number	13 Jul 1989	Effects of fire and training on lesser long-nosed bat	Lesser long-nosed bat	The Service commented on recent fires, and the need for a comprehensive evaluation of effects of military activities at Fort Huachuca on the lesser long-nosed bat
No Number	23 Nov 1988	NEPA and ESA processes	Lesser long-nosed bat	The Service identified a need for better coordination between Fort Huachuca and the Service on NEPA and ESA issues

APPENDIX B
MAJOR UNIT DESCRIPTIONS

US ARMY WHITE SANDS MISSILE RANGE - ELECTRONIC PROVING GROUND

The EPG is an independent Directorate of the US Army White Sands Missile Range, which is in turn a part of the US Army's Material Command in Alexandria, Virginia. The mission of EPG is to conduct laboratory and field tests to evaluate new and proposed military communications and electronic equipment. Tests are also conducted to evaluate new product items, and to evaluate improvements to existing field equipment. The test results are used by the Army, other defense agencies, and equipment manufacturers for decision-making concerning further development or production of the test equipment. Field tests usually consist of deploying vehicles and personnel to a number of on-post and off-post ASA (for the former Army Security Agency) sites. Individual tests typically will employ different combinations of sites, with each site occupied by one or two vehicles containing the test equipment. EPG normally has approximately 200 tests or projects active at any given time. Approximately fifty of these tests are conducted annually using a current network of about 2,400 on-post and 675 off-post "ASA site" field locations. The balance of the tests uses EPG installations located in the cantonment. Tests may also employ UAVs.

EPG test facilities at Fort Huachuca consist of an antenna test facility, a compact range, a radar tracking network, an EMI/EMC test facility, avionics Global Positioning System (GPS) test facility, UAV test facility, and a complete environmental effects test laboratory.

INTELLIGENCE ELECTRONIC WARFARE DIRECTORATE

This organization is the Intelligence Electronic Warfare Test Directorate (IEWTD), with their higher headquarters located at Fort Hood, Texas. IEWTD is responsible for conducting operational tests on communication and direction finding UAV and other electronic warfare systems for the DoD and other national intelligence agencies. The mission of the IEWTD is to conduct realistic operational tests of new and/or upgraded Intelligence and Electronic Warfare equipment and systems. Results of these tests are used by DoD officials in determining the suitability of new systems for purchase and ultimately, fielding throughout the DoD.

The full-time military and civilian strength of IEWTD, to include support contractors, is generally about 130 people. However, in many instances during the conduct of annual tests, the figure may increase substantially for short periods of time. For instance, during a test, there may be as many as 40-50 soldiers and civilians from other military posts at Fort Huachuca on temporary duty to assist with the test. Additionally, support contractors might hire numerous temporary workers for the duration of a test. Test periods do not usually exceed 2-3 months at a time. At the conclusion of the test, the temporary duty soldiers and civilians return to their home post, and temporary support contractor personnel are released.

The IEWTD tests Intelligence and Electronic Warfare equipment. These types of equipment are generally electronic, computer, or radar imaging systems, and can be moved on wheeled, track,

or Army standard aircraft. In the future, IEWTD will test tactical UAVs. On occasion, IWETD uses standard Army motor vehicles as targets for radar systems. Drivers of those vehicles receive extensive training in environmental concerns (i.e., use of oil drip pans when stopped, areas not to drive in, etc.).

The majority of tests are conducted within the confines of the IEWTD compound on Fort Huachuca. Some tests are conducted using existing facilities on Fort Huachuca (i.e., established ranges, buildings owned by other organizations, airfield facilities, etc.). Infrequently, off-post areas and roadways are used for vehicular traffic. In these instances, IEWTD always coordinates and receives clearance from the Fort Huachuca Environmental Office at the DEH.

JOINT INTEROPERABILITY TEST COMMAND

JITC is a Defense Information System Agency (DISA). Their purpose is operational and interoperability testing. Fort Huachuca is a major range and test facility base for this command. They have approximately 650 military, civilian, and contract personnel. They operate in Buildings 57305, 57428, and on a 20-acre remote site leased from the state. They use military communications equipment during normal office hours and occasionally on weekends and holidays.

The DISA aggregates all communications networks, sensors, data entry devices, computer resources, facilities, and staffs which provide collection, production, storage, display, and dissemination of information. JITC tests equipment and systems developed by the individual service branches and evaluates the interoperability of the test equipment with equipment, tactics, and doctrine of the other service branches .

The majority of tests performed at the JITC involve bench tests or other non-environmentally intrusive tests conducted internally within self-contained laboratories or facilities on the installation near LAAF, and at the High Frequency Test Facility (HFTF) transmitter site situated on approximately forty acres of land within the East Range.

US ARMY INTELLIGENCE CENTER

US Army Intelligence Center is comprised of administrative and training functions. The Center is responsible for Military Intelligence doctrine for the US Army. Additionally, the center oversees training of Military Intelligence personnel from Army, Air Force and Marine students throughout their career progression. The USAIC includes several directorates for doctrinal work, and two training brigades, the111TH and the 112TH Military Intelligence Brigades, and several training detachments from other US armed services.

The MI Brigades provide intelligence and electronic warfare training, testing, maintenance and support to the Intelligence Center and Fort Huachuca. The brigades consist of five MI battalions and two detachments. Four battalions (304th MI, 305th MI, 309th MI, and 344th MI) and one detachment (HHD, 111th MI Brigade) are located at Fort Huachuca. In addition to its primary mission of MI training, the units deploy subject matter experts and units equipped with low

density systems such as the UAVs, and Trojan Special Purpose Integrated Remote Intelligence Terminal (SPIRIT) to contingency operations throughout the world.

The UAV Training Center on the West Range is hosted by the 304th MI Battalion, and also provides support to the Shadow UAV Training Site. This training is conducted at the Black Tower Complex, approximately six miles west of the cantonment area on the West Range, by the C/304th and D/304th. Their mission is to train UAV operators for the US Army, and US Marines. Operational proficiency training involves field exercise activity by the active duty operational Army units located at Fort Huachuca; the combined services UAV training; and the MO ANG Advanced Airlift Tactical Training Center. They have approximately 50 personnel and anticipate training approximately 40 students annually through the year 2000. They operate almost entirely on the West Range from approximately 5:00 AM to 4:00 PM with infrequent night operations. They use equipment such as UAVs, ground control stations, five-ton trucks, mobile power units, and antennas.

ARMY SIGNAL COMMAND (PROPOSED TO TRANSITION TO NETCOM)

The ASC is a major command of US Army Forces Command, the primary war-fighting organization of the US Army. The ASC mission is to deliver a responsive, deployable, agile signal force in support of Commanders in Chief and Army Service Component Commanders. Operate, sustain, and protect the Army's portion of the Global Information Grid, enabling force projection and the delivery of decisive combat power. In addition to administrative functions, the ASC also is the higher Headquarters for the 11th Signal Brigade, located at Fort Huachuca.

The 11th Signal Brigade provides contingency communications support as directed by the Joint Chiefs of Staff to United States deployed units and organizations throughout the world. At Fort Huachuca the brigade has approximately 1,500 authorized personnel.

US ARMY COMMUNICATIONS ELECTRONICS COMMAND

The US Army Communications Electronic Command (CECOM) is part of the US Army Electronics Command headquartered at Fort Monmouth, New Jersey. They have 151 personnel, both civilian and military, and they handle communication security equipment. They train 100-250 students annually during one week courses. They operate in Greeley Hall during normal office hours. The US Army Information Systems Engineering Command (ISEC) is a subordinate command of CECOM and AMC. ISEC is the US Army System Engineer. They primarily work on Army projects, but also support other government agencies and DoD branches as directed. At Fort Huachuca they have 380 personnel who operate during normal office hours in three buildings on the installation.

US ARMY GARRISON AND OTHER SUPPORT

The US Army Garrison manages the multitude of functions and services that keep the 73,000-acre installation operating so that other organizations on post may concentrate on their primary missions. In addition to several functional directorates, such as the DIS and the Directorate of Community Activities which are comprised primarily of civilian and contract employees, the

306th Military Intelligence Battalion, located in Riley Barracks, provides support to the Garrison. The 306th exercises battalion-level command over four companies, the 36th Army Band, and the Ceremonial Detachment. As a city unto itself, the Garrison provides support to Fort Huachuca just as any city government supports its community. For instance, the Garrison provides such services as military and civilian personnel, legal, inspector general, logistical, facilities engineering, fire and safety, housing, public affairs, resource management, internal audit compliance review, and crime prevention/law enforcement. The Garrison maintains telecommunications facilities, equipment, and resources common to all partner organizations as well as community facilities and provides necessary services for religious, health, welfare, and entertainment activities. The Garrison is responsible for maintaining Fort Huachuca's quality of life.

Other support activities include the MEDDAC (medical clinics), the DENTAC (dental clinic), AAFES (Post Exchange), the commissary, the Accommodation Schools for army family members, financial services (bank, credit union), and Non-appropriated funds personnel who run restaurants and recreational activities.

US ARMY RESERVE TRAINING ACTIVITIES

The 63rd Army Reserve Support Command (ARSC) is the operational command for US Army Reserve training activities performed at Fort Huachuca. Two Reserve units under this command using the Installation are the 208th and 257th Transportation Companies. Both transportation companies conduct four training exercises each year. The 208th and 257th Transportation Companies on the East Range. The exercises include simulation of convoy training along existing roads and bivouacking for a fourth of the personnel at one time. The 208th has 68 vehicles. The 257th Transportation Company also operates on the East Range. The activity of the unit includes simulation of convoy training along roads, hauling tank equipment on vehicles, and setting up bivouacs for Reservist camping. The 257th Company has 83 vehicles which includes 72 HET vehicles. Other Army, Air Force, and Marine Reserve and National Guard units may drill or perform Annual training at Fort Huachuca on an irregular basis.

APPENDIX C
FORT HUACHUCA FISHING FACTS

Environmental and Natural Resources Division, Building 22526, phone: 533-1867.

Fishing on Fort Huachuca is open to the general public.

Ponds currently available for fishing on-post are:

Golf Course Pond
Gravel Pit Ponds
Woodcutters Pond
O Club Pond (Lakeside Club)

Inquire about current conditions at the Sportsman Center.

1. Fishing License Requirements

   a. Adult Fisherman, age 14 and older must have in their possession the following licenses:

      (1) A valid Arizona fishing license or a valid Arizona combination hunting and fishing license, and

      (2) A valid Fort Huachuca fishing permit ($10 per year) <u>or</u> a 9-day temporary Post fishing permit ($3)

      (3) In order to take trout, Arizona law requires a Trout Stamp to validate a class A (general) fishing license.

   b. Juvenile *Anglers*:

      (1) 9-13 years old, NO Post fishing permit required. (A $3 Post fishing permit fee has been waived).

      (2) 0-8 years, <u>NO</u> Post fishing permit required, but to ensure safety, these children must be accompanied by a <u>licensed</u> fisherman who is at least 16 years old.

   c. Duplicate Post fishing permit ($2).

2. All fishing licenses are sold at the Fort Huachuca Sportsman Center located on Garden Canyon Road. The Sportsman's Center is closed Monday and Tuesday, phone 538-7085. Post fishing permits <u>only</u> (for those who already have their Arizona licenses and trout stamp, if applicable) are available at MWR Rents (Monday and Tuesday) at the corner of Irwin and Hunter Streets, phone: 533-6707.

3. Fishing Regulations: Except for the rules listed below, fishing regulations for Fort Huachuca are the same as Arizona Fishing Regulations.

   a. The daily individual limit of fish on Fort Huachuca is as follows:

Rainbow Trout	5
Channel Catfish (10 inch min)	5
Largemouth Bass (10 inch min)	5
Bluegill and other sunfish	5

   b. Military training has priority over fishing; *therefore* some ponds may be closed to fishing during training. *Anglers* must call Hunter Control (MP Desk) at 533-2181, before fishing at Woodcutters Pond (i.e. ask if Area T3 is open).

   c. Fishing on Post is only authorized during hours of daylight.

   d. The use or transportation of <u>live bait of any kind,</u> including fish, salamanders, or crayfish (crawfish, crawdads) is **<u>NOT AUTHORIZED</u>** on Fort Huachuca.

   e. *Anglers* are not allowed to possess firearms on Fort Huachuca.

   f. *No* boating or swimming is allowed on Fort Huachuca ponds, *except for fishing float tubes.*

   g. Littering and fish cleaning is prohibited at the pond site.

   h. *Anglers* may not camp or build fires by ponds.

   i. **Capture, transport, or release of Salamanders is prohibited.**

   j. Failure to comply with these fishing regulations may result in fines/or revocation of the Fort Huachuca Fishing Permit.

Updated June 2002

APPENDIX D
TERMINATION LETTER FOR 203 ACRE LAND CONVEYANCE

DEPARTMENT OF THE ARMY
ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON DC 20310-0600

REPLY TO
ATTENTION OF

DAIM-MD

9 JUN 2002

MEMORANDUM THRU Commander, U.S. Army Training and Doctrine Command, ATTN: ATBO-GP (Mr. Blanchard), Fort Monroe, VA 23651-5421

FOR Commander, US Army Garrison, US Army Intelligence Center and Fort Huachuca (ATZS-CDR), Fort Huachuca, AZ 85613-6000

SUBJECT: Conveyance of 203 Acres Located on Fort Huachuca to the City of Sierra Vista

1. Reference memorandum, US Army Garrison, US Army Intelligence Center and Fort Huachuca, 14 May 02, subject: Conveyance of 203 Acres Located on Fort Huachuca to the City of Sierra Vista.

2. Your request to terminate processing of subject Report of Excess (ROE) is approved. No further action is required. Point of contact for this action is Mr. Kurre, (703) 692-9229.

PETER F. PORCELLI
Colonel, GS
Chief, Plans and Operations Division

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E
CURRENT LEASES AT FORT HUACHUCA

ITEM NO.	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/ LESSOR	REMARKS
1	BLM No. PLO 2183 91210 Gila Bend	USAEPG 1960 Fac No. LW001	640	INDEF	NONE	Portions of SEC 23, 24, 25, and 26 T4S, R9W, Oatman Mt.	Dept. of Interior	Oatman Mountain Site
1a	BLM No. AR 035662 91319 Gila Bend	USAEPG 1966 Fac No. LP059	N/A	INDEF	NONE	Right-of-way in SEC 7, T4S, R7W Maricopa County, Oatman Mt.	Dept. of Interior	Alt route to site (old file #2a) (.1 ac in RPI)
2	BLM No. AR 028695 91310 Gila Bend	USAEPG 1960 Fac No. LP002	13.77	INDEF	NONE	Portions of SEC 26, 34,35, T4S, R9W Oatman Mt. Site R/W	Dept. of Interior	
9	LA 1330 91310 Gila Bend	USAEPG 1961 Fac No. LP009	1.0	INDEF	NONE	Portions of SEC 25, T4S, R9W Oatman Radar Reflector Site	Dept. of Interior	Utility Pole reflector site
21	LA 2146 91350 Ft Huachuca	USAEPG 1971 Fac No. LP021	14.75 (15.0 in RPI)	INDEF	$100.00 w/amend #5	Mt. Lemmon, bldgs 195 (6,000 SF) & P-13 (USFS bldg-317SF)	US Forest Service	POC: Kim Rinehart/538-3816
27	LA 2349 BLM No. A 7694 91310 Gila Bend	USAEPG 1974 Fac No. LP027	.027	INDEF	NONE	Tract 27, T3N, R3W, Commo & Data BLM Line, White Tank Mts. 20'x60'	BLM - Joint Use	
28	1. AZ #78747 2a. AZ #83597-B 2b. AZ #83598-B	USAEPG ASA Sites a. EPG b. OTC (TEXCOM)	N/A	1. 14 Jan 03 Blanket Permit - Tucson 2. a & b 08 Jan 03 Blanket Permit - Safford	NONE	Various roadside sites located along AZ State Highways: 80, 82, 90, & 92.	1. Arizona State Highway Dept. - District 2, Area 2, Tucson 2. Arizona State Highway Dept. - District 2, Area 3, Safford	ASAs: 2532,76,47,90,93, 218,219,222,226,233, 235,236,237,251,255,256,257,265,266, 314,320,900,2525, 2526,2527,2528,2529,2530,2531,2533,2534. 1 & 2a. EPG POC: Rich NG, 533-8084 1 & 2bb. OTC (TEXCOM): Jim Smith, 538-6159
32	LA 2427/A9227 91310 Ft Huachuca	USAEPG DTEP 1975: Fac No. LP032	.34	INDEF	NONE	Test Site (.23 ac) & helipad (.11 ac) Mule Mountain	BLM - Joint Use	
34	LA 2439 91310 Ft Huachuca	USAEPG 1976 Fac No. LP034	.1	31 Dec 03	NONE	Repeater Site, Heliograph Peak Electronic Site	US Forest Service - Joint Use	Mt. Graham - Safford Ranger District; site is 24 miles from rts 191/366

ITEM NO.	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/ LESSOR	REMARKS
36	DACA09-3-68-34 LA 68304 91360 Gila Bend	USAEPG (SPT) 1967: Fac No. LP036	N/A	INDEF	NONE	P/SEC 26, T5S, R4W, west of Gila Bend right-of-way under SP bridge	Southern Pacific RR - Joint Use	Alt route to site (see file #63)
37	DACA 09-9-98-0002 AZ #23-103417-64 92210 Willcox	USAEPG 1958 Fac No LL037	4.8	30 Sep 02	$1200.00	Tract No. 5, W1/2, of P/SEC 16, T15S, R24E, West right-of-way, 100' wide strip of land; access to Willcox Dry Lake	State of Arizona - Joint Use	
40	DACA 09-5-00-0325 92210 Ft Huachuca	11th Sig Bde 1965 Fac No LL040	8.3	30 Sep 05	$1000.00	P/SEC 3 & 4, T23S, R27E, Bisbee-Douglas International Airport	Cochise County - Joint Use	USAEPG site 19 POC SFC Fraiser S3, 11th Sig Bde 533-1539
41	DACA 09-5-02-0303 92210 Ft Huachuca	11th Sig Bde 1965 Fac No LL041	10.0	31 Dec 12	$2500.00	Safford Airport; FTX SE1/4 SW1/4 of SEC 1, T7S, R26E, G&SRM, Graham County	City of Safford - Joint Use	Coord w/owner required; POC: SFC Frasier S3, 11th Sig Bde 533-1521
43	DACA 09-9-98-0001 AZ #23-103519-64 92210 Ft Huachuca	USAEPG 1972 Fac No LL043	10.0	30 Sep 02	$1200.00	Sands Ranch Commo Site; P/SEC 2, T20S, R19E	State of Arizona - US Gov't Spec Land Use Permit	ASA 21
45	DACA 09-9-88-466 91310 Ft Huachuca	USAEPG Test 1972 Fac No LP045	.92	INDEF	NONE	Commo site - Hereford Rd; SEC 9, T23S, R22E	BLM - SPRCNA, Tucson District - Joint Use	Land adjacent to ASA 94; EPG has key (lock #E437)
47	DACA 09-5-98-303 92210 Ft Huachuca	USAEPG Test 1965 Fac No LL047	40.0	31 MAR 03	$1.00 Term	Tombstone Municipal Airport; Parcel #2, P/SEC 30, T20S R23E	City of Tombstone - Joint Use	POC: SFC Fraiser, SE, 11th Sig Bde; 533-1539. **Contact Mr. Rich Ng, 533-8084 prior to use**. ASA 11 (EPG)
51	DACA 09-9-99-0001 AZ #018-105182-00 92210 Willcox	USAEPG 1961 Fac No LL051	1.82	11 Jan 01 to 10 Jan 2011	$1300.00 Term	East access off of Kansas Settlement Rd to Willcox Dry Lake; P/SEC 27, T14S, R25E	State of Arizona - Right-of-way Permit; Joint Use	POC: Rich Ng 533-8084; fax 533-8018 * Note files 56 & 90
52	DACA 09-5-00-0314 AZ 66-98538-00 92210 Ft Huachuca	USAEPG & JITC 1961: Fac No LL052	60.0	30 Sep 04	$3000.00	Site Sibyl; P/SEC 26, T16S, R21E; 20 ac (EPG) & P/SEC 25, T16S, R21E, 40 ac (JITC)	State of Arizona - US Gov't Spc Land Use Permit - Joint Use	ASA 577 & 648; POC: Rich Ng 533-8084 (EPG) & Bill Depew 538-5379 (JITC)

ITEM NO.	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/ LESSOR	REMARKS
55	DACA 09-9-97-308 AZ 23-103411-64 92210 Ft Huachuca	USAEPG 1978 Fac No LL055	18.76	30 Sep 02	$1200.00	Winchester Site; P/SEC 11 & 14, T13S, R22E, 2.47 acre (original site); added right -of-way (16.29 ac) in Apr 98	State of Arizona - US Gov't Spc Land Use Permit - Joint Use	ASA 499; POC Rich Ng 533-8084
56	DACA 09-9-94-3081 92210 Willcox	USAEPG Test 1970 Fac No LP056	.9	INDEF	NONE	East entry to Willcox Dry Lake off of Kansas Settlement Rd (portion thereof) North 30', NE1/4, SEC 26, T14S, R25E	Robert G. Dycus PO Box 1801 Bisbee, AZ 85603 - Joint Use	Note files 51 & 90
58	LA 1000 AR 09785 RW 91310 Gila Bend	USAEPG 1956 Fac No LW058	3.56	INDEF	NONE	Stone Cabin site; SEC 19, T2S, R19W	BLM - Joint Use	Access of Hwy 95, 52 miles N. of Yuma (includes old file #59). Outgrants to USFWS (File #49) DACA 09-4-91-400; .31 ac & 1,571 SF of bldg and DPS (File 56) DACA 09-3-98-31; 64 SF of bldg X9001
61	DACA 09-4-00-0005 BLM AZA-31348 91310 Gila Bend	USAEPG 1980 Fac No LP061	10.0	10 Jan 06	NONE	Oatman Mt. Material Borrow Site	BLM - Exclusive Use	Previous LA number: LA2512
63	LA 1270 AR 029174 91310 Gila Bend	USAEPG 1960 Fac No LW063	10.0	INDEF	NONE	Gila Bend Commo Site (Forward Test Site); SENESW of SEC 1, T6S, R4W	BLM - Exclusive Use	Previously contained metal bldg 40'x100', subsurface; 'The Pit'
68	DACA 47-5-96-116 NM ROW Easement No. 25894 92210 Ft Huachuca	11th Sig Bde 1982 Fac No LL068	15.0	28 Apr 06	$500.00	Lordsburg, NM FTX Site; SE1/4 of SEC 23, T22S, R18W, NMPM	State of New Mexico - Joint Use	POC: SFC Fraiser; S3; 11th Sig Bde x3-1539 (Easement extended 16 Jul 01 by New Mexico State Land Dept.)
69	DACA 09-5-00-0316 AZ 66-98601-00 92210 Ft Huachuca	USAEPG 1990 Fac No LL073	.63	30 Apr 2010	$1500.00	Mustang Peak antenna site; SWNESENW NW, SEC 25, T20S, R18E	State of Arizona - Joint Use	POC: Rich Ng 533-8084
76	Permit No 2001-0909	USAEPG Trailblazer DT	N/A	20 Sep 02	$105.00	County road side sites	Cochise County Highway Dept. - Joint Use	ASAs: 253,258, & 261
80	Permit No 2001-0910	USAEPG	N/A	20 Sep 02	$35.00	Road side test sites; SEC22, T21S, R21E	Cochise County Highway Dept. - Joint Use	ASA 404 (Charleston and N. Moson Rd)

ITEM NO.	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/ LESSOR	REMARKS
88	1. Permit No 2001-0911 2. Permit No 2001-0803 & 2001-0804	USAEPG - Unnamed Test	N/A	1. 20 Sep 02 2. 08 Aug 02	$35.00 $70.00	County Road side site: 565-Ramsey Rd; 231-Davis/Hi Lonesome Rd; 2521- Gleeson Rd	Cochise County Highway Dept. - Joint Use	1. ASA: 565 2. ASA 231 & 2521
90	DACA 09-9-94-3080 92210 Willcox	USAEPG - AJSC 1960: Fac No LL050	1.82	INDEF	NONE	East entry to Willcox Dry Lake off Kansas Settlement Rd (portion of entry access); N. 30', NE1/4 SEC 26, T14S, R25E	Mr. James T. Puls 2101 2. Detroit St Chandler, AZ 85224 Joint Use	Also see files #51 & 56
91	Permits, LAs, & Agreements	7th Special Forces	Varies	INDEF	NONE	BLM, USFS, Cochise/Santa Cruz Counties	BLM, USFS, Counties	Historic file
92	LAs	USAEPG - UAV Aural/Visual Tests & Short Range	Varies	INDEF	NONE	Collie Springs - UAV; .25 mils NE of mile marker 19, Highway 83; SEC 36	USFS - Sierra Vista Ranger District Coronado National Forest	Historic file; EPG; POC: Rich Ng 533-8084 Temporary use until 31 Dec 02 for ASAs 1009 & 1266
95	Permit No 2001-0912	USAEPG SINCGSARS	N/A	20 Sep 02	$35.00	County road side site	Cochise County - Highway Dept. Joint Use	ASA: 252 (old file #79)
96	PLO 127 WD 91210 Willcox	USAEPG 1958 Fac No LW001	27,386.9	INDEF	NONE	Willcox Dry Lake	Dept. of Interior	ASA: 20, 102 (old file #1a). For previous AZ State lands see file #35
99	Permit Nos 2001-0913 & 2001-0914	USAEPG JTIDS Test	N/A	20 Sep 02	$70.00	County road side sites	Cochise County - Highway Dept. Joint Use	ASAs: 282, 872
101	1. Permit No: 2001-0623 2. Permit Nos: 2001-0624 & 2001-0625	OTC (TEXCOM) - Ground: TRAILBLAZER	N/A	1. 02 Jul 02 2. 02 Jul 02	1. $315.00 2. $70.00	County road side sites: 1) Sibyl Rd (3 ea), Cascabel Rd, Post Ranch Rd, I-10 Frontage (E. Of Benson), & Pomerene 2) Jefferson/Barber Int & Charleston Rd/MP3	Cochise County - Highway Dept. Joint Use	Sites: 1) G,H,J,K,L,P,R,U, V & 2) Jefferson/Barber Int. & Charleston Rd/MP3. OTC (TEXCOM) POC: Jim Smith, 538-6159; fax: 538-8821
104	1. Permit Nos 01-1007, 01-1008 01-1009, 10-1010 01-1011, 01-1012 01-1013, 01-1014 01-1015, 01-1016 2. Permit No 3004	USAEPG SANDBLAST	N/A	1. 22 Oct 02 2. 06 Feb 03	1. $350.00 2. $0.00	1. County road side sites 2. City of Sierra Vista right-of-way permit	1. Cochise County - Highway Dept. Joint Use 2. City of Sierra Vista - Joint Use	1. ASAs: 225,234,259,661,1033,1581, 1582,1583,1584,1591 2. ASA: 1580 - City of Sierra Vista, Snyder Blvd & Avenida Del Sol

ITEM NO.	LEASE OR PERMIT NO.	TASK OR PROJECT	ACRES	EXPIRATION DATE	ANNUAL RENTAL	USE AND LOCATION	PERMITTER/ LESSOR	REMARKS
105	USFS - Ltr of Auth	OTC (TEXCOM) - Air SHORT RANGE	N/A	INDEF	NONE	Operational testing of EPG's Short Range UAVs	USFS - Sierra Vista Ranger District Coronado National Forest	USFS POC: Duane Bennett 378-0311
106	Variable	111TH MI Bde INTEGRATED FTX	Varies	Varies	NONE	Electronic testing along highway rights-of-way N & E of Ft Huachuca	ADOT, USFS, Cochise County	POC: Bud Toepfer 533-3006
108	DACA 09-9-96-1 91360 Gila Bend	USAEPG 1996 Fac No LP108	2.5	INDEF	NONE	Old Hwy 84, right -of-way, Gila Bend, AZ; Sections 3 & 4, T6S, R4W, G&SRM, Maricopa County, AZ	Steven L. Holt & Duane Holt PO Box 30 Gila Bend, AZ 85337	POC: Steve Holt Gila Bend, AZ (602) 683-2449
109	1. USFS - SIE0044; 2. County ROW#2001-0615 91330 Ft Huachuca	USAG Fac No LP111	2.0	1. 31 Dec 20 2. INDEF	NONE	Cimmaron Road; USFS, Coronado Nat'l Forest; NESE of Section 31, T21S, R19E, G&SRM	US Forest Service and Cochise County	Permit covers use of forest land; county permit covers use of Cochise County ROW for warning light to West Gate - Ft Huachuca;USFS POC Duane Bennett, 520-378-0311
110	1. PLO 1471 2. PLO 6788 91210 Ft Huachuca	1. USA 1957 Fac No LW001 2. USA 1990 Fac No LW001	1. 13,463.27 2. (2,040)*	1. INDEF 2. 08 Aug 10	NONE	RDT&E; one half of East Range, Ft Huachuca, AZ	Dept. of Interior	* Mineral rights acreage withdrawn is a part of the 13,463 acres

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX F
SUMMARY OF HYDROGEOLOGY

The purpose of this appendix provides the reader with information on hydrogeological reports cited in the main body of the Fort Huachuca, Future Development Master Plan, Environmental Impact Statement with updates of additional reports as of 2002. These reports are available to the public at public and university libraries or requested from the relevant government agencies. All reports contain references to supporting studies, not summarized here, which may interest the reader. Although not an exhaustive review, the documents included here represent the principal studies on the hydrogeology of the Upper San Pedro River basin.

Because many of the previous models were based on the same or very similar system geometries, distributions of aquifer properties, and estimated inflows and outflows, model-based interpretations have been based on similar simulated responses. Recent reports (such as Pool and Coes, 1999) have shed light on aspects of the hydrologic system that were not addressed in previous studies. Current efforts are using both conventional and new techniques to fill gaps in the knowledge base. The USGS is developing an extensively revised ground-water model that will include re-gridding and re-layering of the model area, new hydrogeologic data that describe both system geometry and properties, and new insights regarding the distribution of ground-water recharge (Steinkampf, personal communications, 2002). This work will continue over the next few years. While no study can fully describe or explain the complex hydrogeology of the Upper San Pedro River basin, the current study represents a major effort to better describe and understand the hydrogeology of the subwatershed.

SUMMARY OF PUBLISHED LITERATURE

Numerous studies have been conducted to improve the understanding of the hydrogeology of the Upper San Pedro River basin. Some of these studies involved actual field survey and data collection, some were modeling efforts, and others provided a review of existing information. All of these studies differ to some extent in purpose and scope but can be grouped into a number of overlapping categories: basic research, water supply, planning, and mitigation.

HYDROGEOLOGY STUDIES

The US Geological Survey (USGS), including field surveys by Roeske and Werrell (1973), Brown and others (1966), the modeling effort of Freethey (1982), and geomorphic research by Hereford (1993) have performed basic research. Pool and Coes (1999) have added a clearer picture when examining the various factors that affect baseflow within the San Pedro River. In addition, published and unpublished USGS streamflow and groundwater data have commonly been used or referenced in other studies. Similarly, the Arizona Department of Water Resources (ADWR) has been a source of basic hydrographic and well water-level data (ADWR 1991).

Several hydrogeologic investigations were commissioned specifically for the purpose of identifying and quantifying the groundwater resources available for Fort Huachuca water supply. These include studies by the USGS (Brown *et. al.* 1966) and the US Army Corps of Engineers (COE) (COE 1974b; Harshbarger and Associates 1974; COE 1987). State agencies have also been

asked to evaluate the water situation of the Fort and to assess the effect of civilian groundwater pumping on the Fort's water rights (AWC 1974; ADWR 1991).

State, federal, and local entities have conducted studies for water planning and management purposes. The ADWR examined the water resources of the Upper San Pedro River basin when considering it for designation as an Active Management Area (ADWR 1988) and produced a comprehensive hydrographic survey report for the basin as part of the Gila River adjudication process (ADWR 1991). To aid in the adjudication, the federal government initiated the development of a hydrologic model of the San Pedro River system on behalf of the Gila River Indian Community (W&EST 1993). Another federal agency, the Bureau of Land Management, examined the hydrogeology of the basin when planning the San Pedro Riparian National Conservation Area. Local groups have commissioned historical and scientific reviews to aid the public in understanding the water situation (ASL 1994; Geraghty and Miller 1995). Additional research in river basin planning and management has been conducted by students and faculty of the University of Arizona (Schwartzman 1990; WWRC 1991; Vionnet and Maddock 1992; Sharma *et. al.* 1997).

The Army and civilian agencies have long recognized that the negative effect of groundwater overdraft to mitigate in order to sustain the ground water supply and protect instream flows. The City of Sierra Vista commissioned research on the feasibility of recharging the regional aquifer with stormflow or treated effluent (SLA 1988; ASL 1995; BOR 1995). The effluent recharge facility is now operational (Brian Bauer, personal communication, 2002). The Army is mitigating groundwater overdraft by implementing additional water conservation measures along with artificial recharge of mountain stormflows and recharge of effluent (USAG 1995a; USAG 1995b; SAIC 1997, EEC 2001).

COMPUTER MODELS

Several of the studies summarized in this appendix employed computer models to simulate the hydrogeology of the San Pedro River basin or portions of the basin. These models were typically used to determine pre-development conditions within the basin, estimate current conditions where no data are present, and predict possible future effects of various water management scenarios on the hydrogeologic system. Such models are well-established tools of the hydrologist and hydrogeologist. However, the validity of model results is highly dependent upon the accuracy and adequacy of the conceptualizations of the hydrogeologic system and groundwater-surface water interactions, quality and sufficiency of the input data, parameter estimates, mathematical formulation, grid geometry, model calibration and especially model assumptions. If the input data are inadequate or the model assumptions incorrect, information generated by a model will be invalid or misleading. This is a particular concern in the San Pedro River basin where lack of information on the complex basin geology, hydrogeology, water table elevations, recharge and discharge, seasonal and long-term streamflow variability, baseflow and flood runoff contributions to river flow, and changes in climate, riparian vegetation and evapotranspiration complicate the modeling process. The work by Pool and Coes (1999) has helped address some of these issues. Published results of modeling efforts made to-date should be considered preliminary. Several investigators are actively working to improve their basin models and to incorporate the latest hydrogeological data being collected by federal, state and local agencies. It is expected that newer

models will more accurately reflect the hydrogeological conditions and processes in the San Pedro River basin, and will be thoroughly validated before the results are used for making water policy or management decisions. The USGS is currently updating groundwater models for use by members of the Upper San Pedro Partnership.

BASIC RESEARCH, WATER SUPPLY, AND PLANNING STUDIES

The studies cited above are summarized in 2 subsections. This subsection lumps together basic research, water supply, and planning studies, and the subsequent subsection covers studies related to existing and potential mitigation measures. The reports are discussed in chronological order within each subsection. Conclusions taken directly from the original report (i.e., quoted) are shown as indented text.

USGS WATER SUPPLY STUDY OF FORT HUACHUCA (BROWN AND OTHERS 1966)

From 1959 to 1963 the US Geological Survey conducted a comprehensive investigation of water resources of the Fort Huachuca Military Reservation and pertinent adjacent areas. The purpose of the investigation was to locate additional water supplies for the Fort and to appraise the water resources in use. The subsequent report described the geology, hydrology, and availability of water in the area, and included analyses of well-field characteristics and water quality.

During the period of study, the investigators found that water levels in an observation well declined more than 7 ft, indicating that the cone of depression formed by pumping the wells at Fort Huachuca and Sierra Vista was deepening and expanding. They concluded that the aquifers tapped by the Fort and Sierra Vista (and adjacent housing developments) were hydraulically connected and that continued pumping of the wells in the Sierra Vista area would in time cause a drawdown of the water table in the Fort's well field. The investigators suggested that spring flow from the mountain canyons could be used to decrease the draft on the groundwater reservoir, or used for artificial recharge of the aquifers. They also suggested that a second well field could be developed to reduce the draft on the established well field, and to utilize groundwater that now moves unused northeastward to the San Pedro River.

USGS REPORT ON THE HYDROLOGIC CONDITIONS IN THE SAN PEDRO VALLEY (ROESKE AND WERRELL 1973)

This USGS report was prepared for the Arizona Water Commission and presented fundamental data on the hydrology, hydrogeology, and water resources of the San Pedro Valley. The investigation included measurement of well water-levels (in about 350 wells), stream and spring discharges, and groundwater pumpage; assessment of irrigated acreage; evaluation of driller's logs; and analysis of groundwater chemistry. From the results of their analyses, the investigators were able to estimate the water-yielding characteristics of the basin aquifers. Some of these data were later used as input to various computer models developed by other researchers. Among their findings, the USGS investigators stated that:

The amount of ground-water withdrawal is in excess of the amount of recharge in the Sierra Vista-Fort Huachuca area; a cone of depression has developed in the area, and near the center of the cone, water levels have declined about 30 ft in 25 years. As withdrawal continues in excess of recharge, the cone of depression will expand and deepen. From 1965 to 1969, the water level in well (D-21-21)27abd about 6 miles east of Sierra Vista declined 9 ft owing to the expansion of the cone of depression.

US ARMY CORPS OF ENGINEERS WATER SUPPLY REPORT FOR FORT HUACHUCA (COE 1974A)

The Army has long been concerned about protecting and enhancing the water supply for Fort Huachuca. The purpose of this report was to evaluate the water supply needs for the Fort and surrounding communities under various population projections; to assess the groundwater resources of the Upper San Pedro River basin; to present results of the East Range drilling program; to analyze the results of Arizona Water Commission groundwater modeling; and to propose concept designs and cost estimates for expanding the Fort's water supply system.

The report included the findings of 4 inter-related studies which were attached as appendices: Report on Water Development in the Ft. Huachuca Area, Arizona (Harshbarger and Associates 1974), Status Report of a Study of the Adequacy of the Water Supply of the Fort Huachuca Area, Arizona (AWC 1974), Investigation and Recommendations for Upgrading the Water System at Fort Huachuca, Arizona (Blanton & Co. 1973), Concept Design Report for Proposed Water System Expansion, Fort Huachuca, Arizona (Blanton & Co. 1974), and Fort Huachuca, Arizona, Supplemental Report: Test Well Drilling and Study of Hydrogeologic Conditions (COE 1974b). The Harshbarger and AWC reports are summarized below.

REPORT ON WATER DEVELOPMENT IN THE FORT HUACHUCA AREA (HARSHBARGER AND ASSOCIATES 1974)

The purpose of this consultant's report, prepared for the US Army Corps of Engineers, was to review existing hydrogeological data on Fort Huachuca and the Upper San Pedro basin and to provide the COE with an independent opinion as to the availability of groundwater supplies and the effect of groundwater development on the hydrogeological system. No field work was conducted by the contractor; the analysis was based solely on data provided by the COE, Arizona Water Commission, and other published reports.

- Adequate volumes of recoverable groundwater are present in the regional aquifer to satisfy the maximum projected demand. It is conservatively estimated that the volume of recoverable groundwater in storage in the regional aquifer is 8 to 15 times greater than the total projected water demand.

- Projected water requirements for a military population of 50,000 could be satisfied by construction of the proposed well field on the East Range. Drawdown in the proposed well field after 80 years of pumping would be on the order of 60 to 100 ft.

- Future interference effects with civilian groundwater users in the area are of acceptable magnitude with a proper management plan. The depression cone developed by the proposed East Range well field would not cause significant infiltration of water in the channel of the San Pedro River.

- Future refinement of the digital model will improve the agreement between simulated and measured water levels in some areas. The magnitude of predicted drawdown in the regional aquifer will not be significantly affected by these future model refinements.

AWC REPORT ON THE ADEQUACY OF WATER SUPPLY IN FORT HUACHUCA AREA (AWC 1974)

The Arizona Water Commission (AWC) began a study of groundwater resources of the Upper San Pedro River basin in 1972 and was subsequently asked by the Army Corps of Engineers to prepare a special report evaluating the adequacy of Fort Huachuca's water supply. The AWC investigators used a computer model (referred too only as a modification of [a model] in use by the USGS) to simulate the basin groundwater system and to evaluate the long-term effects of pumping under a variety of conditions and demands. The AWC reported the following conclusions:

- The digital model of the groundwater reservoir in the Fort Huachuca area has, primarily due to time constraints, not yet been verified to the degree that permits unequivocal reliance. Nevertheless, it is concluded that the model as presently developed is able to give a reasonable prediction of the range of possible effects on the future demands for water on the groundwater resource.

- On the basis of the studies to date, it is evident that the effects of the projected groundwater demands for all demand levels considered have a large impact on the groundwater reserves.

- The studies to date also indicate the impacts of the large withdrawals for Alternative population levels III and IV from the Fort's present well field on the water resources are unacceptably severe as the aquifer underlying this well field as well as that under the adjacent portion of Sierra Vista probably would be dewatered by 2060. However, the impact in this area can be relieved through a water management option that would place a greater share of the demand on the proposed East Range well field where greater groundwater supplies are available.

- Based on studies by the Bureau of Reclamation the [AWC] concludes that the authorized Charleston Dam project could supply sufficient water to meet all the projected water demands in the Fort Huachuca area.

- It is preliminarily concluded that effects of the projected groundwater pumpage for all population levels would reduce the base flows as well as possibly reduce the water supply available to phreatophytic vegetation along portions of the San Pedro and Babocomari Rivers.

USGS HYDROLOGIC ANALYSIS OF THE UPPER SAN PEDRO BASIN (FREETHEY 1982)

The purpose of this US Geological Survey investigation was to develop a numerical groundwater model of alluvial basins in the Southwest. Existing information for the Upper San Pedro River basin, considered to be representative of such basins, was used to develop and test the model. The investigator determined that the three-dimensional model adequately simulated groundwater flow, the stream-aquifer connection, and evapotranspiration, but warned against using the model to simulate and analyze site-specific problems or to evaluate water-level changes throughout the model area. Water-level contour maps derived from existing data and data generated by transient simulations showed similar patterns of water level decline in the Fort Huachuca-Sierra Vista area and the expansion of the cone of depression. Freethey put the following caveat on the application of his model:

> The numerical model developed during this study was designed and calibrated only to a degree necessary to attain a reasonable definition of the hydrologic system and to support, if possible, prior conceptions of how these hydrologic mechanisms work and interact. This model is one viable representation of the system. It should not be regarded as an exact, unique duplication of the hydrologic processes taking place. The model can be used to gain a better understanding of the interrelations that may occur when significant natural or manmade phenomena change one or more hydrologic processes. The model provides a starting point for the development of more detailed models when additional data become available. Water-level monitoring and streamflow measurements need to be continued and expanded as development in this area progresses.

US ARMY CORPS OF ENGINEERS GROUNDWATER MODELING STUDY FOR FORT HUACHUCA (COE 1987)

Previous studies indicated that groundwater pumping by communities near Fort Huachuca would lower the local water table and threaten the Fort's water supply. Consequently, the Corps of Engineers undertook a study to quantify the groundwater parameters of the basin, evaluate future water use scenarios, and propose rehabilitative measures to be further investigated. A USGS regional groundwater model was used to evaluate existing groundwater conditions and predict the basin response to future water use scenarios. The COE used existing data as input to the model; initial values for aquifer parameters were those of Freethey (1982). Although the investigators felt that their model adequately simulated the hydrology of the upper San Pedro basin, they stressed that the reliability of model results was dependent on the reliability of the available recharge and discharge data, aquifer parameters, and historical water level estimates. Some of their findings:

Heavy pumping in the Fort Huachuca-Sierra Vista and Huachuca City areas has created cones of depression in the ground water table. The zone of influence around the Fort measures about 4 miles by 1-1/2 miles wide and is following new commercial development as it moves eastward. The cone in the Huachuca City area is about 3 miles by 1 mile wide and in this zone, the groundwater flow along the Babocomari River has reversed direction for some distance downstream. Ground water that previously flowed eastward, is now attracted to the pumping center.

It is evident that even at the current rate of pumping, the Fort Huachuca water supply may be threatened at some time in the not too distant future. Proposed growth of Sierra Vista would speed up the process of declining water levels, and one or more of the Fort wells may dry out within 45 years. Though the decline in the regional aquifer may be relatively small (i.e., less than 1 foot per year), it is nonetheless evident that overall ground water withdrawals are exceeding the safe yield. Several areas where intensive pumping is occurring will experience noticeable declines in the water table. As stated in many of the previous studies of the water supply for the basin, there is a vast supply of water within the basin aquifers[.] The problem concerns the possibility of existing wells drying out from the declining water levels.

It is becoming increasingly evident that definition of the aquifer's properties (i.e., the storage coefficient and the transmissivity) is very important in the modeling of the ground water system. Borehole and geophysical investigations would allow a clearer understanding of the anticipated drawdown of the water table. Wherever possible, pumping tests should be performed to supplement this analysis. Furthermore, the basin geology should be mapped in detail. This would help locate the boreholes, observation wells, and geophysical investigations. This report is limited by the available data for which a number of assumptions have been made and a complete definition of the substrata would help refine the model results.

As a result of their modeling efforts, the COE investigators concluded that, despite the vast amount of groundwater stored in the regional aquifer, present and future withdrawals far exceed the perennial (safe) yield of the basin, thus threatening not only the Fort's water rights but the water supply of the entire basin. They recommended that the Army use wells on the East Range in order to reduce the stress on the established well field. They also recommended that groundwater levels at the Fort are closely monitored and studies conducted to better define model parameters.

ADWR STUDY OF WATER RESOURCES OF THE UPPER SAN PEDRO (ADWR 1988)

The Arizona Department of Water Resources (ADWR) examined the hydrology and water use of the Upper San Pedro (USP) basin in order to assess the merits of designating the basin as an Active Management Area. The report summarized and interpreted data from previous hydrological studies of the basin (including those described above) and incorporated more-recent ADWR data. The ADWR investigators also employed a regional groundwater model, and Freethey's (1982) data, to update and project future hydrologic conditions in the Sierra Vista area.

Among the findings, the ADWR determined that water levels have declined in the USP regional aquifer an average of less than 1 foot per year outside the vicinity of Sierra Vista and Fort Huachuca; even in areas of little or no groundwater pumping. Although the reason for this was unclear, they speculated that the decline was due to a regional adjustment brought on by down cutting of the San Pedro River. Since the down cutting occurred prior to extensive groundwater pumping in the region, they postulated that the change resulted from overgrazing or climatic variation. The ADWR investigators also determined that, based on flow duration curves, the flow regime of the San Pedro River at Charleston was unchanged over the last 50 years. The ADWR reported the following conclusion to their study:

1. Groundwater withdrawals taking place in the regional aquifer around Sierra Vista result in an average groundwater decline rate of 1.4 feet per year between approximately 1968 and 1986. Decline rates rise to a maximum of 3.7 to 3.9 feet per year for several wells however. A cone of depression of about 7.5 square miles, within the enclosed 4,150-foot water elevation contour, probably occurs in the vicinity of Sierra Vista. This cone has grown from an area of about 5 square miles in 1968. The time at which the cone originally developed is not known.

2. Continued groundwater pumpage between 1986 and the year 2000 will mine an additional 208,000 ac-ft of groundwater from the regional aquifer around the Sierra Vista area, resulting in a maximum groundwater decline of about 80 feet at a maximum rate of about 6 feet per year.

3. Pumpage in the USP basin has not yet affected that portion of the regional aquifer adjacent to the San Pedro River except near Hereford. This conclusion is based on 1986 groundwater levels as estimated by an updated groundwater model of the area, and comparison of these water levels with 1968, 1978, and 1986 water level maps presented in this report. No significant change in groundwater levels has occurred near the San Pedro River at Lewis Springs or Charleston.

4. The groundwater model used to project water levels in the year 2000 showed that water levels in the regional aquifer several miles west of the San Pedro River would rise up to 20 feet at Hereford, would decline by about 10 feet west of Lewis Springs, and would decline by about 10 feet west of Charleston. This decline rate is about 0.7 feet per year. This model projection was based on estimated future pumpage.

5. The artesian heads present in some portions of the regional aquifer underlying the floodplain alluvium of the San Pedro River have decreased somewhat over time due to groundwater development in these areas.

6. The shallow floodplain aquifer which underlies the San Pedro River shows no long term declines in water level.

7. The retirement of agricultural lands acquired by the Bureau of Land Management will affect low flows in the San Pedro River, particularly in the Hereford area. The flow in the river will increase due to cessation of agricultural pumping, which will no longer draw water from the floodplain alluvium and San Pedro River. This will allow water levels in both the confined and unconfined regional aquifer to rise, enhancing groundwater discharge rates to the floodplain alluvium and river and increasing flow rates in the river. The increase in flow may eventually be offset somewhat if phreatophytes are allowed to invade previously fallow land.

8. No land subsidence has occurred in the USP basin to date.

9. There are no known regional water quality problems in the USP basin.

SAN PEDRO RIVER RIPARIAN MANAGEMENT PLAN AND EIS (BLM 1989)

The Bureau of Land Management (BLM) prepared a combined master plan-environmental impact statement for the proposed San Pedro Riparian Natural Conservation Area (SPRNCA). An analysis of the surface water and groundwater resources within the SPRNCA and adjacent lands was presented in Appendix 5 of the document. Although the BLM recognized the San Pedro River as an important and unique perennial desert stream, the agency was also aware that the river system is degraded both in terms of historic hydrologic condition and habitat diversity.

After reviewing the literature and conducting field surveys, the BLM scientists concluded that the San Pedro River has, and is continuing, to undergo an evolution to a new dynamic equilibrium condition that reflects current hydrologic and land use conditions. They were uncertain as to the cause of observed reductions in stream base flow but speculated that it could be caused by:

- reduced recharge of the floodplain aquifer by the regional aquifer;
- reduced recharge of the floodplain aquifer by surface runoff (high flows);
- increased use of the floodplain aquifer through pumping;
- increased use of the floodplain aquifer by phreatophytes; or
- increased loss of floodplain aquifer water to the regional aquifer.

The BLM team went on to state:

> It does not appear that the declines in base flows can be attributed to declines in overall runoff in the basin. Also, it is unlikely that changes in phreatophyte use or losses to the regional aquifer have significantly affected base flows. Thus, it can be deduced that either groundwater pumping in the floodplain aquifer, reduced recharge from the regional aquifer, or a combination of both have contributed to the lower base flows recorded at both [Charleston and Palominas] gauges.

HYDROLOGICAL RESOURCE ASSESSMENT OF LOWER BABOCOMARI WATERSHED (SCHWARTZMAN 1990)

The Babocomari River is a principal tributary to the San Pedro River and flows near to the northern boundary of the Fort Huachuca military reservation. Schwartzman (1990) conducted an investigation of the lower Babocomari watershed in order to evaluate the effects of groundwater pumping on the river. The author summarized existing geological and hydrological information for the study area and monitored water level changes in local wells.

Schwartzman found that pumpage had affected flow patterns in the vicinity of northern Huachuca City and the Fort Huachuca East Range and that a minor cone of depression had formed in the area. Historic water-level declines in the study area had been low to moderate (4-12 inches). He concluded that continued groundwater level declines caused by pumping by local municipalities

and Fort Huachuca would adversely affect the riparian habitat along the Babocomari River. The author recommended that water levels near the river be closely monitored in order to better manage the riparian resource.

ADWR HYDROGRAPHIC SURVEY REPORT FOR THE SAN PEDRO RIVER WATERSHED (ADWR 1991)

The Arizona Department of Water Resources (ADWR) prepared this Hydrographic Survey Report (HSR) as part of the General Adjudication of the Gila River System and Source. The document serves as a compendium of ADWR information concerning the San Pedro River and has been used as a source of data in subsequent analyses and modeling studies. Volume 1 of the report, General Assessment, described the nature of the adjudication proceeding, water supply and water uses, investigation methods used by ADWR, and the results of the investigations for major water users and non-Indian federal law claims. A very useful summary of the water resources of Fort Huachuca was provided in Volume 1, Chapter 5, pages 382-430 and a description of the modeling methodology used to determine pumping effects was given in Volume 1, Appendix G. Volumes 2 through 9 presented additional information on individual water users and uses, well reports, well lists, and maps.

In Chapter 4 of Volume 1 (Hydrologic Analysis), the ADWR researchers listed several conclusions about the hydrology of the San Pedro River. Conclusions relevant to the Sierra Vista-Fort Huachuca situation are given below (with the original item numbers used in the HSR).

6. Cultural depletions impact the hydrologic system by lowering groundwater levels in the regional and floodplain aquifers and/or by directly reducing streamflow in the channels. The removal of groundwater may directly or indirectly interfere with streamflow. Direct interference occurs when the cone of depression of a pumped well(s) intercepts the streambed and induces surface water to move away from the stream. Indirect interference occurs when the cone of depression does not intercept the stream, but reduces the amount of groundwater discharged to the stream by intercepting groundwater flows.

8. The impacts of some cultural or groundwater withdrawals have not yet affected or reduced the surface water supply in the inner valleys, but are impacts in transit toward the younger alluvium that will eventually reach the younger alluvium. As more of these impacts arrive at the younger alluvium, their cumulative effect can be expected to further reduce the surface water quality.

24. A negative change in storage of -11,230 ac-ft is occurring in the Sierra Vista subwatershed as a result of municipal groundwater pumping in the Sierra Vista-Fort Huachuca area and pumpage to supply irrigation uses located near the San Pedro River.

As in previous studies, the ADWR researchers found a direct correlation between population growth and water usage as seen by the declining groundwater levels in the Sierra Vista area. They stated that the cone of depression that has formed under Fort Huachuca and Sierra Vista might cause a problem with the Fort's water supply. The expansion and deepening of the cone would

result in greater pump lifts and increased energy costs. In order to quantify the amount of diminishment of the water supply to Fort Huachuca, the ADWR investigators used the USGS MODFLOW model (Freethey 1982) to predict the effects of groundwater pumping by the Fort and surrounding communities. Two modeling scenarios were compared: the effect of past and future groundwater pumpage by the Fort alone on the water table, and, the combined effect of pumpage by the Fort and the surrounding municipal water companies on the water table. From this analysis the ADWR concluded:

The results of the model runs demonstrate that the additional drawdown to Fort Huachuca's wells because of the additional pumpage from the 8 surrounding water companies from 1940 through 1988 ranges from 13 feet at Fort Huachuca well No. 8 in the East Range, which is furthest from the pumping center, to 41 feet at wells No.1 and No. 2 nearest to the pumping center. The projected cost to the Fort over the 48 year period (1940-1988) could be between $75,000 to $125,000.

A pumpage scenario based on projected increases in population from 1989 through 2038 resulted in additional drawdown of 72 feet at well No. 8 to 223 feet at well No. 1 and No. 2. The projected cost from 1989-2038 could be between $500,000 and $1,880,000 over the next 50 years. [The ADWR stresses that this represents only a sample scenario; actual future growth rates and pumpage rates may be different.]

Fort Huachuca's response to a lowering of water levels might also result in more pumpage being shifted away from the pumping center to the East Range well [COE 1987]. This would result in fewer well deepening costs, repair costs, and a reduction in lift costs.

WATER RESOURCES AND MANAGEMENT OPTIONS FOR THE SAN PEDRO BASIN (WWRC 1991)

In 1990, a student-faculty team from the University of Arizona responded to a request by Upper San Pedro Basin Water Resources Council to examine the water resources situation of the basin and evaluate various management options. The university team developed or adapted 4 models to analyze the situation: a regional groundwater model (MODFLOW), a surface water-groundwater model used to evaluate institutional water use options (MODSIM), a spreadsheet-based, hydrology-economics-water resource allocation model called WATERBUD, and a plan evaluation model known as MATS. The investigators emphasized that the results of their modeling efforts were based upon a 20-year period of analysis during which time the long-term implications of increased pumping from the regional aquifer were not readily apparent.

From the analyses performed with the 4 analytical models the investigators concluded the following:

1. Pumping from the regional aquifer in the Sierra Vista area is depleting stored groundwater reserves there, and accelerated pumping in the future will accentuate this trend unless steps are taken to arrest.

2. Pumping from the regional aquifer is not the major factor imperiling streamflow in the San Pedro River. Drought-related reductions in surface runoff and irrigation-

related pumping from the floodplain aquifer are much stronger influences, particularly in the short term. Management of minimum streamflows and maintenance of riparian ecosystems will require control of agricultural pumping and, possibly, the imposition of drought-coping policies.

3. Potential conflict over water management policies in the Upper San Pedro basin will be rooted in differing value judgments concerning economic and environmental impacts. However, the common desire to maintain local control over water management decisions provides a basis for successful negotiation and policy development.

The university team also made several recommendations for future policy development; including several that have a direct bearing on water policy for Fort Huachuca and the surrounding communities. The team recommended that the problem of groundwater overdraft be recognized and dealt with now rather than waiting for a future crisis. They also urged water conservation be encouraged through educational programs, replacement of water-wasting plumbing with water-saving plumbing, and reuse of effluent, either for irrigation or aquifer recharge.

MODELING OF GROUNDWATER FLOW AND SURFACE/ GROUNDWATER INTERACTION FOR THE SAN PEDRO RIVER BASIN (VIONNET AND MADDOCK 1992)

The purpose of this study, conducted by university investigators and funded in part by the Cochise County Flood Control District, was to improve an existing ADWR groundwater model of the Upper San Pedro River basin by making the following modifications: 1) augmentation of the original MODFLOW module data set with newly acquired information; 2) replacement of river module with new stream-aquifer model; 3) addition of layer to represent bank storage; and 4) recalibration of model using river baseflow data. The model grid was based on that developed by Freethey (1982). A steady state simulation was used to reproduce the mean annual conditions existing in 1940. Information from the steady state simulation was used in the transient simulation which represented the period 1940 to 1988. General conclusions of investigators are given below.

The match between simulated water level contour maps and field data water level contour maps was acceptable. However, a less acceptable match between MODFLOW simulated streamflows and estimated baseflows from field data was obtained...The runoff component of the streamflows was not taken into account during the simulations. It is generally argued that, within the study area, runoff is exceedingly rapid, allowing little infiltration to the ground-water system. However, the runoff volumes provided some surface storage, a small quantity of local storage to the alluvial aquifer, that is usually consumed by riparian vegetation.

Prior to major development, losses to evapotranspiration and to streamflow constitute the majority of the discharge from the system for both cases. The ground-water outflow at Fairbank constituted 3.5% of the total discharge, a small amount compared to the other 2 components.

By the end of the transient simulation period (1988), 13,680 ac-ft/year of water were being extracted through pumping. However, the peak pumpage of 17,190 ac-ft/year (23.7 cfs) was reached during the early 1980's.

Over the 48-year simulation period, the evapotranspiration losses reduced around 20% with respect to predevelopment conditions. Streamflow gains were also reduced drastically over the 48 years. These reductions were due to the ground-water withdrawals to pumpage. Model results indicate that 48% of the pumpage was derived from aquifer storage...

Model results are dependent on the distribution of pumpage in time and space. The pumpage used to simulate transient conditions were provided by ADWR. Municipal pumping has been revised by the ADWR. The ADWR is presently revising pumping figures for agriculture. This process will redefine pumping rates estimates for irrigation wells drilled mainly in the alluvial aquifer. Depending on the scope of this redefinition, model results and conclusions could be affected to different degrees, particularly if the revised wells are located near the river system.

Before any attempt to use this groundwater model, it is essential that the user be aware of the model capabilities and limitations. Conclusions extracted from future simulations with this model will have to be based on the model assumptions and limitations. With these caveats in mind, 2 principal conclusions may be drawn.

1. The geologic formation in the vicinity of Charleston initially inhibits the effects of the Sierra Vista cone of depression on the San Pedro River. Simulation indicates that the cone will spread southward to perhaps intersect the river upstream of the formation.

2. Although a better calibration of baseflows can be achieved by reducing the maximum evapotranspiration rate to partially compensate the absence of runoff volumes, alternative ways to incorporate those volumes should be attempted in the future.

The investigators recommended that a Geographic Information System (GIS) be incorporated into the modeling process; the model grid be extended further east, north, and into Mexico; better field data be collected; water consumption by riparian vegetation be refined; the model time increment should be monthly instead of annual to accommodate seasonal variability; and recharge sources should be more accurately represented in the model.

SAN PEDRO HYDROLOGIC SYSTEM MODEL, PRELIMINARY RESULTS (W&EST 1993)

In 1987, the consulting firm, W&EST, Inc., began development of a hydrological model of the San Pedro River. The work was done on behalf of the Gila River Indian Community, to assist the tribe in assessing its rights to waters of the San Pedro River, a tributary to the Gila River. The purpose of the model (actually, two related model codes: the USGS MODFLOW model and the proprietary WESTSP model) was to simulate pre-development basin hydrology and to predict the future responses of the system to cumulative stresses (e.g., groundwater pumping). The model was also designed to assess the incremental impacts imposed by one or more water users, such as the effect of groundwater pumping around Sierra Vista. Spatial data were assembled, manipulated, and mapped with the help of a GIS.

In their report, W&EST investigators detailed their initial efforts to assemble required input data, calibrate and verify their model, and perform preliminary analyses. Various modeling scenarios were tested to determine the effect of current and predicted pumping stresses on the groundwater

and surface water system. Preliminary results indicated that the existing drawdown cone had not yet reached the San Pedro River, but that future pumping in the Sierra Vista-Fort Huachuca area, especially at increased rates, would result in the drawdown cone eventually reaching the river. The investigators concluded their report by recommending refinements that must be made to the model before results could be finalized.

ENTRENCHMENT AND WIDENING OF THE UPPER SAN PEDRO RIVER (HEREFORD 1993)

This USGS- and BLM-funded study provided a comprehensive and detailed analysis of the geomorphic history and condition of the San Pedro River basin. The investigation included examination of pre- and post-entrenchment alluvium, riparian vegetation changes, channel morphology, and the association of climatic history with channel widening. A summary of the findings showed that:

The river flowed in a shallow, narrow channel on the surface of the un-entrenched valley before 1890. A series of large floods, perhaps beginning as early as 1881, eventually led to entrenchment of the channel between 1890 and 1908. This deepening placed the channel 1 to 10 m below the former floodplain. The channel has widened substantially since entrenchment through lateral migration and expansion of entrenched meanders. The rate of channel expansion, however, has decreased since about 1955, coincident with a decrease of peak-flood discharge suggesting that the channel has stabilized and that further widening will probably be minor under present conditions of land use, discharge, and climate.

The reduction in peak-flow rates was related partly to increased channel sinuosity and to development of floodplains and riparian woodlands. The increased sinuosity produced a reservoir effect that attenuated flood waves, and the development of floodplains enabled flood waters to spread laterally, thereby increasing transmission losses. In addition, flow rates were probably affected by improved land use and changes of rainfall intensity and short-term rainfall patterns, which reduced runoff and decreased the time necessary for channel stabilization. Livestock grazing decreased steadily after the turn of the century, and numerous stock ponds and small water-retention structures were constructed in tributaries. The cumulative effect of these structures probably reduced peak-flow rates. Short-term rainfall patterns of the wet season (June 15-October 15) have probably changed from annual alteration of above- and below-average rainfall to a biennial or longer pattern. Moreover, frequency of low-intensity rainfall (daily rainfall less than about 1.27 cm) was consistently above average for the decade 1957-1967. These factors probably improved conditions for growth and establishment of vegetation both in and outside the channel.

The causes of the large floods that resulted in entrenchment are poorly understood, although climate and land use were key factors. Floods followed closely the rapid settlement of the area brought about by mining activity in the late 1870s; population rose from a few hundred to 6,000 in less than 5 yr. Extensive wood cutting for mine timber and fuel, suppression of wildfire, and reintroduction of large cattle herds undoubtedly exacerbated entrenchment. Flood-producing wet-season rainfall in the Southwest, however, was unusually heavy before, during, and shortly after entrenchment.

The investigator also made some observations regarding the implication of these results to channel and floodplain management of the San Pedro River:

Future development of the San Pedro River channel is a highly speculative topic; a number of geomorphic uncertainties permit only broad generalizations to be made. Nonetheless, management of the resources requires general predictions regarding the stability of the channel system. Evidence indicates that the channel has or is close to a stable configuration. This new equilibrium was reached after at least 55 years of adjustment through widening. The implication for channel and floodplain management is that the system has largely adjusted to the post entrenchment conditions. Therefore, the system will probably not change significantly, if these conditions remain within existing limits.

Impounding of sediment in reservoirs and upstream withdrawals of surface water for agriculture, mining, or domestic use will compromise the present flow regimen, degrading the recently developed riparian community. This community is closely linked with groundwater level; a drop in this level would probably have the same effect on the riparian community as upstream impoundments and withdrawals. The effect of lowering the water table is well illustrated by the extensive degradation of the riparian environment following the entrenchment of the San Pedro River channel between 1890 and 1908. In short, extensive development and exploitation of groundwater resources will almost surely lower the water table, with predictable consequences for the riparian forest.

SIERRA VISTA SUBWATERSHED PRIMER (ASL 1994)

This document was produced for the City of Sierra Vista and 2 local water companies to provide the public with an easy-to-understand summary of the current water situation in the Sierra Vista area. The authors reviewed the existing technical literature and made additional interpretations of the information. Extracts of their conclusions are given below.

1. The water resources issues facing the residents of the Sierra Vista subwatershed do not arise due to insufficient available groundwater supplies. There is ample groundwater in storage to serve the municipal and industrial needs of the current and future residents of the [subwatershed]. [However, even] modest withdrawals from storage have some impact on the regional water balance, and without mitigation, have the potential to impact conditions of the SPRNCA.

2. The challenge facing the community is to develop a water resources plan that recognizes the needs of [the various] water users [in the subwatershed].

3. The groundwater system that supplies the residents of Sierra Vista is an integral component of the hydrologic system of the entire subwatershed and is hydraulically connected to the surface waters of the SPRNCA.

4. Each increment of water use in the Sierra Vista subwatershed, whether it is from increased consumption by riparian vegetation or groundwater pumping changes, to some degree, the hydrologic system of the subwatershed. Significant increases in

riparian vegetation would likely result in increased evapotranspiration and reduce the flux of groundwater to the surface water system much like the effects of groundwater pumping adjacent to the San Pedro River. These changes would likely result in decreased streamflow in the San Pedro River.

5. There are inherent conflicts between groundwater pumping that accompany economic development within this connected hydrologic system and the water resources required to sustain the riparian ecosystem of the SPRNCA. However, the location of the groundwater extractions relative to the San Pedro River bears directly on the degree and timing of impacts to the river. The municipal and military water uses that have occurred to date in the Sierra Vista/Fort Huachuca area have had a much less direct impact on the flows in the San Pedro River than have either drought or the groundwater pumping associated with the agricultural uses in the Palominas/Hereford area. Any impacts to the San Pedro River that may have occurred from the groundwater pumping in the Sierra Vista/Fort Huachuca area appear to be very limited to date and are likely the result of a small reduction in the upward vertical gradients in the basin fill aquifer lessening the groundwater fluxes to the floodplain aquifer of the San Pedro River.

6. [D]eclines in regional aquifer water levels at some distance from the San Pedro River are not necessarily an appropriate measure of impacts of groundwater pumping on streamflow. Such impacts are best assessed through consideration of the basin water balance.

7. [Various investigators] believe that a water resources management strategy can be implemented within the region which, if properly designed and monitored, will abate potential negative impacts to the SPRNCA due to increased pumping.

8. The growth and development that has occurred in the Fort Huachuca/Sierra Vista area does not pose an immediate threat to the flows in the San Pedro River within the SPRNCA. Additional unmitigated groundwater pumping to serve new development will increase the threat to the San Pedro River. At the present time, much effort and resources are being expended on improving the existing modeling efforts.

HISTORICAL FLOWS AND CONDITIONS IN THE SAN PEDRO RIVER (GERAGHTY AND MILLER 1995)

The Water Action Task Force of the Sierra Vista Economic Development Foundation commissioned a consulting firm to investigate the historical (pre-development) flow regime of the San Pedro River. Results of this study were meant to aid decision makers in planning and managing local water resources. The report provided a comprehensive review of historical accounts and scientific evidence regarding past conditions in the San Pedro River basin.

The investigators concluded that historical flows and conditions of the San Pedro River have undergone significant changes. Before the 1850s the river was unincised and meandered through marshy areas and beaver ponds. By the late 1800s, rapid settlement of the valley, watershed

degradation, climatic changes, and a major earthquake caused entrenchment of the river channel and the subsequent lowering of the regional water table. The establishment of a riparian gallery forest (where none had been before) was found to correlate with the systematic decline in the river base flow. Changes in the flow regime have been continuous over the past 300 years and have resulted from a complex interaction of cultural and natural causes. The investigators reasoned that the issue of preserving historical flows in the San Pedro River requires decisions to be made as to which transitional condition the public wishes to preserve.

UPPER SAN PEDRO BASIN MODEL (W&EST 1996)

At the request of the Gila River Indian Community in 1987, W&EST began to develop a mathematical model of the hydrologic regime of the San Pedro River Basin. Progress reports on the modeling efforts were produced in 1993 (discussed in section A.2.14), 1994 and 1996. The goal of the model has been to use it as a tool to define and quantify past impacts of water use in the San Pedro Basin on the availability of water to the Gila River Indian Community. The model is intended to be used for negotiations. The model domain includes the entirety of the basin within the United States, so that the model can be used to model outflows from the San Pedro Basin into the Gila River. The model depicts regional hydrologic conditions and is not intended to simulate local or site-specific hydrologic conditions.

The 1996 progress report includes additional water use and hydrogeologic data. Calibration efforts are continuing. The 1996 report describes a steady state model that simulates pre-development conditions before 1880, and a transient model that simulates historical surface water and groundwater conditions from 1880 through 1988. The model uses the USGS MODFLOW code. The model is comprised of two layers with grid cell dimensions of 0.5 by 0.5 miles. Model input inflows include recharge from precipitation along mountain fronts, recharge from flood runoff, groundwater inflow from outside the model boundary, surface water inflow from Mexico and groundwater recharge from wastewater effluent. Model outflows include streamflow, groundwater underflow, evapotranspiration, river water evaporation, and pumping and stream diversions. The model output includes historical groundwater levels and flows in the San Pedro River. Agricultural return flows are not accounted for. The 1996 progress report addresses concerned raised on the earlier versions about the sensitivity of the model results to changes through time in riparian vegetation and evapotranspiration rates, channel incision, use of baseflow versus mean annual streamflow as model input, large grid cell sizes and elongated geometry of the grids.

The steady state and transient models were used to assess the impacts of pumping by individual water users groups on flows in the San Pedro River. The Sierra Vista/Fort Huachuca area is the only area of the Upper San Pedro Basin with sufficient water level data to map changes through time. A series of steady state and transient simulations were made in which pumping from only one of eight pumping groups was modeled, and river flows were compared with base runs in which no pumping was modeled. The results indicate that 94% of the historical river flow loss through 1988 in the Upper San Pedro Basin is due to agricultural pumpers along the San Pedro River who have used 75% of the groundwater and surface water through 1988. However, if 1988 pumping rates were continued into the future until steady state was achieved, the model predicts that the agricultural pumpers, who use 67% of the water, would be responsible for 76% of the lost river flow, but only 25% of the lost evapotranspiration. According to model results, the municipal users

in the simulation, who use 33% of the total water, are responsible for only 24% of the lost river flow but for 75% of the lost evapotranspiration. If pumping remained at 1988 levels, the model predicts that the flow in the river would continue to diminish in most reaches as the cones of depression from pumping by more distant communities enlarge and increase their impact on the river. Note that pumping by Fort Huachuca was nearly 50% higher in 1988 than in 1997.

The W&EST model indicates that pumping by Fort Huachuca through 1988 is responsible for approximately 0.1 cfs or 2% of modeled streamflow loss at Charleston and 0.17 cfs or 3% at Tombstone under transient conditions and a maximum of 1.2 cfs or 13% at Charleston and 1.7 cfs or 16% at Tombstone under steady state conditions, assuming pumping at 1988 rates. The model report does not indicate how long it would take to reach steady state conditions but states that it is probably considerably longer than the length of time of historical development. The model summarizes the total steady state flow loss from Fort Huachuca as 3.3 cfs at the Benson Narrows (only summarized at this location), based on modeled pumping of 3.4 cfs. In that analysis, model results show that Fort Huachuca contributes 8.6% of the total modeled flow loss of the San Pedro River, based on a total simulated flow loss contributed by all water users of 38.2 cfs.

The W&EST report cautions that all numbers in their report should be used as estimates only because exact hydrologic conditions are not known and that modeled river flows are very sensitive to starting conditions such as initial river stages, aquifer water levels, evapotranspiration, etc. and also to mathematical starting conditions caused by the model's iterative solver. Based on a sensitivity analysis, modeled water levels are most sensitive to changes in hydraulic conductivity and recharge rates. Modeled water levels are sensitive to river flows when evapotranspiration is high. Modeled river flows are most sensitive to the amount of tributary runoff modeled because this runoff flows directly into the river. The river flows are also sensitive to the riverbed geometry and silt layer hydraulic conductivity and thickness because these parameters restrict the flow of groundwater into the river.

The W&EST report compares their model with the ADWR groundwater flow model of the Upper San Pedro Basin (Corell *et. al.* 1995, from W&EST 1996). The ADWR model simulates only the baseflow component of the San Pedro River flow. As a result, the ADWR model can only simulate evapotranspiration at rates reduced to the theoretical levels that would be sustained by groundwater inflow only from the basin-fill alluvium. This type of model accentuates the effects of pumping during the dry months of the year. Both the W&EST steady state and transient models were converted to baseflow models by removing all tributary runoff and significantly reducing the evapotranspiration rates. The modeled river flows were compared to historical baseflow values estimated by ADWR in their 1995 model. The W&EST model was modified to model only baseflows by reducing the evapotranspiration rate to one-third of that used in the calibrations and by reducing the simulated inflow to the model in the San Pedro River from 28 cfs to 1.5 cfs. The modeled baseflows were in the general range of the ADWR estimates but declined steadily throughout the simulation rather than declining in the 1940s and increasing in the late 1970s. The W&EST modelers tried to match the ADWR estimated baseflows by doubling the modeled evapotranspiration rates in the 1940s and reducing the rates in the 1950s, 1960s and 1970s, but considered those conditions physically unrealistic.

The W&EST report reflects a continuing modeling effort and describes progress to date. The modeled groundwater levels are most sensitive to changes in hydraulic conductivity and recharges rates while modeled river flows are most sensitive to the surface water inflow volume from tributary runoff. The authors state that future work may modify the modeling results described in the report. Future work may include updating pumping data through 1994 or 1995, and changes in the transient model. Currently, the model consists of twelve stress periods, the shortest of which is three years. Water uses and supplies are averaged for each stress period. The model should be improved to simulate changing use and supply patterns throughout the year, probably on a monthly basis, in order to allow better forecasting of the effects of water use on river flows during dry times of the year. This improvement would enable modeling of flood flows during monsoon seasons and baseflows at other times.

A GROUNDWATER FLOW MODEL OF THE SIERRA VISTA SUBWATERSHED OF THE UPPER SAN PEDRO BASIN - SOUTHEASTERN ARIZONA (CORELL *ET. AL.* 1996)

This report describes the latest in a series of groundwater models developed for the Upper San Pedro Basin by the Arizona Department of Water Resources. The purposes of this model are to expand the model area from previous studies to incorporate new areas of concern and to develop an analytical tool capable of providing answers to questions concerning the effects on the San Pedro and Babocomari Rivers, their associated riparian areas and floodplain alluvial aquifers, and on the regional groundwater system. The ADWR is interested in modeling the effects of municipal and non-agricultural growth at Sierra Vista and Fort Huachuca, retirement of agricultural lands or increased agricultural activities, municipal and agricultural conservation measures, recharge projects, future development adjacent to the San Pedro River on baseflow and seasonal variations in groundwater levels, river flows of a fully restored riparian system, long term drought, and increased Mexican groundwater use. The model is designed to provide a regional understanding of the interrelationships between the groundwater flow system and groundwater pumpage and recharge. It is not designed to address site-specific problems, seasonal variations in groundwater levels and river flow, and precise water levels and elevation changes.

The area of study includes the Sierra Vista, Huachuca City, Fort Huachuca, Palominas, Hereford, Charleston and Fairbank areas. The total model domain is 22 miles from east to west and 32 miles from north to south. Model cell sizes range from 40 to 160 acres. The model represents the Upper San Pedro Basin as consisting of a regional aquifer and a floodplain alluvial aquifer. The year 1940 was chosen to represent pre-development steady state conditions on the basis of limited groundwater development and the availability of water level and stream gage data. The Freethey (1982) and Vionnet and Maddock (1992) models also used 1940 to represent pre-development conditions. The years 1941 to 1990 were selected to represent the post-development period for the transient simulations. The model uses the MODFLOW code developed by the US Geological Survey. Three model layers were used to represent the hydrogeologic system.

Input data for the model were obtained from Freethey (1982), both specified and unspecified published data, map analysis and estimates by ADWR. Municipal and military pumping records were used in the simulations. (Note: Pumping by Fort Huachuca was significantly higher during the simulated period than at present.) Agricultural pumpage was estimated. Evapotranspiration estimates only include the groundwater-supplied portion of evapotranspiration. Therefore, these

estimates are less than the total use by riparian vegetation. Also, due to the method used to estimate baseflow, near-stream pumpage was overestimated resulting in an overestimate of the effects of groundwater pumping on river inflows and outflows. The estimates of riparian, agricultural and evaporative losses may be smaller than previous estimates because they only include the portion of riparian, agricultural and evaporative uses derived from groundwater discharge to the San Pedro River and not the additional amount of evaporative losses supplied by flood flows, tributary inflows and rainfall.

According to the model report, the major change in the San Pedro River and the associated groundwater system over the past 50 years has been a decrease in groundwater discharge to the river between the years 1935 to 1940 and 1951 to 1956. The model report indicates that average baseflows have decreased through time from 1951 to 1980. However, the report also states that there may have been an increase in average baseflows for the period 1981 to 1990.

Based on a number of statistical comparisons of measured versus simulated conditions, the model appears to reasonably simulate measured water levels. Improvements in model-estimated streamflow could be made with improved estimates of evapotranspiration and recharge. In addition, the conceptual estimates of baseflow may include some component of runoff not accounted for in the model and may include some effects of near-stream pumping. The results of a sensitivity analysis indicate that the model is low to moderately sensitive to changes in streambed conductance, evapotranspiration depth and vertical conductance. The model is more sensitive to changes in evapotranspiration rates, especially in terms of fluxes and streamflows. The ADWR recommends that the model be updated as data become available to improve model calibration. Continuing acquisition of new field data is necessary for future improvements due to many unanswered questions about aquifer parameters, mountain front recharge, evapotranspiration and geology. The model could be improved by further analysis of the spatial and temporal distribution of pumpage, especially with respect to agricultural pumpage and the vertical distribution of pumpage within the aquifer. As the model is currently constructed, with stress periods are as long as 13 years, the model is not able to account for seasonal variations in pumpage, streamflow and evapotranspiration.

ANALYSIS OF HYDROLOGIC DATA COLLECTED BY THE US BUREAU OF LAND MANAGEMENT (1987-1995) AND RECOMMENDATIONS FOR FUTURE MONITORING PROGRAMS (SHARMA *ET. AL.* 1997)

Another hydrologic analysis has been conducted by Sharma, MacNish and Maddock (1997). This study analyzed stream flow and groundwater data collected by the US Bureau of Land Management on the San Pedro and Babocomari Rivers. The purpose of the study was to establish a more efficient monitoring program for the SPRNCA. The report analyzed data on stream flow measurements taken at nine locations on the San Pedro River and one location on the Babocomari River, and groundwater levels in eighteen wells collected from 1987 to 1996. All of the stream discharge data and some of the groundwater level data were collected at non-systematic intervals, and the stream flow measurements may not have been collected at the same location at each site over time. The authors reached qualitative conclusions and suggested that the amount of groundwater entering certain stream reaches had diminished over the period of record (1987-1995) but indicated that their analysis was made difficult by inadequate documentation, inconsistent

procedures and malfunctioning equipment. The report did not recommend future groundwater data collection efforts at the wells at these sites but did suggest that wells specifically designed to monitor the interactions of the regional and floodplain aquifers and the river should be instrumented to capture data on a daily basis, and that data from such stations can be used to verify model calibration in the future. The report concludes that existing groundwater models of the basin, and the expected improvements to them in the next few years, will make it possible to anticipate the effects of groundwater perturbations on the San Pedro River.

The authors made numerous suggestions to improve the surface water monitoring program. Suggestions included assuring that changes in the present relationships between the BLM sites and the Charleston gage can be identified and quantified, develop better relationships between the Palominas Gage and the International Boundary and Hereford Bridge site, maintain the Fairbank site and use it to generate flow data at Tombstone and Summers, obtain better flow data for the Babocomari, improve the utility of the streamflow data with groundwater data, and improve gaging station documentation. The study reports measurements on the Babocomari ranging from no flow to 1.5 cfs for intermittent gaging between 1990 and 1995. However, Sharma *et. al.* (1997) was not happy with their data and state that an accurate data set of generated surface flows at this site was not feasible.

PRELIMINARY INTERPRETATION OF THE 1997 AIRBORNE ELECTROMAGNETIC (EM) SURVEY OVER FORT HUACHUCA, ARIZONA, AND THE UPPER SAN PEDRO RIVER BASIN (WYNN AND GETTINGS 1997)

In 1996 and 1997, Wynn and Gettings, under the supervision of the USGS, collected airborne electromagnetic data for subsurface structural investigations on Fort Huachuca and the Upper San Pedro River Basin. The study provides a preliminary interpretation of the March 1997 Upper San Pedro River basin airborne geophysical survey. Interpretations were based on limited data released to the USGS as of early May, 1997, comprising of (a) uncalibrated mathematical inversions of seven flight lines of the 60-channel airborne electromagnetic data, (b) a merged aeromagnetic map, (c) a graphic representation of the flight-lines, and (d) 6 grids representing x- and z-components of channels 2, 6, and 10 (early, middle, and late decay times corresponding to shallow, intermediate, and near maximum depths of penetration of the airborne EM system) (Wynn and Gettings 1997).

This study found preliminary evidence that suggests the existence of a shallow depth conductor and an intermediate depth conductor that underlies the shallow conductor. Wynn and Gettings (1997) report that based on drilling and ground geophysical surveys this intermediate conductor appears to be a clay body that may block the shallow aquifer between Fort Huachuca and the San Pedro River. While it remains unclear from these limited data how this structure affects water movement in the aquifer, isotopic evidence reported elsewhere, and the appearance of the intermediate conductor both suggest that there is at least some natural isolation between the recharge areas west of Fort Huachuca and much of the San Pedro River in the surveyed area (Wynn and Gettings 1997). The study also cites that if this natural isolation exists, then much if not most of the water in the SPRNCA must derive from the upper reaches of the San Pedro River drainage in Mexico (Wynn and Gettings 1997).

HYDROGEOLOGIC INVESTIGATIONS OF THE SIERRA VISTA SUBWATERSHED OF THE UPPER SAN PEDRO BASIN, COCHISE COUNTY, SOUTHEAST ARIZONA, WRI REPORT 99-4197 (POOL AND COES, 1999)

The purpose of this hydrogeologic study was to "build a better understanding of the hydrogeologic framework, stream-aquifer interactions, and the rate and location of decreasing baseflow caused by ground-water withdrawals".

Improvements in the conceptual view of the Sierra Vista subwatershed include a better definition of silt and clay layers in the regional aquifer and a better definition of the source of base flow of the San Pedro River. Pool and Coes (1999) state that important changes have occurred that include geologic changes, changes in precipitation, changes in the distribution of ground-water withdrawals, and diminishment of summer base flow and annual runoff at the Charleston streamflow gaging station. Effects of these changes on the hydrologic system include variations in water levels, ground-water flow, recharge and discharge.

The authors note that variations in the seasonal distribution have had important effects such as decreased wet season (June through October) runoff after about 1960 and reduced rates of mountain front recharge during the winters (November through February) of the mid-1940's through mid-1970's. Annual runoff at the Charleston gaging station has decreased from more than 45,000 ac-ft before 1935 to less than 20,000 ac-ft during the mid-1990's. Wet season runoff volumes have varied from more than 40,000 ac-ft before 1935 to less than 10,000 ac-ft during the early and mid-1990's. Winter runoff has varied with precipitation.

The authors state in their summary section that even though wet season runoff volumes have decreased, there has not been a corresponding decrease in winter runoff volumes. An absence of a decline in the percentage of winter precipitation indicates that an increase in capture of precipitation and surface flow may have occurred during the wet season. Possible reasons for this include 1) direct capture through increased vegetation; 2) more frequent low-intensity rainfall events; 3) increased surface water diversions; and 4) increased recharge resulting from increased ground-water withdrawals by phreatophytes and by wells.

Additionally, declines in both winter and wet season base flows before 1951 could be related to several causes such as 1) growth and establishment of phreatophytes as the stream stabilized around 1955; 2) declining annual and seasonal precipitation; and 3) withdrawals for irrigation in the Palominas area. Infiltration of winter surface flows, especially during periods of low wet season precipitation and runoff, may be an important source of base flow. Ground-water withdrawals by wells and phreatophytes may have caused changes in winter and summer base flows after 1951 but the effects are probably masked by the effects of variation in infiltration of surface flow.

The authors also state that the entrenchment of the San Pedro River during the early 1900's resulted in hydrologic effects that were largely unrecorded. They go on to say that the hydraulic connection between the regional aquifer and the river improved because of the removal of pre-entrenchment alluvium. Silt and clay layers within the regional aquifer cause low storage capacity

as well as separate the ground-water flow into deep and shallow flow systems while at the same time restricting the interaction between the regional aquifer and the river.

In general, the clay and silt layers occur west of the San Pedro River and north of Lewis Springs and underlie the river south of Lewis Springs resulting in a poor connection between the river and the regional aquifer in this area. In areas further to the south, clay and silt facies are not well known but confined conditions in the Palominas area are known to exist.

Between 1932 and 1982, below average precipitation resulted in water level declines of 0.2 to 0.5 ft/yr. in the regional aquifer with the greatest declines near the mountains. This indicates that mountain front recharge was insufficient to maintain ground-water levels. Between the mid-1960's and mid-1980's, declining water levels were mitigated by greater than average precipitation rates and recharge during associated wet periods.

Water levels have continued to decline where extensive ground-water withdrawals in the Sierra Vista – Fort Huachuca area have occurred. This has diverted ground water that would have normally flowed down gradient toward the Babocomari River and along the San Pedro River downstream of the Charleston gaging station.

Analysis of ground-water samples throughout the basin has identified three sources of groundwater in the San Pedro River. The sources are: 1) water recharged within the Holocene alluvium near the river; 2) recharge to the regional aquifer in Mexico and east of the river along the Mule Mountains; and 3) recharge to the regional aquifer west of the river near the Huachuca Mountains. The groundwater in the Holocene alluvium is distinguished on the basis of specific conductance values, which are greater than values from the regional aquifer. Groundwater recharged near the Huachuca Mountains is distinguished on the basis of stable isotope values, which are different than values from other areas within the basin. During the March 1996 and March 1997 monitoring period, it was found that ground water from the Holocene alluvium that infiltrated near the river during surface flows was the primary source of base flow at the Charleston gaging station. Groundwater discharge from the regional aquifer contributed a minor part of the base flow at the Charleston location during this same time period.

MITIGATION STUDIES

The general purpose of these studies was to examine various water management alternatives for the City of Sierra Vista or Fort Huachuca. A common theme in these reports was the proposal to mitigate the negative effects of groundwater overdraft by recharging the aquifer with storm-flow or treated effluent.

CITY OF SIERRA VISTA SURFACE WATER PLAN (SLA 1988)

The City of Sierra Vista commissioned a consulting firm to prepare a comprehensive surface water plan for the City and surrounding area, including Fort Huachuca. The purpose of the study was to present a regional approach to the future management of surface water runoff within the study area. The intent of the plan was to provide means to protect the public against flood and erosion hazards, while treating surface water runoff and natural drainage ways as amenities to be managed. Phase 1

of the study involved a hydrologic and hydraulic investigation of Sierra Vista and surrounding areas. In Phase 2, these data were used to develop and evaluate alternative surface water management schemes. Phase 3 entailed combining the preferred alternatives into a comprehensive surface water management plan for the study area.

The results of this surface water study provided valuable baseline data on the hydrology and hydraulics of Fort Huachuca's and Sierra Vista's drainage systems. Such information could be used in locating and designing future flood flow detention/retention facilities, both on- and off-post, for use as groundwater recharge sites. One past recommendation was the proposed idea to construct of a conventional earth-filled dam on Garden Canyon Wash for flood control, recreation, and water resources purposes. However, this idea has since been discarded by the city (Don Brush, City of Sierra Vista senior planner, personal communication, June 2002).

GROUNDWATER RECHARGE FEASIBILITY REPORT (ASL 1995)

The City of Sierra Vista retained the services of a consulting firm to determine the feasibility of using sewer effluent to recharge the local aquifer. The study evaluated the potential impacts to the groundwater system and the San Pedro River of: 1) continuing current effluent disposal practices; 2) recharging effluent to maximize augmentation to river flows; and 3) recharging effluent at various other locations. The investigators reviewed previous hydrologic studies and employed an existing groundwater model (MODFLOW: Vionnet and Maddock 1992 version) to predict the effects of effluent recharge. In addition, they assessed the relevant regulatory requirements and estimated the cost of constructing and operating an effluent recharge system. It should be noted that this study examined the effect of future increased water use by Sierra Vista only; future water use by all other communities was held at 1995 rates.

In general, the ASL investigators concluded that a number of feasible effluent recharge strategies would allow for continued pumping by the community while preserving and enhancing flows in the San Pedro River. Other conclusions were:

Groundwater and surface water flow simulations demonstrated that continued and escalated groundwater pumping in the Sierra Vista/Fort Huachuca area will not result in an immediate, catastrophic decline in flows in the San Pedro River. These stream flow declines will occur gradually as the groundwater system changes in response to the pumping. The cone of depression will expand. The capture of mountain front recharge will increase in both volume and area extent, and groundwater gradients approaching the river will decline. However, sufficient time exists for the implementation of mitigation strategies to offset these undesirable outcomes.

Cost effective solutions are possible within the locally available water resources, which can maintain and even enhance San Pedro River baseflows.

Mitigation strategies are possible which allow for continued development within the City of Sierra Vista without harming the San Pedro River.

It would be prudent to address the potential impacts to the groundwater system and the San Pedro River from existing and proposed development in other portions of the subwatershed. Similar

water resource strategies to those presented for the Sierra Vista area may be implemented throughout the subwatershed.

Unmitigated growth throughout the subwatershed could potentially offset any benefits to the San Pedro River accrued through the implementation of the water management strategies mentioned in this report.

Implementation of strategies contained in this report, coupled with a negotiated settlement among the competing water interests in the subwatershed, has the potential to create water resources certainty with the community for the foreseeable future.

SIERRA VISTA WETLANDS AND REUSE STUDY (BOR 1995)

In 1991, the City of Sierra Vista in cooperation with the US Bureau of Reclamation (BOR) initiated a study to evaluate the use of constructed wetlands to improve the City's wastewater management system. The purpose of the study was to determine the feasibility of employing treated effluent for various beneficial uses, including wetland creation, groundwater recharge and river flow augmentation. The investigators constructed and monitored two 3.5-acre pilot wetlands at the City's wastewater treatment plant, and presented conceptual designs and cost estimates for full-scale constructed wetlands. After analyzing and comparing the various alternatives, the investigators found (among other conclusions):

The highest ranking alternative was on-site groundwater recharge using recharge basins. Recharge basins provide maximum reliability, low energy cost (assuming they are gravity-fed), low initial cost, and very good design flexibility. As discussed in the Groundwater Recharge section of this chapter, recharge basins may be highly feasible at Sierra Vista and may be integrated with other alternatives to provide complete reuse of effluent.

Groundwater recharge by injection wells ranked fourth. The potential problem of the wells becoming clogged by effluent not fully treated would require operation and maintenance costs greater than that for recharge basins.

Surface-water augmentation of the San Pedro River using the abandoned Southern Pacific Railroad roadbed alignment ranked sixth. Besides maximizing surface-water augmentation, transporting reclaimed water by gravity-flow provided minimum energy cost and maximum reliability. Initial cost was increased by the number of manholes and air valves required.

Although technically feasible, implementation of the groundwater recharge or stream augmentation options would require compliance with all relevant federal and state water quality standards and permitting processes. The investigators described the various environmental and cultural studies that would need to be conducted if treated effluent were discharged within the San Pedro Riparian National Conservation Area. They also mentioned the need for additional geologic studies if the groundwater recharge option was to be pursued.

WATER RESOURCE MANAGEMENT PLAN FOR FORT HUACHUCA (USAG 1995A, 1995B)

The US Army Garrison, Fort Huachuca, commissioned this study to evaluate, among other things, the potential for expanding the use of reclaimed waste water for irrigation and aquifer recharge. The Water Resource Management Plan includes 2 volumes. Volume 1 provided information on the hydrogeology, water use history, and the feasibility of groundwater recharge. Volume 2 described the landscape and irrigation master plan.

The Army has undertaken a multi-tiered water resource management program in order to efficiently manage and conserve Fort Huachuca's water resources. Some of the major parts of the Water Resource Management Plan are:

Use of Reclaimed Water for Irrigation: In the early 1970's, the Fort constructed secondary treatment facilities at the Wastewater Treatment Plants (WWTP). The Fort also constructed a reclaimed water distribution system to enable the use of reclaimed water (treated wastewater effluent) on the golf course and Chaffee Parade Field. This facility was one of the earliest projects which utilized reclaimed water in southeastern Arizona. Presently, the reclaimed water system has been extended to facilitate the use of reclaimed water at the new Outdoor Sports Complex and the relocated Chaffee Parade Field. Improvements to the WWTP No. 2 will be completed in the Fall of 1995 (WWTP No. 1 was taken out of service several years ago and since, only the effluent holding/pumping facilities at WWTP No. 1 have been utilized). These improvements to WWTP No. 2 will enhance the quality of the reclaimed water allowing it to comply with the Arizona Department of Environmental Quality (ADEQ) rules and regulations for "open access" irrigation. As part of this study, the expansion of the reclaimed water system will be evaluated in an attempt to further reduce the demand for groundwater.

Use of Low Flow Plumbing Fixtures: The Fort has enacted regulations requiring that all plumbing fixtures in new construction and renovations of existing structures utilize a "low-flow" design. In addition to this, the Fort has installed "low-flow" fixtures on many of the existing facilities not scheduled for renovation in the foreseeable future.

Restriction of Non-Essential Water Use: The Fort has enacted regulations limiting the use of potable water for irrigation. The regulations being enforced restrict the permissible method of irrigating, time and day of irrigating, and duration of irrigation.

Stormwater Recharge: Concepts for the recharge of stormwater are under investigation by the Fort as part of the Mountain Front Recharge Project. Concepts include peak flow harvesting, augmentation of in-stream infiltration, and other techniques to promote the infiltration of stormwater back to the local aquifer.

Educational Programs: The Fort has undertaken several programs to educate the population of the Post as to the value of the water resource and methods to reduce consumption.

Intergovernmental Coordination: The Fort has taken an active roll in intergovernmental coordination to assist in formulating a comprehensive plan which addresses the needs of all water interests within the San Pedro Basin.

The purpose of the Landscape and Irrigation Master Plan was to provide policies and standards for the planning, design, construction, and maintenance of landscape and irrigation improvements associated with new facilities to be constructed at the [Fort]. The Plan was also designed to be used in the redevelopment and upgrading of existing landscape and irrigation facilities. The principal goals of the Landscape and Irrigation Master Plan were given as follows:

- To create landscapes on the [Fort] that is compatible with the climatic and other environmental conditions present at Fort Huachuca.
- To create and maintain functional and attractive landscapes that support the missions that have been assigned to [the Fort].
- To utilize whenever and wherever appropriate, drought tolerant native or naturalized plant species in conjunction with [Fort] landscape developments.
- To create and foster a water conservation ethic within the Fort Huachuca community.
- To minimize the consumptive use of water for the irrigation of [Fort] landscape plantings.

INCREASING RECHARGE FROM MOUNTAIN FRONT PRECIPITATION AND RUNOFF (SAIC 1997)

This project is a part of Fort Huachuca's program of water resources protection that includes water quality, water conservation, effluent reuse and recharge. The overall purpose of this project is to develop and implement a program to improve recharge at Fort Huachuca with the ultimate goal of increasing the recharge into the regional aquifer, thereby reducing or mitigating the drawdown caused by local ground water pumping.

Storm water runoff for major watersheds and the cantonment area of Fort Huachuca was analyzed. Seven major watersheds were delineated for the installation. The potential for aquifer recharge from storm water events was analyzed, the watersheds or areas that have the greatest potential to increase ground water recharge were determined, and recommendations for ground water recharge projects were developed. The report includes a summary and discussion of results obtained from an evaluation of recharge methods, selection of recharge methods and sites, baseline and projected recharge analyses, and conceptual design of recharge systems.

Preliminary watershed and surface water analyses indicated that several of the delineated basins may be suitable for developing sites where storm runoff could be captured or detained to enhance recharge. A number of watersheds offer the best potential for capturing runoff from these types of storms including Tinker/Brown, Woodcutters, Blacktail and Huachuca Creek. The potential cantonment sites include Hatfield Ditch, Arizona Ditch and Soldier Creek.

The east range was also evaluated for potential recharge sites. East range sites include Graveyard Gulch north of Sierra Vista and near the southern boundary of the Reservation, Soldier Creek north of Sierra Vista near the southern boundary of the east range, and at its confluence with drainages from Libby Army Air Field-Sierra Vista Municipal Airport, and two large drainages entering the east range from the vicinity of Libby Army Air Field-Sierra Vista Municipal Airport.

The Soldier Creek North and Libby sites appear to offer the best potential to collect and recharge storm runoff. Pending site-specific subsurface investigations, the runoff collection and recharge methods selected for the canyon drainages, i.e., infiltration galleries and vadose zone wells, are also applicable for the east range sites. Impoundment dams could be constructed since land is available, but at greater cost. A series of check dams on the drainages would also retain storm runoff which could either be allowed to infiltrate into the shallow subsurface, or storm water could be decanted and recharged deeper in the subsurface through wells or seepage trenches.

A summary of potential annual runoff and recharge for all sites investigated is presented in the report. The total potential annual runoff available from all of the sites investigated is 5,067 ac-ft. The canyon sites provide 90% or 4,536 ac-ft of that total. The east range sites account for 393 ac-ft, which is eight of the total. The detention basin sites can provide 128 ac-ft of water, which is 3% of the total runoff.

The report recommends that recharge systems be implemented at Huachuca Creek and then Soldier Creek, followed by Woodcutters or Blacktail Creek. For the east range sites, the order of implementation should be Soldier Creek North and then the Libby drainage. Site-specific subsurface investigations should be performed prior to final selection of recharge methods and system design.

ARMY WATER RESOURCES MANAGEMENT PLAN – PHASE 1 (EEC, 2001)

Water conservation and/or water augmentation is required to address the potential impact of groundwater pumping on endangered species and critical habitat in the Sierra Vista subwatershed of the Upper San Pedro Basin.

Groundwater pumping records show a decreasing withdrawal rate. Since 1994 this decrease has been approximately 7 ac-ft (ac-ft) per month. This downward trend is present in all calendar yearly quarters. An analysis of wastewater generation shows that 1,320 family housing facilities comprise 48% of interior water use while 137 non-family housing facilities account for 51% of interior water use.

Water use shows a strong seasonal pattern where average high monthly temperature and groundwater pumping are statistically linked. The months of May, June and July are also linked statistically to groundwater withdrawals. Monthly precipitation amounts do not show statistical linkage to groundwater pumping.

Infrastructure improvements in the water distribution and water collection systems could reduce Post water use by 413 ac-ft per year. Infrastructure improvements coupled with a 10% improvement in water conservation and a 50% reduction in evaporative cooling could reduce post

water use by 523 ac-ft per year. A total reduction of 523 ac-ft per year is a realistic and achievable goal. One acre-foot (ac-ft) of water is 43,560 cubic feet (ft^3) or 325,829 US gallons (gal).

With an additional 561 ac-ft of storm water recharge, groundwater pumping on Fort Huachuca could reasonably obtain a "zero impact" on the local groundwater aquifer.

UPPER SAN PEDRO PARTNERSHIP PROJECTS

The strategies that are being explored by the Partnership include the following: Reducing water consumption while continuing to meet the needs of people and nature by using conservation technologies, public policy and encouraging personal responsibility. Reclaiming used water resources, otherwise wasted, by irrigating with treated effluent or recharging it into the aquifer and reusing gray water. Augmenting existing water resources by harvesting and recharging storm water through erosion/flood control projects and general watershed improvements or by importing water from outside the area.

Reduce Consumption Strategy

The Partnership has identified 42 potential options for reducing water consumption. These options are included in the feasibility/cost/ benefit study slated for completion in the fall of 2002. Water savings for the projects and programs that have been quantified indicate that the savings under this strategy will be 2,426 ac-ft per year (AF/YR) by the end of 2002.

Reclaiming Used Water Strategy

The Partnership has identified 13 options for reclaiming water resources by reusing effluent in lieu of ground water or recharging it back into the ground water. These options are included in the benefit/cost/benefit study slated for completion in the fall of 2002. The City of Sierra Vista and Fort Huachuca have completed their own studies and are proceeding with projects that are expected to begin saving 3,400 AF/YR by mid 2002.

Augmenting Water Resources Strategy

The Partnership has identified eight options for augmenting water resources by increasing storm-water recharge or importing water from outside the area. These options are included in the feasibility /cost/benefit study slated for completion in the fall of 2002. The City of Sierra Vista, Cochise County and Fort Huachuca have completed their own studies and are proceeding with projects intended to increase storm-water recharge.

GENERAL CONCLUSIONS

The San Pedro River is a stream in geomorphic and hydrologic transition. Entrenchment of the stream channel has caused a drop in the regional groundwater level with a resultant reduction in river baseflow.

Groundwater pumping in the Fort Huachuca-Sierra Vista area has caused an overdraft of the regional aquifer, resulting in lowered water-table levels in the vicinity of Fort Huachuca.

Groundwater pumping by Fort Huachuca and the surrounding communities has not yet had a direct impact on flows in the San Pedro River. However, the cone of depression caused by groundwater overdraft may cause a future indirect impact on baseflow to the river.

Sierra Vista has an operational recharge facility online. Fort Huachuca is completing their own recharge facility.

Several government agencies, including the Army, continue to cooperate in programs to monitor the groundwater situation in the Upper San Pedro River basin and to improve models of the basin hydrogeology.

APPENDIX G
FORT HUACHUCA RELATED POPULATION ADJUSTED FOR DOUBLE COUNTING

		survey	# of people	Correction	Correction	Intermediate	Corrected	comments
		page #/para		Factor	Amount	Value	Value	
Military On Post (OP)	`		4840				4840	FH annual economic impact statement
Family Members (FM) OP							4151	FH annual economic impact statement
Military off post			1884				1884	FH annual economic impact statement
FM off post							1895	FH annual economic impact statement
Government Civilians (GC)			2432		416		2016	Govt civilians minus military family members (MFM)
	2 worker homes	12/7.2.2		18.80%	457	1975		minus worker's family members in the heading below
	Mil FM OP	13/7.2.4		10.50%	255	1719		minus number counted as military family members
	Mil FM off post	14/7.2.4		6.60%	161	1559		minus number counted as military family members
GC Family Members		16/14	1559	1.84		2868	2868	calculates family members not already accounted for
		16/14						
Contractors*			3447			607	2840	Contractors on and off post, minus MFM already counted
	2 worker homes	12/7.2.2		21.20%	731			reduce number of households
	Mil FM on post	13/7.2.4		12.70%	438	3009		reduce contractor and household number for MFM
	Second Jobs	12/7.2.1		4.90%	169	2840		reduce for second job on post, likely to be a contractor
					1338			total households already counted above this line
Contractors FM			3447	1.84	1338	2109	3881	calculates family members not already accounted for
2 worker household adjustment		16/14		0.84	1188		998	adds 0.84 household members for 2 worker homes
Military Retirees			3427			2631	796	

	GC employees	13/7.2.3		18.80%	457			reduces for employees already counted above	
	Contractors	13/7.2.3		40.70%	1403			reduces for employees already counted above	
	GC household	13/7.2.3		14.00%	402			reduces for family members already counted above	
	Contractor HH	13/7.2.3		13.00%	369			reduces for family members already counted above	
Retiree family members				1			796	assumes 1 family member for each retiree	
Survivors	258			1.50			387	assumes 0.5 family members per survivor	
Total personnel							27352		
Less 3% living outside SV subwatershed							821		
Net in SV subwatershed							**26531**		
Population Associated with Induced Jobs in the SV subwatershed							**7093**		
Total Population in SV subwatershed Due to Fort Huachuca							**33624**		
Total Ac-ft Due to Fort Huachuca Military, Govt Civilians, Contractors, Retirees and Family Members								**2,675**	**ac-ft**
Total Ac-ft Due to 500 Future Jobs Included in the Proposed Action								**109**	**ac-ft**
Total Portion of the Deficit Fort Huachuca is Responsible For								**2,784**	**ac-ft**
* consists of the 3149 on-post and 298 off-post contractors employed by organizations on post									
assumes similar demographics for the off-post and on-post contractors for the purpose of estimating family members									

APPENDIX H
OFF-POST CONTRACT PERSONNEL

		As of							
		*9/30/2001	For FY 01						
		ON-POST	ON-POST MANYEARS		OFF-POST	OFF-POST MANYEARS		APPROX	
NAME		CONTR	EQUIVALENTS		CONTR	EQUIVALENTS		POC	PHONE'
DOC		448	443		22	22		Ms Parra	
								Ms Rose	
								Mr. Marlow	
EPG(average)		426	426		0	0		Ms Bobb	3-8327
CECOM									
Acquisition Contract Ofc		16	16		0	0		Ms Baker	88243
CSLA		44	44		3	3		Ms Cusack	87553
ISEC		114	94.5		99	81		Mr. Hughes	83067
CECOM-Software		90	90		143	143		Bill Walker	86188
Aerostat		29	29		0	0		Jeff Porter	
Corp of Engr		40	3.3		0	0		Ellen Bartish	8-0680
JITC									
Validity		174	174		1	1		Dan Slaven	80418
Interop		174	173.75		0	0			
TRW		161	158		17	15.6			
Def Intel Agency(DIA)		10	9		0	0		Chris Withers	34037
TUAV- Redstone		44	44		3	3		Maj Gage	452-9060
DECA		32	25		0	0		Ms Carbajal	ext 100
HQASC/USANETA		224	224		0	0		Gordon Lewis	86981
TEXCOM/(IEWTD)		37	36.72		1	0.27		Ken Smith	88818
TRICARE		36	36		0	0		Joe Askounes	30283

DOIM		30	30		8	8		Ms Hodgkins	34697
TRADOC Acq Ctr		37	37		1	1		Toni Guthrie	33069
Ft Eustis/included									
INSCOM/ITRADS		3	3		0	0		Randel Long	32320
WEST CPOC		1	1		0	0		Randy Bostwick	
AF Charlie, 3D		1	1		0	0		Steven Erickson	82865
Weather Squadron									
TMDE		3	3		0	0		Manny Vera	86535
STRICOM-GSA		27	27		0	0		Russ Hanam	88759
General Dynamics		2	2		0	0		SGT Puhlman	34055
TOTAL		2203	2130.27		298	277.87			

APPENDIX I
ECONOMIC IMPACT FORECAST REPORT – 2002

EIFS REPORT

PROJECT NAME
cochise2

STUDY AREA
04003 Cochise, AZ

FORECAST INPUT

Change In Local Expenditures	$233,100,000
Change In Civilian Employment	2432
Average Income of Affected Civilian	$55,838
Percent Expected to Relocate	100
Change In Military Employment	6724
Average Income of Affected Military	$22,501
Percent of Militart Living On-post	88

FORECAST OUTPUT

Employment Multiplier	2.22	
Income Multiplier	2.22	
Sales Volume - Direct	$387,906,700	
Sales Volume - Induced	$473,246,100	
Sales Volume - Total	$861,152,800	141.55%
Income - Direct	$320,865,800	
Income - Induced)	$68,562,980	
Income - Total(place of work)	$389,428,800	24.47%
Employment - Direct	12509	
Employment - Induced	4091	
Employment - Total	16600	37.27%
Local Population	22798	
Local Off-base Population	8065	21.17%

RTV SUMMARY

	Sales Volume	Income	Employment	Population
Positive RTV	6.71	7.65	5.01	3.82
Negative RTV	-5.12	-4.62	-4.3	-1.13

RTV DETAILED

SALES VOLUME

Year	Value	Adj_Value	Change	Deviation	%Deviation
1969	193263	572058	0	0	0
1970	209872	585543	13484	-11244	-1.92

6/24/2002

CENTER FOR ECONOMIC RESEARCH'S ASSESSMENT OF THE ECONOMIC IMPACT OF ACTIVITY ON FT. HUACHUCA AS IT RELATES TO STATEMENTS MADE BY THE CENTER FOR BIOLOGICAL DIVERSITY

DRAFT

June 2002

Cochise College Center for Economic Research
901 N. Colombo Ave.
Sierra Vista, AZ 85635
Phone: (520) 515-5486
Fax: (520) 515-5343
Email: cer@cochise.edu
www.cochise.edu/cer

Table of Contents

Introduction……..384

Analysis of Fort Huachuca Impact……..384

Concluding Comments……391

Bibliography……396

Appendix A - Cited article
"AEGIS has big impact on county economy"

Appendix B - Cited article
Multiplier Analysis of Arizona and Its Substate Areas

Appendix C - Computation of Fort Huachuca's off post responsibility in the Sierra Vista subwatershed

Appendix D - Background on the Center for Economic Research

Appendix E - Center Directors Biography and Vita

The Center for Economic Research (CER), founded in 1995, is a department within Cochise College located in Cochise County, Arizona. The stated mission of the center is to provide, collect, and interpret economic data for communities within Cochise County, to provide forecasts on the business climate, and to educate the communities served by Cochise College, about the economy.

The center prides itself on its role of being independent and neutral on issues of growth and development. The only time the center finds itself involved in issues of this kind is when the center is aware of information and facts that are being misapplied or statements that cannot be substantiated given the available data. The role of the Center for Economic Research in this report is to address issues of reasonableness of the Forts methodology, assumptions and multipliers as they relate to economic and demographic analysis pertaining to the Fort's biological assessment. In addition, the center will render opinions, either favorable or unfavorable, regarding statements and misconceptions made by the Center for Biological Diversity, in previous letters submitted during the public comment period, in regards to Fort Huachuca's Student Plus Up environmental assessment. While the center entered into a contract with Ft. Huachuca to evaluate the above mentioned issues related to the economic impact of the Fort's activities, the center entered into this agreement with the understanding that it was to report its findings, be they favorable or unfavorable, to the Fort. Beyond reporting these findings the CER has no control of how Ft. Huachuca chooses to use the reported findings.

What follows are comments made by the Center for Biological Diversity and Dr. Robin Silver in a letter dated February 23, 2002, to the Commander, US Army Garrison, ATTN: ATZS-ISB (KENT), Fort Huachuca, Arizona 85613-6000. In the pages that follow are opinions and comments to statements made within that letter that the CER specifically view as issues with economic impact. The statement taken from the letter is given first, followed by an addressing of the statement by the CER.

ANALYSIS OF FORT HUACHUCA IMPACT

The EA/FONSI fails to acknowledge that "(a)ttractions for people to move to the area include…" (p. 31) the facilities at Ft. Huachuca for military retirees, including, but not limited to the Base's

- "super clinic… which provide(s) health care services to more than 30,000 area residents" (Sierra Vista Herald 1997),
- the Base's commissary, "one of the military's largest stores…" with "prices that are 20 to 35% lower on a daily basis than civilian supermarkets…" (Sierra Vista Herald 1998)
- Ft. Huachuca's increasing local contracts, and the Base's golf course.

The military does recognize the number of retired military living in the area, according to the "Annual Economic Impact Statement Fiscal Year 2000." The Fort publicly identifies 3,353 military retirees living in the Sierra Vista subwatershed of the San Pedro River. According to the "Annual Economic Impact Statement Fiscal Year 2001" (Draft), there was reported to be 3,427

retired military living in the Sierra Vista subwatershed of the San Pedro River and 258 retiree survivors. Once these figures are adjusted for double counting (number of retirees reduced for those who are already counted as DA civilians and/or contractors), the adjusted numbers become 1,273 family members, 387 survivors and dependents and 796 military retirees. Referring to the Forts impact statement, "because the databases do not cross-reference, and the labor pool is small and often contains multiple members of the same family, significant double counting occurs in the report. Thus the number of "personnel" reported in the AEIC is higher than the actual number of people who are reported in the "personnel" categories. (1999 Fort Huachuca Demographic Survey) According to the "1999 Fort Huachuca Demographic Survey," "many military retirees from active duty as well as from the Reserves and the National Guard are now employed at the Fort as civilian employees or as government contractors."

The indirect multiplier effect, using the Army Environmental Policy Institute (AEPI) commonly used multiplier of 1.684, cannot assume to hold since this multiplier was derived specifically for the impact of Fort employment. While this group would indeed have an impact on the local area, the use of the AEPI multiplier would most likely be inappropriate. Depending on the situation of the adjusted number of retirees (either working in positions other than the Fort or retired and not working) the multiplier could vary greatly. According to "Multiplier Analysis of Arizona and Its Substate Areas" (Charney), multipliers vary according to the situation to which they are applied and can vary over time.

It is the opinion of this Economist and others consulted with that Fort Huachuca cannot be held accountable for military retirees living in the Sierra Vista subwatershed. Therefore the Fort is limited to accounting for retirees only to the extent that they are currently employed as contractors and Government employees. Many retirees chose to live in an area such as Sierra Vista for a variety of reasons beyond the fact that the military base is located there.

The EA/FONSI fails to include and evaluate the cumulative impacts of the fact that from September 30, 1998 to October 1, 2000, Ft. Huachuca's workforce had already increased by 10%, or 1,046 people. The source of this total includes an increase of 778 people and 32 National Guard full-time equivalents in 1999 from Ft. Huachuca statistics. These statistics are published in the Fort's "Annual Economic IMPACT STATEMENT Fiscal Year 1999, October 1, 1998 – September 30, 1999, Fort Huachuca, Arizona," October 1999. The source of this total also includes an additional 236 people in 2000 from Ft. Huachuca statistics as published in the Arizona Daily Star. These statistics are published in the Arizona Daily Star's yearly review of the largest employers in southern Arizona, "Fort retains No. 1 spot, University of Arizona edged out for highest employment total," March 11, 2001. (Arizona Daily Star 2001a)

The above figures stated by Dr. Silver are accurate as detailed in the Forts impact statement. What Dr. Silver neglects to mention is that during the years 1996 to 1998 the Fort's workforce was at its lowest level of the ten-year period (the ten years for which the CER has impact statement data). The ten-year average employment for the years 1991 through 2000 is 11,175. While the Forts total workforce did increase 9.8% during the period 1998 to 2000 the 2000 workforce is only 1.8% above the ten-year workforce average or 200 individuals above the ten-year average. The annual population totals are taken on September 30 of each year and these figures can fluctuate up or down on a daily basis.

According to the 2001 "Annual Economic Impact Statement" (Draft) the Forts workforce is listed as 12,603, which is an increase of 1,228 workforce members. The number of people in the 2001 workforce is 1,428 employees above the ten-year average (1991-2000), representing a 12.8% increase above the ten-year average workforce. The 2001 workforce represents an increase of 1,587 civilian and contractor personnel. During this same one-year period military personnel decreased by 359. Applying the Census 2000 weighted family multiplier of 2.52 for the Sierra Vista subwatershed area, (weighted average of Sierra Vista, Sierra Vista Southeast and Huachuca City census multipliers), this net increase of 1,228 represents 3,095 employees and family members assuming all of these people are new to the Sierra Vista subwatershed area. After adjusting for workforce members living outside the subwatershed, the population count become 2,996. Based on experience with the 1999 Fort Huachuca Demographic Survey, often more than one household member is employed in the Fort Huachuca workforce and therefore once double counting is accounted for the net increase in persons will be less than the above total.

It is not clear where Dr. Silver's figure of 1,046 comes from. Based on the difference in Fort Huachuca workforce between September 30, 1998 and September 30, 2000, 1,013 employees can be accounted for. If adding in his figure of 32 National Guard members the number becomes 1,045. Again, the figure and methodology used to arrive at 1,046 is unclear.

The EA/FONSI fails to include and evaluate the cumulative impacts of the fact that such direct support of 1,046 people translates into direct and indirect support of between more than 4,225 and 4,449 people. These numbers come from calculations based on the Economic Impact Forecast System developed by the US Army Corps of Engineers Construction Engineering Research Laboratory (CERL) (Ft. Huachuca 1999), and based on US Census data. (Census 2000)

The above statement fails to distinguish the differences in population movements in the categories of personnel on Fort Huachuca. While the net effect is correct that the Fort Huachuca Workforce has increased by 1,046 the three categories of personnel must be handled differently when applying the AEPI multiplier and the Census 2000 family multiplier. Specifically the student population that attends school on the Fort does so in large part without the student's family members relocating to the area. According to officials with the Fort, most of the students live on the Fort and do not have personal vehicles. Therefore the family size and the AEPI multipliers overstate the student impact on the local community, since these students typically spend the majority of their time on the Fort and do not require household and family expenditures in the community.

The above statement does not address the fact that during this two-year period the student population increased by 1,753 while the combined military and DA civilian/contractor population fell by 740. Therefore applying the Census 2000 family multiplier results in little, if any, change in the student population and an overall decline in the military and DA civilian/contractor population of 1,865 (740 employees plus 1,125 family members based on an average Census 2000 family multiplier of 2.52 for Sierra Vista subwatershed area). The impact of using the census multiplier is a net decline of 112 individuals resulting from direct employment changes or more specifically a decline of 53 individuals in the Sierra Vista

subwatershed area (based on findings of 3.2% of workforce and employees living outside the watershed area), on Fort Huachuca between 1998 and 2000.

Based on this reduction in workforce the impact is further reduced by the induced jobs resulting from the initial reduction in military/contractor/DA Civilian workforce. Based on multipliers of 1.332288 for military and 1.383932 for DA Civilian and contractors, the result is a loss of 330 induced jobs. When applying the family multiplier of 2.52 the result is a net decline of 832 induced jobs and family members plus the above net decline of 53 persons for a total of 885 persons linked to Fort Huachuca in the year 2000.

Calculation for the year 2001 impact can be found in the response to the previous statement made by Dr. Silver.

As further evidence that this huge population increase did not take place between 1998 and 2000, a review of Sierra Vista Public Schools enrollment in fall 1998 and fall 2000 shows an increase of only 27 students for the two-year period (1998 equals 6,765 and 2000 equals 6,792 students). The Palominas School District, located south of Sierra Vista, reported an increase of 34 students for this same time period (1998 equals 981 and 2000 equals 1,015 students). During this same period AEGIS Communications opened a facility in Sierra Vista adding approximately 800 jobs. At that time Dr. Silver made a similar claim of these positions being filled by people moving into the area with a similar multiplier effect (Sierra Vista Herald).

The EA/FONSI fails to acknowledge and evaluate the fact that the greatest impact of Ft. Huachuca's presence remains outside the Base's gates, with its support of more at least 34,000 groundwater dependent people as of December 1999. (USFWS 1999) This total has obviously increased dramatically since then.

Considerable time and effort was spent to determine the total responsibility and impact that Fort Huachuca has on the population living in the Sierra Vista subwatershed. Data related to Fort Huachuca's workforce and population was taken from the 2001 impact statement draft. Other information used in the analysis was taken from Census 2000 information. The detailed description of the methodology and the steps taken in computing the total responsibility the fort has in the Sierra Vista subwatershed can be found in Appendix C.

Based on year 2000 data, the most recent year for which information is available, Fort Huachuca is responsible for a total of 18,036 persons living off the Fort but in the Sierra Vista subwatershed area. This figure includes all government employees, contractors and enlisted military and their families living off of the post. In addition this figure includes the net induced jobs and family members of the persons holding these jobs. In the analysis every attempt was made to apply characteristics found in the total population of the subwatershed area to families of the Fort Huachuca workforce and to households where a member is employed in an induced job resulting from employment on Fort Huachuca. Such characteristics applied to these populations include household size, percent of the population employed, and percent of the population employed in induced jobs.

Based on previous comments regarding retired military personnel and survivors these population groups were not included in the overall responsibility of the Fort. Retired military spouses and siblings and survivors currently employed on Fort Huachuca are included in the population as members of the Fort's workforce. It is a strongly held belief by this economist and other economists, collaborated with for an opinion, that Fort Huachuca cannot be held responsible for military retirees choosing to locate in the Sierra Vista subwatershed area. If retirees, family members and survivors are added in, the total figure increases to 20,015.

A final comment is needed to further clarify the induced jobs resulting from the employment of the Fort Huachuca workforce. It is quite possible that the total number of induced jobs calculated could be further reduced by at least two scenarios. In the calculation of induced jobs held by residents in the subwatershed area who are not spouses or siblings of members of the Fort's workforce, it is assumed that only one member of a household is employed in an induced job. Also, two or more persons in a household may hold induced jobs and therefore reduce the total impact of the Fort by this double counting of families. It is possible that some of the induced jobs in the community could be held by members of the enlisted military on a part time basis. It is known that members of the military as well as contractors and government civilians do hold second jobs off the post. To the extent that these persons are employed in sales and service jobs, assumed to be induced jobs, the total impact of the Fort on the community in terms of induced jobs and family members.

The EA/FONSI fails to include and evaluate the cumulative impacts of the fact that Ft. Huachuca's off Base purchases in Sierra Vista alone have increased by 32% or $50.8 million, from $158.1 million in Fiscal Year (FY) 98 to $208.9 in FY99. (Ft. Huachuca 1999) Total Ft. Huachuca expenditures in Cochise County were even higher. Ft. Huachuca's off base purchases in Cochise County have increased by $52.6 million, from $433.2 million in FY98 to $458 in FY99. Increased local purchases of $50.8 million (an increase of 32%) in Sierra Vista and $52.6 million (an increase of 12%) in the county represent significant expansion and modification of Ft. Huachuca's activities since December 1999.

The above fails to mention that during fiscal year 98, the Fort's total spending in Sierra Vista was the lowest of the nine-year period between FY92-FY00. When taking the nine-year average, the average spending in the Sierra Vista area is $203.5 million. The 1999 figure, which was reported to be 32% above that of 1998, is actually only 2.65% above the nine-year average for spending. Dr. Silver fails to mention that the 1998 spending is 29.1% below that of 1997 and 22.3% below the nine-year average. Drawing from the above, it appears that data has been selectively chosen to support the desired outcomes for his argument.

When spending for each of the nine-years is inflated to year 2000 dollars, the average for the nine-years becomes $224.9 million. In other words the total spending for 1999 is actually 7.1% below the nine-year average when adjusted to current dollars. In determining the nine-year average, unless each year is adjusted to current dollars (inflated) there is a natural bias for the average to be understated due to the weight of unadjusted totals in earlier years. Dollar amounts were inflated based on the Bureau of Labor Statistics Monthly Inflation Index.

In addition, much of the spending has already been analyzed in the form of payments to Fort contractors as wages and benefits. The local spending mentioned in the above argument is not completely exclusive to wages and benefits already measured for impact.

When this spending data is analyzed for the most recent year for which data is available, the Fort Huachuca Annual Economic Impact Statement 2001 (Draft), the ten-year spending average in 2001 dollars is $227.5 million. With the fiscal year 2001 spending totaling $198.1 million, the 2001 amount is actually 12.9% below the ten-year average for spending once spending is adjusted for inflation.

The EA/FONSI fails to include and evaluate the cumulative impacts of the fact that the Base also plans to provide new, direct support for another 106 employees to expand what is now called the West Civilian Personnel Operations Center (WCPOC). (Ft. Huachuca 2001) Based on CERL and US Census multipliers this will provide new, direct and indirect support for at least 437, and up to 460 local, deficit groundwater pumping, dependent people. Approximately, half of WCPOC's new employees will be recruited to move to Sierra Vista. The Base claims that all other new employees will be hired locally; however, decisions to hire locally in an economy with very low unemployment inevitably means that new employees ultimately have to relocate to the region to fill vacant jobs.

The original projection of 106 employees was scaled back to 80 with much of this hiring not occurring until FY 2002, and therefore is not reflected in either the 2000 or 2001 impact statements. Based on information provided by Fort Huachuca, as of the end of May 2002 approximately 72 of the projected 80 employees have been hired. Estimates indicate that approximately one-third of these hires were already employed on the Fort, one-third were local hires, and one-third were relocated to the area. That being the case, the impact on the local area would be approximately 86 additional residents considering employees and family members (61) plus induced jobs and related family members (25). The hiring of these additional employees will be reflected in the Fort's 2002 Annual Economic Impact Statement. Any previous hiring related to the West Civilian Personnel Operations Center (WCPOC) has already been included in the 2000 and 2001 workforce as noted in the impact statement for those years. In other words, hiring activity in the WCPOC and for that matter other Fort related missions is not exclusive to, but rather inclusive, in the annual impact statements. In some of the claims brought forth against the Fort, it would appear as though activity such as this is in addition to the overall impact statements issued by Fort Huachuca.

The EA/FONSI fails to include and evaluate the cumulative impacts of the fact that Ft. Huachuca plans to transfer land to the City of Sierra Vista resulting in new support for an additional 757 jobs by 2005. The NEPA documentation to date fails to accurately disclose the full effects of providing new support for these 757 jobs. (Coffman Associates 2001a)(Coffman Associates 2001b) In addition, in spite of a very low unemployment rate, the NEPA documentation to date inappropriately assumes that 56% of new employees will be hired from within the local community. (Coffman Associates 2001a)(Coffman Associates 2001b) This again ignores the fact that low unemployment rates will result in new people moving into the area to fill any vacated jobs.

Since the US Department of the Army Fort Huachuca withdrew the offer of 203 acres to the City of Sierra Vista in late April 2002, the above mentioned is no longer a relevant issue as it pertains to the environmental and economic impact for Fort Huachuca.

While exaggerating protection for the San Pedro River from the wastewater recharge projects on post and in the City of Sierra Vista, the EA/FONSI fails to acknowledge and evaluate with a cumulative effects analysis that the Census 2000 data demonstrates that highest growth rates are in areas not protected as assumed in the Biological Opinion. This growth is supported in large part by Ft. Huachuca's contracts and support work. Recent Census 2000 data presented by Cochise County proves that the highest rates of growth are not found in areas mitigated by the wastewater treatment plants. Growth immediately north of the City of Sierra Vista has grown by 18% from 1990 to 2000. (Cochise County 2001) Growth immediately southeast of the City of Sierra Vista has grown by 58.4% from 1990 to 2000. Id. Growth in the Palominas area has grown by 78.4% from 1990 to 2000. Id. No significant protection and/or mitigation for the San Pedro River have been provided for in any of these areas of high growth. Id.

While it is true that the areas with strongest growth during the past decade are in the unincorporated areas outside Sierra Vista, it can be argued that, according to Dr. Silver, "this growth is supported in large part by Fort Huachuca's contracts and support work."

During the period 1990 through 2000 the workforce on Fort Huachuca, as reported in the "Annual Economic Impact Statements," show the workforce declining by 6.1% (1990 equals 12,119 and 2000 equals 11,375). During this same ten-year period the population of Sierra Vista increased by 14.5% (1990 equals 32,983 and 2000 equals 37,775), while the population of Cochise County increased by 20.4% (1990 equals 97,800 and 2000 equals 117,755) (Sierra Vista Economic Focus 2001-2002) As Dr. Silver mentions, the population to the south and east of incorporated Sierra Vista was increasing much faster. In some cases census figures show the population in the Palominas and Hereford area to be growing at rates greater than those cited by Dr. Silver.

The point in referencing the above figures is to show that activity on Fort Huachuca is not directly correlated to population changes in the Sierra Vista subwatershed area. If this was indeed the case, the population figures for the city and the surrounding areas should have also shown a decline between 1990 and 2000. Since population counts indicate no direct correlation between the Forts workforce and the surrounding area, the argument that "this growth is supported in large part by Fort Huachuca's contracts and support work," (Letter from Center for Biological Diversity to the Commander, US Army Garrison February 23, 2002) cannot be supported.

Therefore since there is no correlation between workforce changes on the Fort and population changes in the watershed area, Fort Huachuca cannot be held accountable for the growth occurring in areas in and around Sierra Vista as claimed. Rather the Fort's responsibility is related to the direct impact of its workforce and the induced impact on the watershed area. It is obvious that there are other factors driving growth such as climate, the areas natural beauty, and other job opportunities. At present Cochise County is addressing mitigation issues as they relate to these unincorporated areas.

CONCLUDING COMMENTS

The following are comments and observations based on the writings of Dr. Robin Silver, of the Center for Biological Diversity. This is an attempt to summarize some of the specific comments made in rebuttal to the addressed comments in the preceding pages and also includes a number of general comments or observations noted while preparing the above materials. In some cases these comments may better serve to address the overall charges brought by the Center for Biological Diversity. It is hoped that the following serves to bring together in a summary form many of the overriding points made in the preceding action.

1. The Fort appears to use an effective method for accounting for measuring households directly related to the workforce and for accounting for retired military and survivors. The methodology is derived from the 1999 Fort Huachuca Demographic Survey with an overall sample size of 1,004 persons with this number weighted by the percent each classification within the workforce represents (military 522, government civilians 241 and support personnel 241 persons in the survey). The total number of responses was 552, a total response which is large enough to give at least a 95% confidence level based on the original workforce population. The Center for Economic Research uses a similar methodology in many of its surveys across the county.

Without such a methodology there would be no accurate way for measuring the double counting that takes place within the overall workforce. The double counting results from more than one family member in the Forts workforce and then assuming each employee is representative of a household, in other words, without the use of the above methodology a total number of households represented from direct employment from the Fort is significantly overstated. Also, a great deal of double counting would occur in measuring the Forts workforce and the number of retired military households since a large percentage of retired military in the area are employed as contractors and government civilians on the post.
The Forts use of an induced multiplier of 1.684 tends to overstate the induced employment impact. That is, the induced employment resulting from the Forts workforce reflects a larger impact of employment in the community than most likely is the case. Based on discussions with a University of Arizona professor, well versed in the use of multipliers, and having previously determined multipliers for several employment sectors within Cochise County, my recommendation is to apply a multiplier of 1.332288 for members of the military and 1.383932 for the Forts government civilians and contractors.

The Forts assumptions on households represented by the overall workforce and the induced multiplier appears to be fair. While the multiplier is overstated the result of that is an overstatement by Fort Huachuca as to the impact its workforce has on the community. In other words, if the Fort is in error it is on the side of overstating the impact on the community rather than understating the impact.

As mentioned above, the recommended multipliers are county multipliers. There are no known multipliers established for the city of Sierra Vista, typically the smaller an area is in population the smaller the multiplier will be, however much of the population base and employment base for Cochise County is in the Sierra Vista area. I would expect a city multiplier to be only minutely

smaller than the county multiplier. For example, a state multiplier would be larger than a county multiplier, which would be larger than a city multiplier. As the area increases in size and population, more impact is captured and therefore the multiplier increases.

2. Dr. Silver selectively addresses data as it relates to Fort Huachuca by choosing the specific years most favorable to his arguments. Specifically this relates to both the inquires on the charges of personnel on the Fort from 1998 to 2000 and an increase of spending during FY 1999. In both cases, when observed over a number of years the one or two-year change deviates very little from the nine or ten-year averages examined. For example, the increase of personnel between 1998 and 2000 presents an increase of only 1.8% above the ten-year average for the years 1991 to 2000. When these numbers are looked at in detail, most of the increase appears to be in student population with a decrease occurring in military and civilian population. The net effect of this change is actually a decline in overall impact when family size is considered. Concerning the allegation of Fort Huachuca increasing spending during the one-year period of 1998 to 1999, it is noted that spending during that period is only 2.65% above the nine-year average for spending (1992 to 2000) by the Fort in the Sierra Vista/Cochise County area. When annual spending is calculated using year 2000 current dollars (adjusted for inflation), the 1999 spending figure is actually 7.1% below the nine-year average. The year selected as the base year for his argument was well below the nine-year average for spending.

3. The statements made of a significant increase in spending by Fort Huachuca between the years 1998 and 1999 includes some double counting by Dr. Silver. Included within the spending is dollars for contracts. This issue is covered previously in personnel and employees and their families. The issue of personnel and the induced impact can be measured either from the side of employees or from the side of spending. As presented in the statements, this appears to be two separate arguments and two separate issues. In reality the spending patterns are dollars spent on contracts. Since personnel have already been counted in the population counts for Fort Huachuca and goods and services have partially been covered by the computation for induced employment, there is no need to re-present the argument from the spending side.

4. There appears to be an overall acceptance by both Dr. Silver and the Center for Biological Diversity and the US Department of the Army, that the AEPI's multiplier of 1.684 can be used when discussing water use. That multiplier was developed for use as a spending multiplier and a jobs multiplier. While correct use of the multiplier allows the Fort to measure the amount of induced employment in the area resulting from activities on Fort Huachuca, it is a gross over simplification to assume that this same multiplier, 1.684, can also be used in measuring increased water usage resulting from the induced employment by the Fort. Perhaps this assumption rests on the belief that the induced employment is always new to the area, but that is not necessarily the case. The induced employees or induced employee hours added by the multiplier can occur without any addition to a population to an area. This can occur in a number of ways including additional working hours for current employees in the community, employees taking on a second job, increased employee efficiency possibly resulting from economies of scale, and the creation of competitive wages such that persons not previously in the labor force but living in the area now enter the labor force due to higher and more competitive wages. Also, the assumption of increased water usage resulting from the induced employment fails to consider that spouses and

siblings of the Forts workforce may be employed in these so called induced jobs in the community. Without consideration for this possibility double counting occurs.

As an example, an increase of 100 employees on Fort Huachuca may not necessitate the additional hiring of bank tellers or store cashiers but may reduce the down time or idle time between customers. Eventually with enough new employees added to a workforce the induced employment impact will result in more hours for current employees or the hiring of additional employees in the community. Similar results were found to be true when AEGIS Communications, a large telecommunications company, that moved to Sierra Vista in the late 1990s. (Appendix A). The idea of equated employees is similar to what happens in colleges with the use of full-time student equivalents or FTSE. As an example consider the following. A college has 400 students taking three credit hours each. This equates to 1200 credit hours or 100 FTSE (1200 credit hours/12 credit hours per full-time student). The college does a good job of marketing and finds that it has a total of 2400 credit hours, twice as many credit hours as during the previous term. The college now has 200 FTSE, this figure has now gone from 100 to 200 students. Yet it is quite possible that the college has not seen an increase in enrollment, merely each of the original 400 part-time students is now taking six credit hours per person creating no actual increase in students. The same charge could be made of the college, that the college has doubled its credit hours and assumed enrollment thereby increasing the demand for water use from 100 to 200 students. Yet as noted above, there was no increase in total students and common sense tells us that water use does not increase when a student takes an additional class. The same can be said in a community of part-time persons employed 20 hours per week who move to 30 hours, or spouses of employed persons living in the community who decide to enter the labor force. By accepting the position the assumption does not hold that water usage increases. The argument is correct in claiming that induced employment results from each new employee on the Fort. However, the argument breaks down when carried beyond that point to a relationship with water usage.

Often times in measuring economic impacts, there is difficulty in quantifying social costs and social benefits. In many cases these impacts cannot be measured and appear only as a footnote or a general comment in the overall impact statement. Whenever possible a next best scenario is used to put some type of quantification to these costs and benefits which are difficult to measure. In the case of Fort Huachuca's attempt to measure the impact it has on water use, the application of the induced multiplier is the best means for approximating the impact induced employment has on overall water consumption. The result of using the multiplier (1.332288 and 1.383932) likely results in an overstatement in impact on water use as the same problem with double counting that faced the Forts workforce also occurs (two or more Fort related employees in the same household). An example of this is one household having a Fort employee and an employee holding an induced job or a household having two or more persons holding induced jobs, each of these households would result in double counting and thus an overstatement of water use. The problem is the multiplier assumes each induced employee to be from a separate household. Also, it is quite possible that members of the Forts workforce might hold second jobs that could be claimed as induced jobs resulting from the Forts workforce. The effect of this again is an overstatement of induced households. Keeping all of this in mind the application of the multipliers appears to be the best approach since if an inaccuracy results it is in overstating rather than understating the induced household impact.

5. As a follow up to point four above, current discussion of induced employment appears to overstate the impact Fort Huachuca has on water usage off of the Fort. While induced employment can be measured and is effective as a means of determining the importance of the Fort in the area, the correlation of induced employment with water usage is incorrect. The current application of the connection of induced employment and water usage seems to be a worst case scenario. While water usage can be measured based on direct employment on Fort Huachuca and the impact of military, civilian and contractor families, it is a gross overestimation of the problem to infer a direct correlation of new employment from the multiplier. The multiplier measuring induced employment does not equate with new employment. As an example, to imply that the addition of 10 new military or civilians results in 4.0 new jobs and thus new hires within the community in support of those 10 military positions is a oversimplification of the problem. Whereas these 4.0 equated jobs equals 160 additional hours of employment needed in the community to support these additional positions on Fort Huachuca, there are a number of ways that this 4.0 equated-employed persons can be addressed in the community. For example, 160 hours could be added to 160 part-time employees by adding one hour per week to each employee or as stated above in an earlier argument, no additional hours may be needed. Instead the result is less slack time or down time for employees (the induced jobs were based on a multiplier of 1.383932).

Also, economies of scale may enter into the picture in that once a business clientele reaches a certain size, it may become efficient and effective for that business to increase automation thus reducing the amount of per person time an employee spends with each customer. An example of this is the electronic scanning machines used at checkouts as opposed to ringing each item into a cash register.

6. There is an underiding assumption that any retired military living in the area has chosen to locate here because of services available to them on Fort Huachuca. For many retired military and military survivors this may be the case, however it is also worth noting that military retirees are located all across the country and in many cases are located far away from any military installation. Besides the location of the Fort, there are a number of reasons why retired military and military survivors may select the area. Included among them are other family members located in the area, post military job opportunities (not necessarily military related), climate, and the overall size of the community, not to mention others. Therefore to assume all retired military and survivors located in the area are here because of the Fort serves to overstate the responsibility of Fort Huachuca. Based on the above comments it is my opinion that Fort Huachuca should not be held accountable for retirees living in the area other than those employed as contractors and government civilian employees. These retirees are already counted for in the overall workforce for the Fort. Retirees not employed as part of the Forts workforce are not bound to this area for their pensions as would a current employee be bound to this area because of the location of his or her employment. Therefore the Fort cannot be held responsible or accountable for water usage by retired military and survivor households.

7. There is also the implication or assumption that growth in the Sierra Vista area and the San Pedro Basin is directly correlated with activity and growth on Fort Huachuca. It should be no surprise that there are many other factors that are effecting growth in the area and the Fort is just one of many. For example in 1990 the Forts workforce population was 12,119 whereas in 2000,

the Forts workforce population was listed as 11,375 according to the Fort Huachuca "Annual Economic Impact Statement 2000." During that ten-year period population or employment on Fort Huachuca fell by 6.1%. During the same period of time, population in Sierra Vista expanded from 32,983 (1990 census population) to the census population of 37,775. If Fort Huachuca was the main contributor to growth for the Sierra Vista area during that decade, either directly or induced, population in the Sierra Vista area should have declined by an equivalent percent. This was not the case, and to attribute recent population increases in the Sierra Vista subwatershed area to Fort Huachuca is an oversimplification of the issue. All one has to do is look at the population growth in the state of Arizona over the past ten years. It is obvious there is something much greater than Fort Huachuca driving growth in the state and the local area. Based on Census 2000 data, there are 12 other cities in the state that are growing at a rate faster than Sierra Vista. Fort Huachuca cannot be held responsible for overall population growth in the Sierra Vista subwatershed area beyond household population totals calculated for direct and induced employment.

8. It is true that low unemployment rates may necessitate a need for recruiting additional employees outside the immediate area. However, a tight labor market resulting from low unemployment can also generate interest by persons residing locally, but not currently in the labor force, to enter the labor force. Typically with low unemployment comes increased competition for a limited number of potential employees, as such, wages tend to move upward. This upward movement of wages entices persons not in the labor force to now secure employment since wages have moved to a level that is more appealing to these people. Also, increased job opportunities will lure students away from education and into the labor force. This behavior was experienced with the locating of AEGIS Communications to the area (Appendix A).

BIBLIOGRAPHY

Charney, Alberta, and Taylor, Carol. "Multiplier Analysis of Arizona and its Substate Areas." Arizona Review. College of Business and Public Administration. University of Arizona: Tucson. Fall 1985.

Chart of Cochise County Multipliers (unpublished working copy) College of Business and Public Administration. University of Arizona: Tucson.

Cochise College Center for Economic Research. Sierra Vista Economic Focus. Cochise College: Sierra Vista. 2002.

Directorate of Resource Management. Annual Economic Impact Statement: 1989-1990, 1992-2000. USAIC&FH: Fort Huachuca. 1990-1991, 1993-2001.

Directorate of Resource Management. Annual Economic Impact Statement: Fiscal Year 2001 (Draft). USAIC&FH: Fort Huachuca. 2002.

Jones, Ken. "Aegis has big impact on county economy." Sierra Vista Herald. 20 Jun. 1999.

Palominas Public School District. Telephone Interview. 30 May 2002.

Science Applications International Corporation. 1999 Fort Huachuca Demographic Survey. Phoenix. 1999.

Sierra Vista Public Schools. Telephone Interview. 29 May 2002.

Appendix A

Ken Jones

Center for Economic Research
901 N. Colombo Ave.
Sierra Vista, AZ 85635
Phone: 520-515-5486
E-mail: cer@cochise.cc.az.us

For release: August 8, 2001

CER reveals real numbers on Aegis

Recently the Sierra Vista area and Aegis Communications, the largest private employer in Cochise County, came under attack by Robin Silver and the Southwest Center for Biological Diversity. Silver challenged American Express and Qwest Communications to relocate their Aegis call center contracts to other Aegis facilities because he and his organization believe that Aegis' employees are "contributing to the demise of the San Pedro River".

It has been the policy of the Cochise College Center for Economic Research (CER) to remain neutral or impartial on economic and political issues in the area. As a research center, the CER's purpose is to provide the most accurate and unbiased information possible. It is for this reason that the CER feels compelled to correct some of the inaccurate economic impact figures released by Dr. Silver and to reiterate some information from an original CER research report, released June 20, 1999, on the economic impact of Aegis on the community.

First, Dr. Silver states that 800 new positions were created by Aegis locating in Sierra Vista and implies that 800 workers moved to the area as a result. Original research by the Center for Economic Research found that most of the original employees hired by Aegis Communications were already residing in the immediate area. In fact, 94.1% of employees hired by Aegis resided in the area between Huachuca City and Hereford. This information was calculated by the CER using the training registration forms completed by the new Aegis employees. Also, Aegis did not originally hire 800 employees, but grew to that number by fall of 2000.

As further evidence of Aegis hiring local people, the June 1999 press release by the CER stated that the hiring resulted in a local area labor shortage. The Center also found that two-thirds of the new Aegis employees were already employed in the area before starting at Aegis and one-third of those hired were unemployed prior to beginning work at Aegis. The Center surveyed local employers through the Chamber of Commerce and noted that, after the initial Aegis hiring, 36% of local employers had to raise wages in order to attract employees to replace those who left after being hired by Aegis. In addition, 26% of employers in our survey indicated they had to raise wages after the opening of Aegis in order to keep their current employees from leaving.

The Center for Economic Research received a copy of Dr. Silver's letter to American Express and Qwest Communications and reviewed it for accuracy. In that letter Dr. Silver incorrectly uses an economic jobs multiplier, the result of which is a double counting of some employees. In addition, Dr. Silver incorrectly applies a family multiplier which double counts one person in each household. His multiplier (resulting in 3.3 persons per household) is well above the 2.48 average household size for Sierra Vista according to Census 2000.

The overall result of Aegis Communications moving into the area is that the labor force in the area expanded, but not necessarily the population. You might ask how that could be. It stems from a basic economic principle of marginal cost and marginal benefit. While some people will not enter the labor force and choose to work at $5.15 per hour they may see it worth their while to seek employment if they could work at a position paying $7.00 an hour. In other words, the marginal benefit of $7.00 per hour exceeds the marginal cost of giving up leisure time, schooling, or volunteer work. Those same individuals may not have done so at $5.15 an hour, because they value their leisure time, schooling, or volunteer work (even though unemployed) more than earning $5.15 an hour. For some, the marginal cost is greater than the marginal benefit of working. Or for some, the marginal cost may be that of their children's day care and not of leisure time. The cost of day care may be such that at $5.15 an hour, the net earning per hour may be too low to attract a parent to enter the labor force.

If this is not enough, further proof of the lack of substance of Silver's charge of massive influx of new workers and their families can be seen in the local school enrollments. In January 1999, prior to Aegis opening in Sierra Vista, Sierra Vista Public Schools district enrollment was listed at 6,812 students. In October 2000, after Aegis had been established in Sierra Vista, public school enrollment increased to 6,825, an increase of only 13 students, well below the hundreds that Dr. Silver claims would impact the local area from the 800 jobs.

Aegis is responsible for one increasing number, local area income. As of fall 2000, the Center for Economic Research's Top 50 Cochise County Employers survey listed Aegis as having a payroll of $12 million. That $12 million translates into area sales which pay wages to others and local tax dollars that are converted to improved city and county services.

Who is impacted by this misleading information released by the Southwest Center for Biological Diversity? You -- the citizen of the local area. By encouraging businesses to leave the area, your livelihood is threatened as well as that of your neighbor's, and your quality of life in the form of decreased governmental services.

Based on information dated June 1999, and observing data as of today, the only real accusation that Aegis Communications can be charged with is improving the quality of life for residents of Sierra Vista and the Cochise County area. You can contact the Center for Economic Research at 515-5486 or e-mail: cer@cochise.cc.az.us.

####

Appendix B

Appendix C

COMPUTATION OF FORT HUACHUCA'S OFF POST RESPONSIBILITY IN THE SIERRA VISTA SUBWATERSHED

In measuring the impact of the Forth Huachuca workforce on the Sierra Vista subwatershed, that is determining the population living off of the Fort for which Fort Huachuca is responsible for in regards to water use, involves several calculations. First a determination must be made as to the percent of the overall civilian population living in the Sierra Vista subwatershed area that is employed. For this determination the population of Huachuca City, Sierra Vista, and the area to the South and East of Sierra Vista, known as Sierra Vista Southeast, was determined. Since military personnel are not included in figures on civilian employment, military members were subtracted out of the overall population of this area only for purposes of determining the percentage or ratio of civilian employees to the total civilian population living in the area. Next the total persons (civilian) employed in the subwatershed area, was obtained by using Census 2000 information. This figure was then divided by the total civilian population of the area. Total population for SV, SVSE, and Huachuca City:

665 (Huachuca City total employed)
13,739 (SV total employed)
6,438 (SVSE total employed)
20,842 (total civilians employed)

1,751 (Huachuca City total population)
- 26 (minus military in Huachuca City)
1,725

37,775 (SV total population)
-4,958 (minus military in SV)
32,817

14,348 (SVSE total population)
- 202 (minus military in SVSE)
14,146

= 48,688 (total civilian population)

20,842/48,688 = 42.8% (percent of civilian population employed)

Results show that 42.8% of the civilian population hold a job. This then will be used to project on the population of spouses and family members of military, government civilian, and contractor employees to estimate the number of jobs these spouses and siblings hold in the community. Second it was necessary to compute household size for the Sierra Vista subwatershed area in order to determine the impact of induced jobholders. That is to measure the number of induced jobholders and family members of these persons for which the Fort is

determined to be responsible for. A weighted average of family sizes for communities in the subwatershed area was used to calculate the overall family size multiplier of 2.52. Again Census 2000 information was used to determine this multiplier. Third, a determination had to be made as to the size of the Fort Huachuca workforce and, thus, the number of induced jobs resulting. The total count of enlisted military, based on the 2001 Fort Huachuca Annual Impact Statement (Draft) was multiplied by the multiplier of .332288 for military personnel in Cochise County. 95% of students on the Fort were subtracted out prior to the application of the multiplier since the student population resides on Fort Huachuca and these students are without personal vehicles. Students are, for the most part, totally reliant on the Fort for consumption purchases and have very little reason to create demand in the community. The other 5% of the student population was found to be officers attending school on the post and allowed to live off post with their families.

Next the number of contractors and government civilians was totaled, again based on figures from the 2001 Fort Huachuca Annual Impact Statement (Draft) for Fort Huachuca and a multiplier of .383932 was applied to measure induced jobs created in the community as a result of this workforce. Then, both of these totals were multiplied by 96.8% since this was found to be the percent of the workforce living in the Sierra Vista subwatershed area. A total of 3,536 induced jobs were determined to result from the Fort's workforce of military, government civilian, and contractor populations.

4,199 * .332288 * .968 = 1,351
5,879 * .383932 * .968 = 2,185

Total induced jobs = 3,536

An effort was then made to determine the population of spouses and siblings of the Fort Huachuca workforce believed to hold civilian jobs in the community. The population of siblings and spouses totaled 11,052 before an adjustment was made for families not living in the Sierra Vista subwatershed area (3.2%). It was assumed that this population held jobs in the same percentage as did the overall civilian population for the Sierra Vista subwatershed. That is 42.8% of the overall population of spouses and siblings were believed to hold jobs in the Subwatershed area. Since 3.2% of the Fort's workforce live outside the subwatershed area, 3.2% of the sibling and spouse population was also assumed to be outside of the subwatershed area. A total of 4,579 spouses and siblings hold civilian jobs in the subwatershed area:

11,052 * .968 * .428 = 4,579 (Family members employed)

Next it was necessary to determine the percent of spouses and siblings employed in sales and services (the two areas most frequently associated with induced jobs). Using Census information for the population within the subwatershed area, it was calculated that 48% of civilian jobs are in either sales or services. This percentage was then applied to the employed population of siblings and spouses to arrive at 2,198 employed in sales or services in the community.

9,994/20,842 = 48% (Percent of civilian jobs in sales and services)
4,579 *.48 = 2,198 (siblings and spouses employed in sales or services in the community)

Then a determination was made as to the actual number of induced jobs for which Fort Huachuca is responsible. That is the total number of induced jobs determined earlier to be 3,536 was then reduced by the 2,198 spouses and siblings holding sales or services job to arrive at a net of 1,338 induced jobs. Applying the family multiplier determined by the weighted average of household sizes in the subwatershed area, the net induced jobs and associated family members of these persons totaled 3,372. Finally a calculation was made of the overall population living off the Fort accountable to Fort Huachuca. This population includes the Forth Huachuca workforce living off the post and their family members along with persons holding induced jobs and their family members. The total number of persons living off post for which Fort Huachuca is responsible for is 18,036.

1884 (Military off post population)
1895 (Military family members off post)
3447 (Contractors)
3447 (Contractor family members)
2432 (Government Civilians)
1559 (Government civilian family members)
3372 (net induced jobs and family members)
18,036 (total off post population associated with Fort Huachuca)

If one insists that retirees and survivors must be included as a responsibility of the Fort, then the overall number that Fort Huachuca is responsible for is 20,015.

Appendix D

ABOUT THE CENTER FOR ECONOMIC RESEARCH

CENTER FOR ECONOMIC RESEARCH

Since its inception in the spring of 1995, the Cochise College Center for Economic Research (CER) has served the communities of Cochise County by providing economic data, analysis, and forecasts. The CER provides annual economic forecast luncheons and publications for Sierra Vista, Douglas, and most recently, Benson. The CER maintains a strong presence in these cities throughout the year by means of contracted projects, special studies, newspaper interviews, weekly press releases, and a quarterly newsletter reviewing Cochise County's economy.

MISSION STATEMENT

The Center for Economic Research is dedicated to providing, collecting, and interpreting economic data for communities within Cochise County, to forecasting on the business climate, and to educating the community served by Cochise College about the economy.

ECONOMIC FORUMS

The idea for the Center for Economic Research started with the development of a Sierra Vista economic forum. After attending economic forums for the Tucson/Pima County area and recognizing that the economic indicators of Cochise County were often included with those of Santa Cruz County, Ken Jones proposed the idea of holding an economic forum for the Sierra Vista area. The purpose of the forum would be to provide a consolidated view of local economic indicators and to provide a forecast for the coming year.

Local community leaders were called together to determine the interest for a forum and the types of information to be included. This group became the advisory board for the forum. Board members conceded to hold the forum as quickly as possible. The first Sierra Vista forum was brought together in five weeks including data collection, brochure writing, publication, and presentation.

The forum sparked enormous interest in the local economy and the phone literally kept ringing from the forum date in April to the end of school in May. As a result Ken Jones and his staff of student workers volunteered their time that summer to handle the incoming data and analysis requests. In August 1995, Dr. Walter Patton, then college president, officially recognized the Center for Economic Research, approved the title of Director for Ken Jones, and granted him six hours of release time from his faculty duties to direct the activities of the CER. In the fall of 1998, college President Karen Nicodemus and the college Governing Board approved two full time positions for the CER: Director and an Information Specialist.

The Sierra Vista Economic Forum has become an annual event which attracts around 180 attendees each year. In 1996, the Center for Economic Research expanded its services into the community of Douglas. The first Douglas Economic Forum attracted 160 attendees. In 1997, the

Douglas Economic Forum was moved to a larger location to accommodate nearly 180 attendees. In 1997, the community of Benson invited the CER to provide similar services in their community. The first Benson Economic Forum, which had approximately 140 attendees, was held on May 28, 1998. Each community has its own advisory board.

In the spring of 1998, the Center for Economic Research hosted a one-day conference for economic development leaders from the cities and towns across the county in an effort to coordinate economic development and planning on the county level. The Strategic Planning for Effective Economic Development (SPEED) conference was coordinated by the Center for Economic Research, facilitated by the University of Arizona Center for the Management of Information, and included a luncheon with Congressman Jim Kolbe as the keynote speaker.

STATE DATA CENTER

In February 1996 the Center for Economic Research was recognized by the Arizona Department of Economic Security as a State Data Center/Business and Industry Data Center affiliate. That designation means the CER is able to provide up-to-date information on forecasts in population trends, demographics, and census information to interested businesses and the general public. In addition to information provided through the state data center, the CER maintains its own collection of data and analysis services. The CER currently collects county-wide statistics on employment and unemployment, job trends, median and average prices of homes sold, number of housing units sold and active, days on the market for housing units sold, county and local retail sales, taxable sales, and commercial construction. The CER also tracks its own indicators, including price indexes for various baskets of goods.

DATA DISSEMINATION

During a typical week the Center for Economic Research answers several calls from local businesses, governments, and media needing data and information relevant to their current projects. Many of these data-users have been referred to the CER by other county agencies or organizations. Chambers of commerce, Cochise County, the Department of Economic Security, and real estate associations all refer calls to the CER concerning data analysis and interpretation. Since the CER is reputed to provide accurate, unbiased information, the CER also receives a large number of calls from prospective businesses outside the Cochise County area and developers in the Tucson/Phoenix area. In the year 2000, the CER began publishing a quarterly newsletter containing local economic information and indicators.

PUBLIC EDUCATION

Another involvement of the Center for Economic Research is public education relevant to the area's local economy. Articles on the local economy appear in the Sierra Vista Herald/Bisbee Review, Douglas Daily Dispatch, Range News, and San Pedro Valley News-Sun and the Tombstone Tumbleweed. Press releases appear in other weekly publications and are aired on local radio news broadcasts. The CER is asked to comment on breaking news stories as to the implications on the local economy on a weekly basis. The CER has also been contacted by reporters from newspapers around the state, the Associated Press, and Los Angeles Times.

In addition to providing information to the public, the Center for Economic Research also offers students educational opportunities in economics. A program of four classes is available for use in county high school classes on topics ranging from the basics of economics to interpreting local economic data. At Cochise College, the activities of the CER are incorporated into business and economic classes. Further, the CER hires competent business and computer information students to work on CER activities. This opportunity offers students experience in their field of study and exposure to the business community.

CONSULTING AND CONTRACTING

In its efforts to generate operating revenues, the Center for Economic Research has taken on consulting duties. Contracted projects range from fee-for-service consulting to economic impact studies to survey development and presentation. For example, the CER completed an $11,000 contract with the City of Sierra Vista to survey 1,400 residents and businesses on the West Side of Sierra Vista, to facilitate three town-hall style meetings, and to present findings to the Downtown Neighborhood Commission. The findings were used to develop a strategic plan for that part of the City. Projects by the Center for Economic Research have ranged from retail and tourism to cross border traffic and shopping patterns. For additional information, contact the Cochise College Center for Economic Research by phone at 520-515-5486 or fax 520-515-5464 or by e-mail at: cer@cochise.cc.az.us.

These are among the businesses and organizations the CER has contracted with:

-Airport Commission, city of Sierra Vista

-Arts and Humanities Commission, city of Sierra Vista

-Castle and Cooke

-City of Benson

-City of Douglas

-City of Sierra Vista

-Cochise County

-Fort Huachuca fifty

-Our Lady of the Mountain Catholic Church

-Parks and Leisure, city of Sierra Vista

-SSVEC

-SV Herald

-Udahl Center, Tucson, AZ

Appendix E

KEN'S BIOGRAPHY

Ken earned a Bachelor of Arts degree in Business Administration from Mount Saint Clare College in Iowa and a M.B.A from the University of Arizona. He has completed Doctoral work in Higher Education Finance. He has completed fellowships through the University of California, University of North Texas, and the University of Arizona. During the summer of 1997, he studied at the University of Arizona's Experimental Economics Lab on a fellowship. In 1991 he began conducting economic impact studies. He founded the Cochise College Center for Economic Research in the spring of 1995. Since then he has received a National Institute of Staff and Organizational Development (NISOD) Award for his work with the Center and in the classroom. He has also been recognized by Who's Who Among College and University Instructors. In November 2001, the Sierra Vista Economic Development Foundation presented him with an award for his contribution to area economic development.

His articles dealing with the economy in Cochise County appear in newspapers and on radio countywide. He has been interviewed for articles on the economy by such sources as the Associated Press and the L.A Times. He has gained recognition throughout the state with political and community leaders for his research. Today, although totally blind, he continues his work as director of the Center for Economic Research.

KENLEY E. JONES

Office: Cochise College • 901 North Colombo Avenue • Sierra Vista, AZ 85635 • 520-515-5486
Home: PO Box 1433 • Sierra Vista, AZ 85650 • 520-803-9140 • joneske@cochise.edu

PROFESSIONAL EXPERIENCE

1995-Present DIRECTOR, CENTER FOR ECONOMIC RESEARCH
Cochise College, Sierra Vista, Arizona
Founded the Center for Economic Research, which serves the county with economic studies and analysis. Developed annual forecasts for the economies of Sierra Vista, Douglas, Benson, Bisbee and Cochise County. Developed and administered economic and public opinion surveys. Designed economic impact studies. Prepared weekly news column for local print media.

1992-1998 BUSINESS INSTRUCTOR
Cochise College, Sierra Vista, Arizona
District department head for business and vocational studies since 1996. Initiated major curriculum changes in middle management program. Served on several college committees. Developed an international business program. Taught business classes and served as an academic advisor for business students. Coordinated campus-wide health fair and community voter Awareness program.

1994-1998 BUSINESS INSTRUCTOR
University of Arizona, Sierra Vista, Arizona
Taught FIN 311—Corporate Finance, MAP 305—Organization and Behavior Management, MAP 376—Statistical Inference in Management, and ECON 330—Macroeconomic Institutions and Policy for the business program.

1991-1992 COORDINATOR OF GRADUATE STUDENT PREPARATION PROGRAM
University of Arizona, Tucson, Arizona
Administered the Graduate Student Preparation Program. Worked with faculty and students in all phases of the program which addressed the academic risks many students face in undertaking the MBA program. Administrative duties included budget preparation, class scheduling, preparing student profiles, and securing program facilities and materials.

1991-1992 RESEARCH ASSOCIATE, STUDENT AFFAIRS
University of Arizona, Tucson, Arizona
Conducted student affairs research and statistical analysis as requested by Dr. Christine Phelps.

1989-1991 ENROLLMENT MANAGEMENT INTERNSHIP
University of Arizona, Tucson, Arizona

Worked with Dr. Dudley Woodard on enrollment & minority retention issues. Developed enrollment models and reports for the vice-president and the Board of Regents on enrollment forecasting and retention issues.

1986-1992 ACCOUNTING INSTRUCTOR

University of Arizona, Tucson, Arizona 1986-89, 1991-1992
University of North Texas, Denton, TX 1989-90
Taught financial accounting to undergraduates and graduate students. Initiated an accounting tutoring program.

1984-1986 ACADEMIC ADVISOR

University of Arizona, Tucson, Arizona
Advised undergraduates on program requirements, advanced standing applications, degree checks, and other curriculum matters.

1983-1984 DEVELOPMENT OFFICER

Mount St. Clare College, Clinton, Iowa
Planned and conducted a solicitation program for new and past donors during which time the annual campaign gifts increased 50%.

1981-1983 STUDENT ACTIVITIES COORDINATOR/CONTINUING EDUCATION SPECIALIST

Clinton Community College, Clinton, Iowa
Served as an administrator of Community Education program for a two-county area and directed a staff of six local facilitators in the rural areas. Developed classes and community offering. Hired instructors for 600 classes annually. Developed college and community cultural arts programming. Responsible for all public and media relations related to these programs including writing and producing television programs. Managed all budgets for courses and programs. Scheduled all campus classrooms and facilities.

Advisor to Student Senate and director of all campus student organizations. Served as financial officer for all student activity funds. Provided direction to faculty advisors of student groups. Developed special campus programs such as Alcohol Awareness Week and Voter Awareness Day. Responsible for publicity of all student events. Implemented student leadership training programs. Attended national student activities conferences.

Courses Taught

Undergraduate Financial Accounting
Graduate Financial Accounting
Business Math
Survey of American Business
Microeconomics
Macroeconomics
Business Statistics
Corporate Finance
Organization and Behavior Management
Statistical Inference in Management
Macroeconomic Institutions and Policy
Economic Research and Forecasting

EDUCATION

In Progress	PH.D. DEGREE UNIVERSITY OF ARIZONA, TUCSON, ARIZONA Passed Exams (A.B.D.) Sept. 1991 Major: Higher Education Finance Minor: Student Services	
Dissertation Topic	Economic Implications from the Matriculation of Nonresident Students: A Case Study of the University of Arizona	
May 1988	MBA DEGREE GPA: 3.61/4.00	UNIVERSITY OF ARIZONA, TUCSON, ARIZONA
May 1981	BA DEGREE GPA: 3.83/4.00	MOUNT ST. CLARE COLLEGE, CLINTON, IOWA

PROFESSIONAL FELLOWSHIPS

1995-96	University of Arizona's Economic Science Laboratory
1995	Innovative Faculty Fellowship to develop the Center for Economic Research
1990	Doctoral Fellowship and $10,000 award University of Arizona, Tucson, AZ
1989	Doctoral Fellowship and $10,000 award University of California, Irvine, CA, $10,000
1989	Doctoral Fellowship and $10,000 award University of North Texas, Denton, TX, $10,000

CERTIFICATIONS

Permanent Teaching Certification, Arizona Community Colleges

PUBLICATIONS

July 1995-
Present — Weekly economic news column
Sierra Vista Herald and newspaper throughout Cochise County

Bishop, Sharon and Jones, Ken, "The Impact of September 11 on Cochise County," The Indicator. Douglas. Cochise College Press. Spring 2002, pp 6-11.

March 2002 — *01/02 Sierra Vista Economic Focus: A Review of 2001 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 2002*
Cochise College, Sierra Vista, Arizona

November 2001 — 00*/01 Douglas Perspective: An Overview of the Douglas Economy*
Cochise College, Sierra Vista, Arizona

June 2001 — *00/01 Benson Prospectus: An Economic Overview of Benson, Arizona and the San Pedro Valley*
Cochise College, Sierra Vista, Arizona

March 2001 — *00/01 Sierra Vista Economic Focus: A Review of 2000 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 2001*
Cochise College, Sierra Vista, Arizona

October 2000 — *99/00 Douglas Perspective: An Overview of the Douglas Economy*
Cochise College, Sierra Vista, Arizona

August 2000 — *99/00 Benson Prospectus: An Economic Overview of Benson, Arizona and the San Pedro Valley*
Cochise College, Sierra Vista, Arizona

February 2000 — *99/00 Sierra Vista Economic Focus: A Review of 1999 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 2000*
Cochise College, Sierra Vista, Arizona

October 1999 *98/99* — *Douglas Perspective: An Overview of the Douglas Economy*
Cochise College, Sierra Vista, Arizona

June 1999 *98/99 Benson Prospectus: An Economic Overview of Benson, Arizona and the San Pedro Valley*
Cochise College, Sierra Vista, Arizona

March 1999 *98/99 Sierra Vista Economic Focus: A Review of 1998 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 1999*
Cochise College, Sierra Vista, Arizona

October 1998 *97/98 Douglas Perspective: An Overview of the Douglas Economy*
Cochise College, Sierra Vista, Arizona

June 1998 *97/98 Benson Prospectus: An Economic Overview of Benson, Arizona and the San Pedro Valley*
Cochise College, Sierra Vista, Arizona

February 1998 *97/98 Sierra Vista Economic Focus: A Review of 1997 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 1998*
Cochise College, Sierra Vista, Arizona

October 1997 *96/97 Douglas Perspective: An Overview of the Douglas Economy*
Cochise College, Sierra Vista, Arizona

February 1997 *96/97 Sierra Vista Economic Focus: A Review of 1996 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 1997*
Cochise College, Sierra Vista, Arizona

October 1996 *95/96 Douglas Perspective: An Overview of the Douglas Economy*
Cochise College, Sierra Vista, Arizona

February 1996 *95/96 Sierra Vista Economic Focus: A Review of 1996 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 1996*
Cochise College, Sierra Vista, Arizona

April 1995 *94/95 Sierra Vista Economic Focus: A Review of 1996 Economic Indicators for Sierra Vista and a Perspective on the Economy of Sierra Vista for 1995*
Cochise College, Sierra Vista, Arizona

October 1993 "How Important is Education in the Job Search?"
Job Quest Employment and Career Guide, Vol. 1, No. 4

PRESENTATIONS

November 2001	Kiwanis Club, Sierra Vista. Presentation on local economic indicators.
November 2001	Keynoted border conference on impact of 9-11 on border communities-3 state conference Douglas, AZ
October 2001	SSVEC Board of Directors Report on Consumer Satisfaction Survey conducted by the CER, Rio Rico, AZ
June 2001	KTAN Radio, 1-hour talk show, spoke on Cochise County economic conditions
May 2001	Physical Geography class, Cochise College, Benson, AZ
December 2000	Sierra Vista City Council Work Session, Report on Performing Arts Theater Study.
March 1999	Presentation to city of Sierra Vista and Udahl Center, Report on Water Issues Survey
February 1999	"Morning with Valley," 1-hour talk show KTAN Radio
November 1998	U of A Tucson, Economic Business Research Program- The Economy of Cochise County.
September 1998	Sierra Vista Area Association of Realtors, Sierra Vista, Arizona Presentation on local housing market and economic indicators
September 1998	Women's Club
May 1998	League of Women Voters
November 1997	Business Technical Writing, Cochise College, Sierra Vista, Arizona Presentation on skill and techniques used in technical writing.
July 8, 1997	Managerial Communications Class, Wayland Baptist University, Sierra Vista, Arizona Presentation on research techniques, descriptive statistics, and quality visuals in short reports.
March 26, 1997	Buena High School, Sierra Vista, Arizona Presentation on local economic indicators.
October 1996	Economics Class, Cochise College, Sierra Vista, Arizona Presentation on measuring economic indicators.

October 1996	Douglas Rotary, Douglas, Arizona Presentation on local economic indicators.
October 1996	Douglas Chamber of Commerce, Douglas, Arizona Presentation on local economic indicators.
October 1996	Douglas Lions Club, Douglas, Arizona Presentation on local economic indicators.
September 1996	Sierra Vista Area Association of Realtors, Sierra Vista, Arizona Presentation on local housing market and economic indicators.
April 2, 1996	Buena High School, Sierra Vista, Arizona Presentation on capitalism and free enterprise, April 2, 1996.
March 27, 1996	Sociology Class, Cochise College, Sierra Vista, Arizona Presentation on North American Free Trade Agreement.
February 28, 1996	Economic Forum, Sierra Vista, Arizona Presented a review of and forecast for the Sierra Vista economy to business and government leaders.
February 1996	Technical Writing Class, Cochise College. Presentation on skills and techniques used in technical writing.
January 1996	Kiwanis Club, Sierra Vista. Presentation on local economic indicators.
April 26, 1995	Economic Forum, Sierra Vista, Arizona Presented a review of the health of the Sierra Vista economy to business and government leaders.
March 1994	Marketing Class, Cochise College Presentation on North American Free Trade Agreement.
Summer 1993	Enrollment Management Doctoral Seminar, The University of Arizona Taught several sessions for Dr. Woodard
Fall 1991	Enrollment Management Doctoral Seminar, The University of Arizona Presentation on computer models for enrollment management.

HONORS AND AWARDS

2001	Economic Development Foundations Award, Recognizing economic development in Sierra Vista
1998	National Institute for Staff and Organizational Development Award
1996	Who's Who Among America's Teachers
1994	Outstanding Local Chapter Advisor, Arizona State Phi Beta Lambda, Business Organization
1988	Beta Gamma Sigma, Honorary Fraternity for Business
1987-1990	Dean's List, University of Arizona, College of Business, for outstanding teaching based on student evaluations
1986	Scholarship, University of Arizona, MBA program
1983	Honorary Lifetime Member, Iowa Phi Beta Lambda
1981	Who's Who in American Colleges and Universities
1981	National Finalist Mr. Future Business Executive, Phi Beta Lambda National Conference, Chicago, IL
1981	First Place, Mr. Future Business Executive, Phi Beta Lambda State Conference, Iowa
1980	Wall Street Journal Student Leadership Award
1976	Alpha Tau Omega, honorary fraternity, Mount Saint Clare College
1976	Iowa Bar Association, American Citizenship Award

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX J
SIERRA VISTA SUBWATERSHED DATA

		Population*	Households*		Jobs**	Unemployed	Labor Force
Bisbee		6,090	3,316		2,831	155	2,986
Huachuca City		1,751	844		656	51	707
Naco		833	298	***	257	13	270
Sierra Vista		37,775	15,685		14,200	594	14794
SV SE		14,348	5,857		4537	195	4732
Tombstone		1,504	839		520	25	545
Whetstone		2,354	1,056		609	33	642
	Total	64,655	27,895		23,610	1,066	24,676
SV subwatershed - Population Supported per Job				2.73845828			
Induced Population			Induced Jobs				
		3,536	Induced Jobs Appendix I				
		946	Reduced for Fort FM in those jobs****				
7092.606946		2,590	Net Induced Jobs				
26,531		Fort Huachuca mil, civ, contractors, FM, retirees					
33623.60695		Total Direct, Indirect, Interrelated and Interdependent Population (2002)					
2675.119235	**ac-ft**	**Deficit Attributable to Fort Huachuca (2002)**					
		Using similar analysis for the increase in mission					
1369.22914			# Projected Population associated with Future Jobs at Fort Huachuca				
108.9368911	**ac-ft**	**Deficit for future jobs**					
2784.056126	**Total ac-ft Attributable to Fort Huachuca**						
*Data from 2000 US Bureau of Census (Census 2000)							
** Data from AZ DES - Average first five months of 2002 (does not include uniformed military personnel (DES 2000)							
*** Naco is not included in AZ DES - estimated as similar to Bisbee							
**** Detailed Calculation for this reduction is shown on page 2 of spreadsheet							

Fort Associated Family Member Labor Force	
4151	Mil FM on post
1895	Mil FM off post
2868	Govt Civ FM
3881	Contractor FM
998	Two Wage Earner FM
13793	Subtotal - Not Adjusted for FM working on post
1,023	Minus FM employed as Govt civilians or Contractors
12,770	**Total Potential FM Labor Force in SV subwatershed**
0.365168974	Ratio of jobs to population in SV subwatershed (23,610/64,655)
4663.207795	FM Employed in SV subwatershed (.3652X12,770)
23,610	Total Jobs in SV subwatershed
6177	Minus Govt Civilian and Contractor Jobs
17,433	Total Jobs Available off Post for FM employment in SV subwatershed
0.267493133	Percentage of FM working Off Post in SV subwatershed (4663/17,433)
3,536	Induced Jobs Appendix I
945.8557198	Reduced for Fort FM Holding induced jobs (.2675X3,536)

APPENDIX K
ESTIMATED WATER BUDGET FOR THE SIERRA VISTA SUBWATERSHED

Estimated Water Budget for the Sierra Vista subwatershed				06/24/2002	Rick Koehler - EEC		
Withdrawals (ac-ft)	Current	Potential					
Bisbee & Naco	-1,000	0	xfer wells out of watershed				
Tombstone	-250	0	xfer wells out of watershed				
Huachuca City	-275	-275					
Fort Huachuca	-1,655	-1,655					
Unincorp areas	-3,808	-3,808					
Irrigated Ag	-5,200	0	compensate farmers to eliminate irrigation				5.647764
Sierra Vista/Water Co.'s	-6,884	-6,200	reduce water consumption by 10%				
section subtotal	**-19,072**	**-11,938**					
Effluent Recharge	Current	Potential					
Bisbee	0	392					
Bisbee septic offset (600 homes)	73	73					
Fort Huachuca	528	435*	As Fort conserves, recharge will decline to 435 ac-ft by 2011				
Tombstone	2	107					
Tombstone septic offset	27	27					
Huachuca City	0	120					
Naco	0	56					
Sierra Vista	2,622	2,622	Assume 90% recharge which includes 100 ac-ft loss to evaporation				
Sierra Vista septic offset (800 homes)	97	97					
Unincorp area septics	1,371	1,371					
section subtotal	**4,719**	**4,865**					
"Natural" system inputs and outflows	Current	Potential					
Inflow from Mexico	3,000	3,000					
Mtn front recharge	13,750	13,750					
Enhanced stormwater recharge	0	6,100	ASL, 1995; includes 1,040 ac-ft for Fort.				
Outflow from Fairbank	-350	-350					
Evapotranspiration	-7,191	-7,191	6591 ac-ft for San Pedro, 600 for Babocomari*				
section subtotal	9,209	15,309					
subwatershed subtotal	**-5,144**	**8,236**	**estimated overdraft/surplus**				
*assumes 100% groundwater use, still waiting on SALSA data to see what reduction factor for surface water use is appropriate; also does not adjust for recent reduction of vegetation due to fire							

		year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
	% factor												
Start overdraft			**-5144**	**-4989**	**-4835**	**-4680**	**-4526**	**-4371**	**-4217**	**-4062**	**-3908**	**-3753**	
Reduction	10%	on Post	122	122	122	122	122	122	122	122	122	122	1220
Reduction	10%	off Post	145.5	145.5	145.5	145.5	145.5	145.5	145.5	145.5	145.5	145.5	1455
Reduction	10%	off Post	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	109
Mission Jobs													
Growth	2%	SV	-138	-138	-138	-138	-138	-138	-138	-138	-138	-138	
		SV recharge	50	50	50	50	50	50	50	50	50	50	
Growth	1%	Bisbee	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	
		Bisbee recharge	2	2	2	2	2	2	2	2	2	2	
Growth	0%	Tombstone	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
		Tombstone recharge	0	0	0	0	0	0	0	0	0	0	
Growth	2%	Huachuca City	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	
		HC Recharge	2	2	2	2	2	2	2	2	2	2	
Growth	1%	Unincorp areas	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	
		Unincorp recharge	20	20	20	20	20	20	20	20	20	20	
Other options													
end overdraft			-4989	-4835	-4680	-4526	-4371	-4217	-4062	-3908	-3753	-3599	

Water user	Withdrawals (ac-ft)	Source
Bisbee & Naco	-1000	Arizona Corporation Commission (ACC) reports
Tombstone	-250	ACC reports and communications with Tombstone city staff
Huachuca City	-275	communications with Huachuca City's city clerk
Fort Huachuca	-1655	communications with Post staff

Unincorp areas	-3808	Fluid Solutions (not including Naco)
Irrigated Ag	-5200	Fluid Solutions/NRCS/BLM. (917 acres at 5.65 ac-ft per acre)
Sierra Vista/Water Co.'s	-6884	ACC reports and Fluid Solutions
Effluent Recharge	Current	
Bisbee	0	communications with Bisbee city staff
Bisbee septic (600 homes)	73	communications with Bisbee city staff
Fort Huachuca	528	communications with Post staff
Tombstone	2	communications with Tombstone city staff
Tombstone septic (223 homes)	27	communications with Tombstone city staff
Huachuca City	0	communications with Huachuca City's city staff
Naco	0	communications with Naco Sanitation District staff
Sierra Vista	2622	communications with Sierra Vista city staff
Sierra Vista septic offset (800 homes)	97	communications with Sierra Vista city staff
Unincorp area septics	1371	adjustment of Fluid Solutions value, 36% recharge rate assumed.
		septics are assumed to provide a constant recharge value
		this value is incorporated into overdraft value.
"Natural" system inputs and outflows		
Inflow from Mexico	3000	Pool and Coes, 1999 (citing Freethey, 1982 and Corell and others, 1996)
Mountain front recharge	13750	Pool and Coes, 1999 (average of listed Freethey, 1982 and Corell and others, 1996 values)
Enhanced Stormwater Recharge	0	ASL 1995
GW Outflow from Fairbank	-350	Pool and Coes, 1999 (citing Freethey, 1982 and Corell and others, 1996)
Evapotranspiration	-7191	Goodrich, *et. al.*, 1999 (estimated 6,591 ac-ft for San Pedro riparian corridor) Corell, 1996 (estimated 600 ac-ft for Babocomari)

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX L
UPPER SAN PEDRO PARTNERSHIP PLANNING OPTIONS

USPP PLANNING OPTIONS

UNDER CONSIDERATION NEEDS FURTHER STUDY

PUBLIC EDUCATION OPTIONS

ALT #		OPTION	COST	WATER

REDUCE CONSUMPTION OPTIONS

ALT #		OPTION	COST	WATER
R/C	6	Growth Restrictions	$182	1100
R/C	11	Use Mitigation (new developments)	$286	700
R	3	Eliminate New Golf Courses	$0	800
R	4	Eliminate Existing Golf Courses	$515	680
AG	2	Prevent Additional Agriculture (formerly IA 2- INA)	$22	500
AG	1	Eliminate Existing Agriculture	?	?

REUSE WATER OPTIONS

ALT #		OPTION	COST	WATER
MRW	2	Ft Huachuca Effluent Recharge	?	?
MRW	**2a**	**Ft Huachuca Effluent Reuse PDS**	**?**	**?**
MRW	**1a**	**Sierra Vista Effluent Recharge Upstream**	**?**	**?**

AUGMENT WATER OPTIONS

ALT #		OPTION	COST	WATER
WIE	1a	Move Bisbee Wells to Douglas Sub-Basin	$830	1010
WIE	2	Move SV/FtH Wells to North SPRNCA	$673	9050
WIE	1c	Move SV/FtH Wells to Douglas	$881	8750
SWR	1	Detention/ Retention Basins (BY OTHERS)	?	?

UNDER CONSIDERATION NO FURTHER STUDY NEEDED

PUBLIC EDUCATION OPTIONS

ALT #		OPTION	COST	WATER
PE	2	Enhanced version	$545	550
PE	1	Incremented version	$370	270
R/C	9	Large water user Audits	$767	30
IA	3	Use Audits	$85	130

REDUCE CONSUMPTION OPTIONS

ALT #		OPTION	COST	WATER
R/C	4	Landscaping Stds/ Regs (Exist Users)	$51	490
R/C	10	Water saving Incentive Contracts	$600	500
R/C	5	Landscaping Stds/ Regs (New Users)	$32	100
R/C	8	Water System Leak Detection/ repair	$163	190
R/C	12	Conservation Water Rates	$191	230
R/C	14	Outdoor Use Restrictions	$477	130
R	2	Restrict Landscaping (Parks/ Golf)	$526	380
R	6	Conservation Incentives (Golf)	$700	300
R	7	Limit Water Use (parks/ Golf)	$0	150
R	8	Landscape Modification (Parks)	$429	70
R	11	Restrict New Swim Pools	$0	30
IA	5	Land Retirement Program	$56	900
IA	8	Production Loss Payments	$56	900
IA	6	Restrict New Uses (easements)	$41	900
IA	4	Pay for water conservation	$50	2600
IA	1	Irrigation Technology Incentives	$92	130
IA	7	AMA Designation	$200	110

REUSE WATER OPTIONS

ALT #		OPTION	COST	WATER
MRW	1	Sierra Vista Effluent Recharge/ Reuse	$350	4000
MRW	4	Bisbee Effluent Recharge/ Reuse	$771	830
R	1a	Effluent (SV) Irrigation SV Parks/ Golf	$334	458
R	1b	Effluent (HC) Irrigation SV Parks/ Golf	$964	56
R	1c	Effluent (BS) Irrigation TV Golf	$455	101
R	1	Effluent Irrigation SV Parks/ Golf	$411	615
MRW	3	Huachuca City Effluent Recharge/ Reuse	$900	100
MRW	5	Naco Effluent Recharge/ Reuse	$900	50
MRW	6	Tombstone Effluent Recharge/ Reuse		

AUGMENT WATER OPTIONS

ALT #		OPTION	COST	WATER

PROBABLY NOT UNDER CONSIDERATION DO NOT EVALUATE IN PHASE 2

PUBLIC EDUCATION OPTIONS

ALT #		OPTION	COST	WATER
PE	3	Net Zero Users	$1,014	70

REDUCE CONSUMPTION OPTIONS

ALT #		OPTION	COST	WATER
R/C	1	Indoor Plumbing Retrofits	$1,383	600
R/C	2	Gray Water Reuse	$1,947	685
R/C	3	Outdoor Irr Eff Improvements	$1,167	60
R/C	7	Reduce Car washes	$26,150	0.2
R/C	13	Pressure Reduce Valves	$4,952	210
R/C	15	Restrictions on Specific Uses	$3,000	20
R/C	16	Rainwater harvesting	$6,171	216
R/C	17	Replace septic w/ Sewer	$182,105	19
R/C	17a	Replace septic w/ Sewer (Sierra Vista)	$65,789	6
R/C	17b	Replace septic W/ Sewer (County)	$220,714	14
R	5	Use Audits (parks/ golf)	$2,050	20
R	10	Reduce Swim Pools (Pool Cover Voucher))	$22,200	10
R	12	Eliminate Existing Swim Pools	$1,500	100
R	13	Discharge Pool Water to Sewer	$480	25

REUSE WATER OPTIONS

ALT #		OPTION	COST	WATER
R	9	Reduce Swim Pools (education)	$2,917	24

AUGMENT WATER OPTIONS

ALT #		OPTION	COST	WATER
WIE	1	Import All Municipal Water from Douglas	$881	10030
WIE	1b	Move Tombstone Wells to Douglas	$1,072	270
WIE	3	Import CAP water	$1,815	9050
WIE	4	Replace Tombstone Pipeline	$1,515	270

SELECTION CRITERIA		
IN		COSTS LESS THAN $1000/ AF
		COST UNKNOWN
IN		SAVES MORE THAN 500 AF
OUT		COSTS MORE THAN $1000/ AF
OUT		YIELD LESS THAN 500 AF

	NEEDS MORE ANALYSIS (INDIRECT COST and/or DEFINITION)
	NO MORE ANALYSIS- (ENOUGH INFORMATION)
	NO MORE ANALYSIS- (NOT ENOUGH YIELD)
	ELIMINATE FROM CONSIDERATION AT THIS TIME

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX M
FORT HUACHUCA PROJECTED PUMPING 2001 – 2011

		Ac Feet 2001	Ac Feet 2002	Ac Feet 2003	Ac Feet 2004	Ac Feet 2005	Ac Feet 2006	Ac Feet 2007	Ac Feet 2008	Ac Feet 2009	Ac Feet 2010	Ac Feet 2011
Baseline Pumpage		**1655**	**1655**	**1655**	**1655**	**1655**	**1655**	**1655**	**1655**	**1655**	**1655**	**1655**
Conservation Projects												
Horizontal Axis Washers			20	30	30	30	30	30	30	30	30	30
Xeriscape Conversion			1	2	3	4	5	5	5	5	5	5
Residential Greywater/ Rooftop Capture*				15	30	45	60	75	90	105	120	120
Barracks/Transient Greywater Reuse**				20	40	60	80	100	120	140	160	160
Replace Evap with A/C***			7	14	28	42	56	70	84	94	104	114
Phase II MCA					116	116	116	116	116	116	116	116
Rooftop Capture					15	30	45	60	70	80	90	100
Adjustments for Empty Housing Units Support Reconstruction*			**168**	**56**	**129**	**174**	**192**	**171**	**0**	**0**	**0**	**0**
Subtotal Conservation			196	137	391	501	584	627	515	570	625	645
Baseline - Conservation			**1459**	**1518**	**1264**	**1154**	**1071**	**1028**	**1140**	**1085**	**1030**	**1010**
Increase in Personnel				**208**	**208**	**208**	**208**	**208**	**208**	**208**	**208**	**208**
Projected Pumping			**1459**	**1726**	**1472**	**1362**	**1279**	**1236**	**1348**	**1293**	**1238**	**1218**
Subtotal Conservation 2001 baseline	**437**											

* Ph 1 AWMP estimates 119.5
** Ph 1 AWMP estimates 172.4
***Ph 1 AWMP estimates 116 ac ft
Fort Huachuca has completed Phase 1 of the Army Water Resource Management Plan (AWRMP). Phase II will be completed in 2002.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX N
FORT HUACHUCA EFFLUENT ANALYSIS 2001 – 2011

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Project Plumbing	**1655**	**1459**	**1726**	**1472**	**1362**	**1279**	**1236**	**1348**	**1293**	**1238**	**1218**
Available Effluent	1013	889.99	1052.86	1018	963	948	913	878	843	808	808
Irrigation	362	362	362	373	373	373	373	373	373	373	373
Recharge	540	527.99	690.86	654	610	575	540	505	470	435	435

Note - Recharge Basins not Completed for all of CY 01
Note - Negligible Evaporation Observed - Basins work well
Note - Phase II Implemented in 2004
Note - Irrigation System Assumed Funded and Installed in 03
Note - Estimated Effluent Used in 2004 is Golf Course 245 ac/ft (improved irrigation at 30% savings plus 12 ac ft for Chaffee and Prosser plus 116 ac/ft (OCE info) for new irrigation
Note - Available Effluent in 2002 and 2003 Based on 61% of Groundwater Pumped
Note - Xeriscaping, irrigation with effluent, and replacing evap with effluent will not reduce available effluent
Note - Effluent available in 2004 is equal to CY 2003 effluent (1053 - 35) (greywater savings in 2004)

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX O
USING CONSERVATION EASEMENTS TO SAVE THE UPPER SAN PEDRO RIVER

Using Conservation Easements to Save the Upper San Pedro River

By Kevin J. Luster[13]
Lieutenant Colonel, US Army
kevin.luster@hua.army.mil

I. INTRODUCTION

This paper will discuss how Fort Huachuca, in cooperation with The Nature Conservancy and the Bureau of Land Management (BLM), has become the first Army installation to use conservation easements[14] to fulfill its responsibility under the Endangered Species Act to conserve endangered and threatened species dependent upon the Upper San Pedro River ecosystem.[15] Fort Huachuca sits at the base of the Huachuca Mountains on the western fringe of the San Pedro River Valley in Cochise County, 60 miles southeast of Tucson and 15 miles north of Mexico. The Fort covers 73,142 acres of terrain at elevations ranging from 3,940 feet to 8,625 feet.[16]

II. BACKGROUND

A. FORT HUACHUCA - FROM CALVARY POST TO THE HOME OF ARMY INTELLIGENCE AND COMMUNICATIONS

The Department of War established Camp Huachuca in 1877 as one of 70 Army outposts stretching across the southwestern frontier, to protect local settlers and cut off the Apache escape route into Mexico. In 1886, four years after the War Department designated Camp Huachuca a permanent fort, Fort Huachuca provided troopers to help capture Geronimo and his band of Apaches in Sonora, Mexico. Following the Indian Wars, troopers from Fort Huachuca patrolled the Mexican border and, in 1916, units from Fort Huachuca, to include the 10th Cavalry "Buffalo Soldiers" Regiment, accompanied Brigadier General John J. "Blackjack" Pershing during his punitive expedition into Mexico. During World War II, Fort Huachuca housed and trained over 25,000 African-American soldiers from the 92nd and 93rd Divisions.[17]

---

[13] Lieutenant Colonel Luster is grateful to the following people who contributed to this paper: Mr. Dan Haws, Office of the Staff Judge Advocate at Fort Huachuca, Ms. Gretchen Kent, Directorate of Installation Support, US Army Garrison (DIS, USAG), Fort Huachuca, AZ, and Mr. Robert Bridges, DIS, USAG, Fort Huachuca, AZ.
[14] Under the Arizona Uniform Conservation Easement Act, "'Conservation easement' means a non-possessory interest of a holder in real property imposing limitations or affirmative obligations for conservation purposes or to preserve the historical, architectural, archaeological or cultural aspects of real property." ARIZ. REV. STAT. § 33-271 (2001).
[15] Endangered Species Act of 1973 § 7, 16 USC. § 1536.
[16] Environmental Assessment: Expansion of the West Civilian Personnel Operations Center, Fort Huachuca, Arizona 7 (August 2001) (unpublished study on file with the DIS, USAG, Fort Huachuca, AZ) [hereinafter EA: WCPOC].
[17] CORNELIUS C. SMITH, JR., FORT HUACHUCA: THE STORY OF A FRONTIER POST 172-74 & 277-309 (1976).

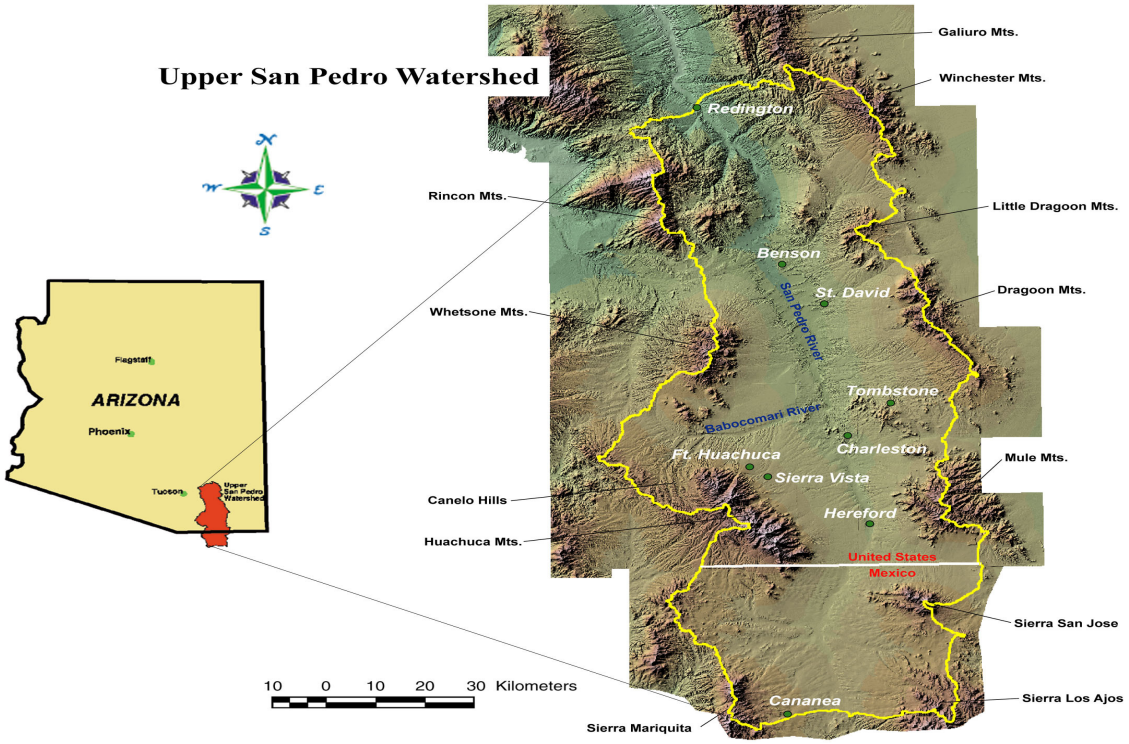
After the war, the US Government closed Fort Huachuca and gave it to the State of Arizona to serve as a training area for the Arizona National Guard and for wildlife management. The State returned the Fort to the Department of the Army during the Korean War, and it reopened in 1954 as the headquarters of the US Army Electronic Proving Ground. Today, Fort Huachuca is the home of the US Army Intelligence Center, the US Army Signal Command, the US Army Electronic Proving Ground, the Joint Interoperability Test Command, and the US Army Information Systems Engineering Command.[18] Its moderate, year-round climate, clean air, and pristine electromagnetic spectrum make it a perfect location for testing electronic systems, test-flying unmanned aerial vehicles, and training military intelligence soldiers. Fort Huachuca has a noontime population of roughly 15,500, consisting of approximately 4,200 assigned military, 3,000 military students, 4,000 military family members, and 4,300 civilian employees.[19]

B. THE UPPER SAN PEDRO RIVER BASIN

Fort Huachuca sits atop a regional aquifer that covers approximately 1,200 square miles with a high desert watershed nestled between the Mustang and Huachuca mountains to the west and the Mule Mountains to the east.[20] At its closest point, Fort Huachuca is less than a mile from the San Pedro River, which flows north from its headwaters in Sonora, Mexico to southeastern Arizona. The San Pedro River is one of the few remaining perennial rivers in the southwestern United States. Though the River receives seasonal flow from precipitation and snowmelt, it depends primarily on groundwater to sustain its baseflow.[21] The River covers two geographic units: the Upper and Lower basins. The Upper San Pedro River Basin supports an ecosystem that rates the second highest in diversity of land mammals in the world. It also provides habitat for nearly 390 different species of birds, many of which are migratory.[22] In 1988, recognizing the importance of the basin's unique biodiversity, Congress created the San Pedro Riparian National Conservation Area (SPRNCA), which consists of approximately 57,000 acres stretching 36 miles along the Upper San Pedro River from Mexico north to St. David, Arizona.[23] The BLM manages the SPRNCA, which provides critical habitat for two endangered species: a bird, the Southwestern Willow Flycatcher, and a plant, the Huachuca Water Umbel. It also provides habitat for two threatened native fish: the Spikedace and the Loach Minnow.[24]

---

[18] *Id*. at 312.
[19] EA: WCPOC, *supra* note 4, at 13.
[20] *Id*. at 18-19. See also US Army Intelligence Center and Fort Huachuca, Integrated Natural Resources Management Plan and Environmental Assessment 2001-2005 at 25 (2001) (unpublished study on file with the DIS, USAG, Fort Huachuca, AZ) [hereinafter INRMP].
[21] Environmental Impact Statement: Approval of Land Use and Real Estate Investment Strategies in Support of Real Property Master Planning, Fort Huachuca, Arizona 3-41 to 3-45 (May 1999) (unpublished study on file with the DIS, USAG, Fort Huachuca, AZ) [hereinafter EIS: Master Plan]. *See also* US Department of Interior, US Fish and Wildlife Service, Biological Opinion: Ongoing and Planned Military Operations and Activities at and Nearby Fort Huachuca at 77-84 (October 27, 1999) (unpublished document on file with the DIS, USAG, Fort Huachuca, AZ) [hereinafter 1999 BO].
[22] Harvard University Graduate School of Design, Summary Report: Alternative Futures for the Upper San Pedro River Basin, Arizona, USA, and Sonora, Mexico 1 (December 2000) (unpublished report on file with the DIS, USAG, Fort Huachuca, AZ). *See also* Barbara Kingsolver, *A Special Place: The Patience of a Saint, San Pedro River*, 197, No. 4 NAT'L GEOGRAPHIC 81, 85 (April 2000).
[23] 16 U.S.C. § 460xx. *See also* 1999 BO, *supra* note 9, at 74.
[24] 1999 BO, *supra* note 9, at 74 and 127-29.



Source: Directorate of Installation Support, US Army Garrison, Fort Huachuca, Arizona

Two subwatersheds support the Upper San Pedro River Basin: the Sierra Vista and Benson subwatersheds. Fort Huachuca, the City of Sierra Vista, nearby Huachuca City, and most of the SPRNCA make up the Sierra Vista subwatershed.[25] The region's residents, to include Fort Huachuca, depend entirely on groundwater.[26] In 1991, the Arizona Department of Water Resources (ADWR) estimated that, with an annual precipitation ranging from 14-26 inches, the annual water supply into the Sierra Vista subwatershed was 56,820 ac-ft.[27] The ADWR also estimated that approximately 39,200 ac-ft flow out of the system as surface flow in the San Pedro River and 28,850 ac-ft a year is withdrawn for consumptive use, resulting in a deficit of 11,230 ac-ft per year.[28] Even though the area's population has increased in the past ten years, local reductions in agricultural pumping have reduced the subwatershed's estimated water deficit

[25] EA: WCPOC, *supra* note 4, at 18.
[26] EIS: Master Plan, *supra* note 9, at 3-48 to 3-49. There are over 80 registered wells in the two townships adjacent to Fort Huachuca – all with depths exceeding 800 feet. The Fort has eight high-capacity wells with depths between 710 and 1230 feet. It also has five low-capacity wells supporting military testing and research throughout the post.
[27] 1999 BO, *supra* note 9, at 82, citing Arizona Department of Water Resources, Preliminary Hydrographic Survey Report for the San Pedro River Watershed Vol. 1 at 548 (1991). Phreatophytes (deep-rooted plants) accounted for approximately half of this consumption; consequently, human activities within the subwatershed consumed roughly 14,4250 ac-ft annually. 1999 BO, *supra* note 9, at 82. Outside the subwatershed, agricultural irrigation and mining operations in Mexico may also impact the flow of the Upper San Pedro River. See *Id.* at 81. An acre-foot is 325,850 gallons, or the volume of water that would cover one-acre to the depth of one foot. BLACK'S LAW DICTIONARY 23 (5th ed. 1979).
[28] *Id.*

to roughly 7,000 ac-ft per year.[29] According to the 2000 US Census, 37,775 people live in the City of Sierra Vista, 1,751 people live in Huachuca City, and 117,755 people live in Cochise County.[30] Roughly 9,000 people currently live on Fort Huachuca.[31] Currently, there are approximately 500-900 acres of irrigated agricultural land in the subwatershed, which pumps between 1,500 to 2,800 ac-ft of water each year.[32] This leaves approximately 7,900 to 6,600 ac-ft annually attributable to non-agricultural, human consumption within the subwatershed.

C. THE 1999 BIOLOGICAL OPINION

In 1995, Fort Huachuca began formally evaluating the potential effects of on-going military operations and activities at Fort Huachuca on the federally listed threatened and endangered species on and off-post.[33] On March 30, 1998, Fort Huachuca submitted to the US Fish and Wildlife Service (the Service) a biological assessment, which determined that the Fort's ongoing actions "may affect, but are not likely to adversely affect" the Huachuca Water Umbel (off-post), the Canelo Hills Ladies' Tresses, the Southwestern Willow Flycatcher, the Loach Minnow, and the Spikedace. The biological assessment also concluded that the Fort's operations were "likely to adversely affect" the Huachuca Water Umbel (on post), the Blumer's Dock, the Peregrine Falcon, the Mexican Spotted Owl, the Lesser Long-nosed Bat, and the Sonora Tiger Salamander.[34] This prompted the Fort to request formal consultation with the Service under Section 7 of the Endangered Species Act on the potential effects of the Fort's on-going activities on the endangered and threatened species in the area.[35] In late 1998, the Service issued a draft biological opinion which concluded that deficit groundwater pumping is the greatest threat to threatened and endangered species in the region. The Service feared that if deficit groundwater pumping were left unabated it would ultimately reduce and dry up the Upper San Pedro River. The draft biological opinion listed reasonable and prudent alternatives to the Fort's activities, which essentially proposed that the Fort assume responsibility for eliminating the groundwater

---

[29] 1999 BO, *supra* note 9, at 82.

[30] According to the US Census, in 1990, 32,983 people lived in the City of Sierra Vista, 1,782 people lived in Huachuca City, and 97,624 people lived in Cochise County. EA: WCPOC, *supra* note 4, at 12, citing the US Census.

[31] Directorate of Resource Management, US Army Garrison, Fort Huachuca, Annual Population Survey (2001).

[32] 1999 BO, *supra* note 9, at 82, citing San Pedro Expert Study Team, Report to the Secretariat of the Commission for Environmental Cooperation: Sustaining and Enhancing Riparian Migratory Bird Habitat on the Upper San Pedro River (1999).

[33] Section 7(a)(2) of the ESA, requires the Army, in consultation with the US Fish and Wildlife Service, to "insure that any action authorized, funded, or carried out by [the Army] is not likely to jeopardize the continued existence of any endangered species or result in the destruction or adverse modification of habitat of such species . . ." To accomplish this Army installations will typically prepare a biological assessment under Section 7(c)(1), which states in part: "To facilitate compliance with the requirements of subsection (a)(2) of this section, each Federal agency shall . . . conduct a biological assessment for the purpose of identifying any endangered species or threatened species which is likely to be affected by such action." 16 USA § 1536(a)(2). *See also* 50 C.F.R. § 402.12, Biological assessments, which delineates the guidelines and procedures for preparing and coordinating biological assessments with the Service.

[34] Letter from Fort Huachuca to the US Fish and Wildlife Service (March 30, 1998).

[35] *Id*. Under formal consultation, the Service evaluates the potential effects of the action on threatened and endangered species and any critical habitat, and prepares a biological opinion on "whether the action, taken together with cumulative effects, is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat." If the Service finds jeopardy or adverse effects, it "shall suggest reasonable and prudent alternatives" which it believes the agency can apply to avoid violating Section 7(a)(2) of the ESA. ESA § 7(b)(3), 16 U.S.C. § 1536(b)(3). *See also* 50 CFR § 402.14(g)(4).

deficit for the entire subwatershed.[36] The Fort objected to the draft biological opinion, because it had neither the resources nor the authority to mitigate the groundwater deficit for the entire subwatershed.[37]

Through extensive consultations over the next ten months, the Service and Fort Huachuca negotiated a memorandum of agreement listing several measures the Fort could undertake to reduce on-post water use and address the regional water deficit. The agreement enabled the Service, after 19 months of formal consultations, to issue its biological opinion on October 27, 1999. The biological opinion, covering all ongoing and planned military activities at and near Fort Huachuca for the next ten years, incorporated the memorandum of agreement. In the biological opinion, the Service concurred with the Fort's earlier determination that activities at the Fort were not likely to adversely affect the Spikedace, Loach Minnow, or Canelo Hills Ladies' Tresses. It also concluded that Fort Huachuca's activities over the next ten years were not likely to jeopardize the continued existence of the Huachuca Water Umbel, Southwestern Willow Flycatcher, Mexican Spotted Owl, Lesser Long-nosed Bat, or Sonora Tiger Salamander, or adversely affect critical habitat for the Southwestern Willow Flycatcher or Huachuca Water Umbel.[38]

In the biological opinion, the Service did not hold the Fort responsible for the estimated local annual water-pumping deficit of 7,000 ac-ft. Instead, the Service estimated that approximately 34,530 people lived in the subwatershed because of the Fort's presence. It calculated that, at 150 gallons per day for per capita use, 34,530 people would consume roughly 5,802 ac-ft each year (34,530 x 150 x 360 = 1,890,517,500 gallons or 5,802 ac-ft).[39] According to the Service, this amount represents approximately 62% of all groundwater pumped from the subwatershed.[40] As a baseline from which to judge the Fort's progress under the biological opinion, the Service applied the Fort's on-post water use in 1996: 2,355 ac-ft.[41] Consequently, the Service infers in the biological opinion that the Fort is responsible for 3,447 ac-ft of water pumped off-post each year. The Fort's figure is a bit less. The Fort believes that only 2,766 ac-ft of water is pumped off-post annually because of the Fort's presence in the subwatershed.[42]

---

[36] US Department of Interior, US Fish and Wildlife Service, Draft Biological Opinion: Ongoing and Planned Military Operations and Activities at and Nearby Fort Huachuca (December 1998).

[37] Letter from Commander, USAIC&FH to Field Supervisor, US Fish and Wildlife Service (October 5, 1999). Essentially, the Service expected the Fort to assume responsibility for reducing water use in the subwatershed by 7,000 ac-ft per year. In 1998, the Fort pumped only 2,176 ac-ft for on-post use.

[38] Letter from USFWS to COL Michael W. Boardman, Commander, USAG, Fort Huachuca, AZ (October 27, 1999), accompanying the 1999 BO.

[39] 1999 BO, *supra* note 9, at 116-17. Fort Huachuca disagrees with the Service - it believes that only 5,121 ac-ft of the groundwater pumped from the subwatershed each year is attributable to the Fort's presence. The Fort estimates that only 2,560 ac-ft of water is pumped off-post each year to support military and civilian employees and their dependents, contractors and their dependents, and military retirees and their families. Additionally, the Fort calculates that its presence has caused 1,228 additional people to live in the subwatershed and that these additional people consume approximately 206 ac-ft of water per year (1,228 x 150 gallons x 365 = 67,233,00 gallons, or 206 ac-ft). After adding these amounts to the baseline established in the biological opinion for on-post use each year (2,355 ac-ft), the Fort concludes that it is responsible for 5,121 ac-ft of the groundwater pumped in the subwatershed each year (2,560 + 206 + 2,355 = 5,121). *Id.* at 115-16.

[40] *Id*. The Service applied the 1999 San Pedro Expert Study Team's estimate that the total water pumped in the Sierra Vista subwatershed would be approximately 9,400 ac-ft in 2000.

[41] *Id*. at 114.

[42] *Id*. at 115-16.

To mitigate the potential effects of deficit groundwater pumping on threatened and endangered species in the Sierra Vista subwatershed of the Upper San Pedro River Basin, Fort Huachuca agreed to undertake several measures in the memorandum of agreement.[43] One of these measures included working with regional partners in the Upper San Pedro Partnership[44] to develop a regional, water resources management plan to maintain the baseflow of the San Pedro River. Other measures included developing an Army Water Resources Management Plan, developing annual work plans with the Service to further the goals of the agreement, implementing scheduled water management projects, and implementing measures listed in appendices A and B to the agreement.[45] Appendix A is the Army Water Resources Management Plan. Its stated purpose is to "maintain the Army's mission at Fort Huachuca while protecting and maintaining populations of listed species and their habitats." The Plan obligates Fort Huachuca to reduce its net water consumption over the next ten years through water conservation and recharge projects.[46] Appendix B to the agreement lists the Fort's requirements under the biological opinion, such as species and habitat monitoring, fire management, restrictions on various military and recreational activities, and other general mitigation measures to reduce adverse effects to listed species and their habitats.[47] Finally, the biological opinion stressed the importance of the City of Sierra Vista's planned wastewater recharge project for delaying any impact on the Upper San Pedro River from regional deficit pumping.[48]

D. ACHIEVING ZERO-BALANCE

The memorandum of agreement and the Army Water Resources Management Plan committed Fort Huachuca to undertake aggressive water conservation, recharge, reuse, and other mitigation measures, and to cooperate with regional stakeholders through the Upper San Pedro Partnership to reduce, if not eliminate the annual water deficit in the Sierra Vista subwatershed. However, only through real, documented progress can the Army and the Service determine whether these measures will work.[49] The chart below depicts the Fort's progress in reducing its on-post water

---

[43] Memorandum of Agreement between the US Army and the US Fish and Wildlife Service, Subject: Water Resources in the Sierra Vista Subwatershed of the Upper San Pedro River Basin (October 27, 1999) [hereinafter Memorandum of Agreement]. *See* 1999 BO, *supra* note 9, at Appendix 1.

[44] Charter members of the Upper San Pedro Partnership (USPP) include: the Bureau of Land Management, Fort Huachuca, the US Forest Service, the US Geological Survey, the Arizona Department of Water Resources, the Arizona Department of Environmental Quality, the Arizona State Land Department, Cochise County, City of Sierra Vista, City of Bisbee, The Nature Conservancy, and the Town of Huachuca City. Memorandum of Understanding Establishing the Upper San Pedro Partnership (November 1998). *See* 1999 BO, *supra* note 9, at Appendix 1.

[45] Memorandum of Agreement, *supra* note 31, at 1.

[46] Army Water Resources Management Plan, Appendix A to the Memorandum of Agreement. *See* 1999 BO, *supra* note 9, at Appendix 1.

[47] Army Requirements from Current Formal Consultation, Appendix B to the Memorandum of Agreement. *See* 1999 BO, *supra* note 9, at Appendix 1.

[48] 1999 BO, *supra* note 9, at 91-96. The City of Sierra Vista began constructing an effluent recharge facility near the Upper San Pedro River in early 2001, which, when completed will recharge between 2,000 to 4,000 ac-ft annually to the aquifer. David Rupkalvis, *City Slow from the Starting Blocks but Gaining Steam on Water Conservation Campaign*, SIERRA VISTA HERALD, April 25, 2001, at A1.

[49] Soon after the Service issued its biological opinion, the Center for Biological Diversity, a non-profit environmental group, with other interested parties, filed suit in US District Court for the District of Arizona (Civil No. 99-203 TUC-ACM). The suit, which is pending decision on summary judgment motions, currently alleges five causes of action: (1) the Service's decision to issue the non-jeopardy biological opinion base on the Memorandum of

use over the past several years. The Fort has accomplished this reduction through extensive investments in water conservation technology, by aggressively conserving water, by reducing water leaks through an relentless leak detection program, and by demolishing excess infrastructure.[50] As shown by the chart below, the Fort has progressively reduced its water use over the past four years, even though its population has increased. The Fort is also returning more water to the aquifer through projects that channel and capture stormwater, and recharge the aquifer with stormwater and treated effluent via settling or recharge basins. Currently, the Fort recharges approximately 500 ac-ft per year with its current recharge efforts. It will soon increase this recharge by approximately 250 ac-ft annually through irrigation repairs, erosion control, and additional stormwater channeling. Additionally, the Fort will soon complete construction of seven recharge basins that may return as much as 1,000 ac-ft per year to the regional aquifer. Consequently, Fort Huachuca will eventually achieve zero-balance between its annual on-post water usage and the amount it recharges to the aquifer.[51] However, Fort Huachuca still faces the tremendous challenge of reducing and/or offsetting its share of the off-post water-pumping deficit - whether the deficit is 3,447 ac-ft annually or 2,766 ac-ft annually.

Agreement was arbitrary and capricious; (2) the Service's decision to limit its review of impacts to a ten-year period is arbitrary and capricious and violates the ESA; (3) the Service's reliance on the Sierra Vista recharge project to delay impacts to the San Pedro River is arbitrary and capricious; (4) the Service's decision is illegal because there is no rational connection between its analysis of the impacts of growth and its no-jeopardy conclusion; and (5) because the biological opinion is arbitrary and capricious, the Army is violating its duty to avoid jeopardy. *See* Plaintiff's brief in support of their motion for summary judgment (on file with the author).

[50] Water conservation technology includes low-flow showerheads, horizontal-axis washing machines, and waterless urinals. Conservation methods include strict restrictions on irrigation on post, replacing lawns with xeriscaping, leak-detection surveys of both water and sewer lines, and preaching a "water-wise" mentality.

[51] These figures are based upon estimates prepared by the Fort Huachuca Directorate of Installation Support.

Fort Huachuca Population and Water Use (Pumpage) History
(Population Data is from 30 September of Each Year)

Year	*On-Post Population*	*Noonday Population*	*Water Use In Ac-ft*
2001	N/A	15,826	1,655
2000	9,728	15,518	1,843
1999	8,584	15,466	1,893
1998	7,603	14,793	2,176
1997	7,760	14,850	2,357
1996	8,656	15,310	2,355
1995	8982	15,842	2428
1994	9388	16,420	2568
1993	8534	16,183	3028
1992	8163	16,386	2846
1991	8410	16,195	2709
1990	9210	17,075	2747
1989	9204	17,133	3207
1988	9142	16,687	3200
1987	9667	16,960	2470
1986	8918	16,563	2896
1985	8887	16,778	2984
1984	9022	16,341	3088
1983	9860	16,360	2874
1982	9433	15,840	2735

Source: Directorate of Installation Support, US Army Garrison, Fort Huachuca, AZ

III. CONSERVATION EASEMENTS

A. WORKING WITH PARTNERS

To fulfill its obligation under the biological opinion and memorandum of agreement, the Fort must cooperate with local partners to reduce, if not eliminate, the estimated annual local water-pumping deficit of 7,000 ac-ft. The Fort is working with the Upper San Pedro Partnership to identify and implement such projects as the City of Sierra Vista's effluent recharge project, conservation technology, public awareness campaigns, and reusing treated effluent to irrigate

parks and golf courses.[52] Additionally, to substantially offset its off-post impact, the Fort has joined with The Nature Conservancy and the BLM to undertake an innovative approach towards conservation within the Sierra Vista subwatershed.[53]

B. COOPERATIVE AGREEMENT

On February 14, 2000, less than four months after signing the memorandum of agreement with the Service and receiving the final biological opinion, representatives from Fort Huachuca, The Nature Conservancy, and the Service met to discuss potential acquisitions of conservation easements near the SPRNCA, to include "the Gap," or the section of private lands along the Upper San Pedro River that divide the SPRNCA.[54] Much of the private lands in this rural area along the Upper San Pedro River are large parcels, often greater than 100 acres each, currently undeveloped, and dedicated to ranching and farming. The BLM has already received a limited amount of funds through the Land and Water Conservation Fund to acquire lands and easements near the SPRNCA. Their goal is to establish an open space corridor for wildlife to access the River, close "the Gap" separating the SPRNCA, and connect the SPRNCA with public lands in the Huachuca Mountains and Forest Reserve lands in Sonora.[55] This would ensure the continued vibrancy of the region's biodiversity by maintaining an unencumbered corridor for the region's wildlife. It would also protect those species most dependent upon the River by reducing groundwater pumping within the subwatershed, which is the greatest threat to the River's baseflow.[56] The Service determined that Fort Huachuca could earn credits towards its obligation under the memorandum of agreement and biological opinion to reduce deficit water pumping by acquiring conservation easements through The Nature Conservancy that would complement the BLM's efforts.[57] The Service proposed that these credits would equal the difference between the estimated water used on the acquired properties in 1990 and the projected water use on the properties under the easements.[58]

On September 27, 2000, Fort Huachuca, through the US Army Medical Research Acquisition Activity,[59] executed a cooperative agreement with The Nature Conservancy primarily to identify

---

[52] Upper San Pedro Partnership, Semi-Annual Report 3-4 (April 12, 2000).
[53] The Nature Conservancy is a non-government, non-profit, environmental organization with the primary mission to preserve biodiversity by identifying and protecting rare species and their fragile ecosystems. The Nature Conservancy posses a unique expertise to negotiate acquisitions of private lands for conservation purposes. See Cooperate Agreement, Statement of Work at page 1.
[54] Letter from Mr. David L. Harlow, Field Supervisor, US Fish and Wildlife Service to Colonel Michael W. Boardman, Commander, US Army Garrison, Fort Huachuca (March 20, 2000).
[55] *Id.*
[56] *Id*. *See also* Cooperative Agreement between the US Department of the Army, Fort Huachuca and The Nature Conservancy, Arizona Chapter, Statement of Work 2 (September 27, 2000) [hereinafter Cooperative Agreement].
[57] *Id*. at 2.
[58] *Id*.
[59] The US Army Medical Research Acquisition Activity, located at Fort Detrick, Maryland, has authority to administer cooperative agreements under 31 U.S.C. § 6305. The US Army Medical Research Acquisition Activity has unique experience administering these types of agreement. In addition to this agreement between Fort Huachuca and The Nature Conservancy, the US Army Medical Research Acquisition Activity administers a similar agreement for Fort Bragg in North Carolina. *See* Cooperative Agreement between US Department of the Army, Fort Bragg, US Army Environmental Center, and The Nature Conservancy (September 1995) (on file with the author).

and acquire conservation easements within the Upper San Pedro River Basin.[60] The cooperative agreement has three stated objectives: (1) support the military mission at Fort Huachuca by protecting, maintaining, and enhancing threatened and endangered species and their habitat in the Upper San Pedro River Basin; (2) encumber private property land uses of willing landowners near the Upper San Pedro River Basin with conservation easements, and (3) improve long-term management of threatened and endangered species within the Upper San Pedro River Basin.[61]

Under the cooperative agreement, The Nature Conservancy will identify lands that have a history of groundwater pumping for agricultural irrigation and/or posses a high potential for significant subdivision and development. Either of which can contribute to the groundwater deficit and adversely impact the baseflow of the Upper San Pedro River.[62] The cooperative agreement requires The Nature Conservancy to obtain written permission from landowners before entering their properties to survey and appraise them.[63] Additionally, The Nature Conservancy must obtain a certified land appraisal and complete a report describing the environmental baseline for each candidate property before drafting any easement. This report will establish the current conditions and use of the property, which will help calculate the credit-value of the easement and establish a baseline on which to monitor and enforce the easement.[64] The Nature Conservancy works with the landowner to draft an easement that establishes long-term management guidelines to protect and enhance threatened and endangered species habitat.[65] Typical easement conditions will limit or prohibit agricultural irrigation on the property, restrict the landowner's right to subdivide the property, limit the number of structures on the property, and prohibit fencing that could impair wildlife movement. Limits on development rights are important because real property developed into quarter-acre lots can consume as much water per acre as irrigated

---

[60] Fort Huachuca entered into this agreement pursuant to the Sikes Act, codified at 16 U.S.C. § 670. Under this authority, "[t]he Secretary of Defense may enter into cooperative agreements with States, local governments, non-governmental organizations, and individuals to provide for the maintenance and improvement of natural resources on, or to benefit natural and historic research on, Department of Defense installations." 16 U.S.C. § 670c-1. Additionally, the Secretary of Defense may contribute matching funds to carry out programs under these agreements. 16 U.S.C. § 670c-1(b). An overarching cooperative agreement between the Department of Defense (DoD) and The Nature Conservancy establishes the procedures for planning and conducting cooperative efforts between the DoD and The Nature Conservancy on DoD lands. Cooperative Agreement between the Department of Defense and The Nature Conservancy (December 13, 1988). Under this agreement, installation commanders can obtain technical assistance from The Nature Conservancy and allow The Nature Conservancy to study significant ecosystems under the Army's control. *See also* Army Regulation 200-3, Natural Resources – Land, Forest and Wildlife Management, 28 February 1995, at paragraph 2-8d. Consequently, installation commanders may enter into cooperative agreements with The Nature Conservancy and fund those agreements if the agreements benefit natural resources on their installations. Though the cooperative agreement between Fort Huachuca and The Nature Conservancy provides for The Nature Conservancy to acquire conservation easements to lands off of the installation, the easements will benefit threatened and endangered species that reside on the installation, namely the Southwestern willow flycatcher and the Huachuca water umbel, as well as other species who would benefit from the continuing flow of the Upper San Pedro River. Furthermore, Fort Huachuca has entered into this cooperative agreement to fulfill its statutory mandate under Section 7(a)(1) of the Endangered Species Act to "utilize [its] authorities in furtherance of the purpose of this chapter by carrying out programs for the conservation of endangered species and threatened species . . ." 16 USC § 1536(a)(1).

[61] Cooperative Agreement, *supra* note 44, at 2.

[62] *Id*. at 2.

[63] *Id*. at 5.

[64] Programmatic Environmental Assessment: Purchase, Transfer and Management of Conservation Easements in the Southern Upper San Pedro Basin in Arizona, August 22, 2001, at page 5.

[65] Cooperative Agreement, *supra* note 44, at 4.

agricultural lands. Furthermore, development can harm the River through erosion, sedimentation, and accelerated runoff.[66] Additionally, the easements will require the landowners to allow entry onto their land by the BLM representatives to monitor compliance with the easements.[67] After The Nature Conservancy negotiates, drafts, and acquires the easements, the Army will pay The Nature Conservancy for the costs of the easements, and The Nature Conservancy will in turn transfer the easements to the BLM to manage.[68]

C. RECENT ACQUISITIONS

The first of the two parcels that The Nature Conservancy has already acquired under the Cooperative Agreement is the Clinton Ranch. In July 2000, The Nature Conservancy purchased the Clinton Ranch, a 940-acre parcel south of Highway 92, adjacent to the SPRNCA. Previous owners had irrigated 120 acres of this property to grow alfalfa in the past, consuming 636.3 ac-ft of water annually. According to the Service, the Clinton Ranch is key to creating an open space corridor between the SPRNCA and public lands to the west in the Huachuca Mountains.[69] Last year, The Nature Conservancy sold the 940-acre parcel with an easement against the property that prohibits agricultural irrigation and any structures other than a house with supporting buildings and a small garden. The new owners are renovating the house into a bed and breakfast. In July 2001, Fort Huachuca paid The Nature Conservancy $760,700 for the easement, which is the difference between the amount that The Nature Conservancy originally paid for the property and the amount that it received from the subsequent buyers of the property with the easement attached. After The Nature Conservancy transferred the easement to the BLM to manage, the Service tentatively agreed this past January to credit Fort Huachuca with conserving 630.8 ac-ft annually through the easement.[70]

The second parcel is the Drijver tract, which is a 105-acre tract of land within "the Gap" that divides the SPRNCA. In August 2001, The Nature Conservancy purchased the Drijver tract, which had 75 acres of irrigated pasture that consumed approximately 508 ac-ft of groundwater in 1990. Because the tract is adjacent to the Upper San Pedro, the Service believes that retiring the tract from irrigation will directly benefit the baseflow of the River.[71] Once The Nature Conservancy sells the tract with the appropriate easement, Fort Huachuca will reimburse The Nature Conservancy for the difference, which will in turn transfer the easement to the BLM to manage. Any easement against the Drijver tract will prohibit irrigation for agriculture and subdivision for development. Fort Huachuca expects to pay approximately $260,000 to obtain 507.2 ac-ft in water-savings credit from the Drijver tract. Finally, The Nature Conservancy is considering other tracts than may net over to 800 ac-ft in water-savings credit for the Fort.

---

[66] *Id.* at 4.
[67] *Id.* at 4.
[68] Under the Arizona Uniform Conservation Easement Act, the US Bureau of Land management may hold and enforce conservation easements in Arizona because it is "[a] government body empowered to hold an interest in real property under the laws of this state or the United States." ARS § 33-271, para 3(a).
[69] Letter from Mr. David L. Harlow, Field Supervisor, US Fish and Wildlife Service to Colonel Michael W. Boardman, Commander, US Army Garrison, Fort Huachuca (March 20, 2000).
[70] *Id.*
[71] *Id.*

Together, these properties will enable the Fort to offset its share of the off-post water-pumping deficit by over 1,900 ac-ft annually.[72]

IV. CONCLUSION

In less than three years, Fort Huachuca has made substantial progress towards achieving its goals under the biological opinion. It is close to achieving zero-balance between its on-post water consumption and the water it returns to the aquifer. To date, the cooperative agreement between Fort Huachuca and The Nature Conservancy has produced one conservation easement worth an annual credit of 630.8 ac-ft. Soon, it will produce a second easement that will likely earn the Fort an additional 507.2 ac-ft credit from the Service, for a total of 1,138 ac-ft. From a purely numbers perspective, this reduces the amount of off-post water consumption that the Service attributes to the Fort to 2,309.[73] Furthermore, the cooperative agreement has the very real potential of reducing the Fort's share of the water-pumping deficit another 800 ac-ft to 1,509 ac-ft.[74] Considering what the Fort has also accomplished towards achieving a zero-balance between its on-post water use and recharge to the aquifer, this is tremendous progress within less than three years under the biological opinion.

Of course, Fort Huachuca still faces challenges to achieving its goals under the biological opinion. First and foremost is that conservation easements alone cannot save the Upper San Pedro River. As noted above, current agricultural irrigation within the subwatershed only consumes between 1,500 to 2,800 ac-ft of water each year.[75] Consequently, there is a limit to the amount that water conservation easements can reduce the deficit. Even so, Fort Huachuca should continue to receive credits for permanently retiring land from agricultural irrigation and development based on the land's historical use, potential for development, and proximity to the SPRNCA. This strategy will continue to reduce some of the deficit groundwater pumping impacting the River; however, it is also effective at managing future increases in groundwater pumping. Especially when aimed at strategically located parcels – parcels that have the greatest potential of impacting the River's flow. Of course, this will require substantial knowledge of the region's hydrology. Though the region's hydrology is well beyond the scope of this paper, know that it is both complex and controversial, and that the involved federal and state agencies and other interested parties are striving to better understand it. By acquiring conservation easements in cooperation with The Nature Conservancy and the BLM, Fort Huachuca is making solid, substantial progress towards protecting the SPRNCA and the Upper San Pedro River Basin. It is also earning credibility with the Service by making significant progress towards offsetting its impact on off-post water use. More importantly, Fort Huachuca is demonstrating leadership to its partners within the subwatershed on how to work together to save the Upper San Pedro River.

---

[72] *Id.*

[73] This number is a product of subtracting the 1,138 ac-ft of credit from the 3,455 ac-ft annual off-post consumption that the Service attributes to the Fort in the biological opinion. Applying its own figure of 2,766 ac-ft, the Fort believes that it will soon reduce its outstanding liability for the off-post water-pumping deficit to 1,628 ac-ft. *See supra* notes 27-30 and accompanying text.

[74] Or 628 ac-ft according to the Fort's calculations. *See supra* notes 27-30, 60 and accompanying text.

[75] *See supra* note 20 and accompanying text.

APPENDIX P
FORT HUACHUCA WATER USE MITIGATION POLICY

DEPARTMENT OF THE ARMY
UNITED STATES ARMY INTELLIGENCE CENTER AND FORT HUACHUCA
FORT HUACHUCA, ARIZONA 85613-6000

REPLY TO ATTENTION OF

ATZS-CG (200)

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: POLICY--Fort Huachuca Water Use Mitigation Policy

1. Fort Huachuca has an obligation to be a responsible steward of our desert environment. Water conservation is required at Fort Huachuca, and constitutes part of the Fort's compliance with the Endangered Species Act. One way we can accomplish this legal mandate is to implement mitigation methods whenever the number of employees, to include contractors, increases. This policy memorandum instructs all organizations and tenant activities on how to mitigate water consumption whenever the size of their work force increases.

2. On 27 October 1999, after nearly two years of formal consultation, Fort Huachuca was issued a Biological Opinion by the US Fish and Wildlife Service (USFWS). In that document, Fort Huachuca agreed to stringent water management practices in order to reduce potential effects on threatened and endangered species and avoid adverse modification of their designated critical habitat in the San Pedro River Basin. The USFWS monitors the installation's compliance with the Biological Opinion, and expects each year's water use to be less than the previous year.

3. To comply with the Biological Opinion, and allow for mission requirements, any organization increasing its overall personnel strength in the Fort Huachuca area must mitigate the water use associated with these additional personnel and their family members. This mitigation policy also applies to contract employees who work on the installation.

4. Each employee authorization adds direct, indirect, and cumulative water usage for themselves, their families, and within the community. Mitigation will be assessed based on increases from the organization's personnel baseline on 30 September 2001, as reflected in the installation post population planning report.

5. Mitigation for large increases (over 30 personnel associated with a single project or action) in personnel, to include civilian contractors who work on post, will occur prior to the personnel increase or hiring action. Otherwise mitigation will be paid when the annual 30 September post

ATZS-CG
SUBJECT: POLICY--Fort Huachuca Water Use Mitigation Policy

population report is issued. Mitigation may be accomplished by the gaining organization in at least two ways. Either method must be coordinated through the Environmental and Natural Resources Division, DIS.

a. The first mitigation method is on-site. For organizations with large facilities, conservation technology may be installed in their facilities if it will completely mitigate the increased water use of the additional personnel. However, this will be done at the gaining organization's expense.

b. If the organization increases personnel and cannot reduce water use at their facilities sufficiently on their own, the second method of mitigation requires working with the DIS. Cost for this mitigation method is $1,000 per additional employee. This money will be paid to the DIS and is a one-time fee per position added. The fee applies to all personnel increases, regardless of where the employee or contractor worked or was located prior to the hiring action. The mitigation fee is not an augmentation to the Garrison's appropriated funds budget because it pays to mitigate water consumption resulting from personnel increases that have not been otherwise funded by Department of the Army in the Garrison's annual budget.

c. Finally, organizations may develop in coordination with the DIS, a hybrid of the above two mitigation methods.

6. Mitigation fees for temporary personnel increases will be based on the specific action, and will be assessed according to the amount and duration of the increase in water use.

7. Point of Contact is Ms. Gretchen Kent, Environmental and Natural Resources Division, at 533-2549.

8. The proponent for this Policy Memorandum is the DIS, Environmental and Natural Resources Division, ATZS-ISB.

JAMES A. MARKS
Brigadier General, USA
Commanding

APPENDIX Q
UPPER SAN PEDRO PARTNERSHIP PROPOSED WORKING PLAN OUTLINE

3/14/02

USPP Coordinating Committee Workgroup
Proposed Working Plan Outline

INTRODUCTION

A. Partnership

1. Formation
2. Legal Authority and Constraints
3. Stated Goal

B. Purposes of Working Plan

1. To begin synthesizing and consolidating ongoing and completed studies (Fluid Solutions/BBC, Stormwater Recharge, SPRNCA needs, etc.).
2. To communicate USPP objectives and Member Agencies' completed, ongoing and proposed projects to public as well as other Member Agencies;
3. To identify gaps in baseline information/projects and recommend/propose alternatives;
4. To assess, on an iterative basis, the effectiveness of Member Agency projects as they relate to overall USPP objectives and studies' results, and make adjustments to objectives and recommendations as appropriate.

BACKGROUND

A. Historical Information (e.g. AZ State Museum study)

B. Water Issues in Sierra Vista Sub-Watershed

1. Legal Issues

a. Gila River Adjudication (by reference or appendix)
b. Endangered Species Act
c. AMA Petition Evaluation
d. ADWR sub-flow proposed rules

2. Hydrologic/Environmental Issues

a. Cone of depression
b. Stream-flow and sub-flow in SPRNCA
c. Depth to groundwater
d. Others

FORECAST

A. Demand –

1. As it relates to projected growth (to be addressed by Fluid Sol./BBC)
2. As it relates to SPRNCA
3. Assessment Tools for Evaluating Future Demand

B. Supply

1. Overall supply based on most current data (USGS, ADWR, Tech. Committee)

C. Discussion of Water Budget (ADWR AMA Petition Evaluation, other data)

USPP OBJECTIVES

STRATEGIES

A. General discussion of Reduce, Re-use, and Augment

B. Summarization of Fluid Solutions/BBC Final Report

1. Key assumptions
2. Cost/Yield ratios
3. Other factors

C. USPP evaluation and ranking of alternatives

D. Discussion of how results of studies will be or are being used as a decision-support tool for ongoing and future projects by Member Agencies, as they relate to overall USPP objectives.

MEMBER AGENCY PROJECTS/ACTIONS

A. Array of Reduce, Re-use and Augmentation Strategies as they relate to Agency Projects (graphic)

MEMBER AGENCIES (FOR ILLUSTRATION PURPOSES ONLY)

STRATEGIES	County	City	Fort	BLM	TNC	Etc…… …
Reduce Alternative 1	X				X	
Reduce Alternative 2	X	X		X		
Re-Use Alternative 1			X			X
Re-Use Alternative 2				X		X
Augment Alternative 1 Etc.		X				

B. Array of USPP Objectives as they relate to Agency Projects (graphic)

MEMBER AGENCIES

OBJECTIVES	County	City	Fort	BLM	TNC	Etc…… …
USPP Objective 1	Action			Action		
USPP Objective 2		Action				Action
USPP Objective 3			Action		Action	

C. Agency by Agency description of projects
   1. Completed projects
   2. On-going projects
   3. Proposed project
   4. Summary of USPP evaluation/cataloguing of projects

OVERALL CONCLUSIONS

A. Preliminary Assessment of Actions versus USPP Objectives and Strategies
   1. Quantitative
   2. Qualitative

B. Gaps

RECOMMENDATIONS

A. Iterative Review/Assessment Process
B. Specific Recommended Actions

1. by USPP
2. by Member Agencies

APPENDIX R
FORT HUACHUCA ENVIRONMENTAL PROGRAM REQUIREMENT PROJECTS

Project Number: HUAF010002

Project Name: COMPLY W/BO (WATER MANAGEMENT PLAN)

Narrative: REQUIRED TO COMPLY WITH THE ESA, 50 CFR 402 AND THE 1999 BIOLOGICAL OPINION. BO, APPENDIX A, ENTIRE SECTION, AND MOA, PAGE 3, c(1), REQUIRES THE FORT TO REDUCE NET WATER CONSUMPTION. DEVELOP AND UPDATE A COMPREHENSIVE WATER RESOURCES MANAGEMENT PLAN FOR FORT HUACHUCA. PLAN WILL INCLUDE BACKGROUND, REFERENCE LIST, GOALS AND MEASURES TAKEN, PLANNED AND UNDER INVESTIGATION IN THE AREAS OF WATER CONSERVATION, REUSE, AND RECHARGE. PLAN MUST BE AVAILABLE FOR USFWS REVIEW WITHIN 3 YEARS OF BO BECOMING FINAL, AND IS REVIEWED ANNUALLY FOR PROGRESS TOWARD WATER REDUCTION GOALS. SOME FEASIBILITY STUDIES FOR CONSERVATION TECHNOLOGY IMPLEMENTATION WILL BE INCLUDED IN INITIAL AND ANNUAL UPDATES. PURPOSE OF WATER USE REDUCTION IS TO PROTECT CRITICAL HABITAT FOR SOUTHWEST WILLOW FLYCATCHER, AN ENDANGERED SPECIES. HIGH COST OF PLAN IS DUE TO SIGNIFICANT TECHNICAL AND ENGINEERING EXPERTISE REQUIRED FOR ADEQUATE IDENTIFICATION OF OUT-YEAR INITIATIVES.

Comments:

Fiscal Year	Programmed Funds
2001	$370,000.00
2002	$50,000.00
2003	$50,000.00
2004	$50,000.00
2005	$50,000.00
2006	$50,000.00
2007	$50,000.00
2008	$50,000.00
2009	$50,000.00
2010	$50,000.00

Project Number: HUAF010003

Project Name: COMPLY W/BO (USPP)

Narrative: USPP-UPPER SAN PEDRO PARTNERSHIP. REQUIRED TO COMPLY WITH THE ESA, 50 CFR 402 AND THE 1999 BIOLOGICAL OPINION, APPENDIX A, I, IV AND MOA, PAGE 4, NO.8. BO REQUIRES THAT THE FORT REDUCE NET WATER CONSUMPTION. USFWS HOLDS THE FORT RESPONSIBLE FOR A SIGNIFICANT PORTION OF OFF-INSTALLATION NET WATER USE. MOA TO THE BO COMMITS FORT HUACHUCA TO WORKING WITH THE REGIONAL PARTNERSHIP TO SUPPORT WATER USE REDUCTION PLANS AND IMPLEMENTATION OF PROJECTS IN THE SIERRA VISTA SUB WATERSHED. FUNDING IS FOR FORT'S CONTRIBUTION TO FEASIBILITY STUDIES AND IMPLEMENTATION OF PROJECTS LEADING TO NET REDUCTION OF WATER USE IN THE REGION. FORT'S CONTRIBUTION WAS ESTIMATED BASED ON PROJECTS CURRENTLY UNDER REVIEW BY USPP. THOSE PROJECTS ARE BASED GREATLY ON RECOMMENDATIONS IN THE NAFTA CEC EXPERT REPORT ON THE SAN PEDRO. THESE INCLUDE PURCHASE OF CONSERVATION EASEMENTS, PURCHASE OF WATER RIGHTS, INTERBASIN WATER TRANSFERS AND ASSOCIATED INFRASTRUCTURE, ETC. PARTNERSHIP 5 YEAR BUDGET PROJECTION IS AVAILABLE UPON REQUEST.

Comments:

Fiscal Year	Programmed Funds
2001	$831,000.00
2002	$500,000.00
2003	$500,000.00
2004	$500,000.00
2005	$500,000.00
2006	$150,000.00
2007	$150,000.00
2008	$150,000.00
2009	$150,000.00
2010	$150,000.00

Project Number: HUAF010004

Project Name: COMPLY W/BO(UMBEL/FLYCATCHER MONITORING IN SPRNCA)

Narrative: THIS PROJECT IS REQUIRED FOR COMPLIANCE WITH THE ESA, 50 CFR 402 AND BO/MOA, APPENDIX B, PAGE 3, NO 6, FROM THE FISH AND WILDLIFE SERVICE WHICH STATES, "...THE FORT SHALL FUND COMPREHENSIVE ANNUAL STATUS SURVEYS FOR FLYCATCHERS AT ALL SUITABLE HABITATS...ON FORT HUACHUCA AND THROUGHOUT THE SPRNCA." THIS INCLUDES ANNUAL MONITORING OF THE HUACHUCA WATER UMBEL AND WILLOW FLYCATCHER OFF POST AS WELL AS HABITAT MONITORING AND VEGETATION MAPPING, WHICH SHALL BE ACCOMPLISHED BY CONDUCTING OVERFLIGHT SURVEYS, AND THE AERIAL PHOTOS WILL BE USED FOR THE VEGETATION MAPPING, AND ALSO FOR SUFFICIENT GROUND TRUTHING TO ASSURE REASONABLE ACCURACY OF AERIAL PHOTOS, FOR THE FLYCATCHER IN THE SPRNCA IN 2000, 2004, AND 2008. VEGETATION MAPPING OF AERIAL PHOTOS FOR THE SPRNCA IS REQUIRED BY BO IN 2001, 2005, AND 2009. ESTIMATES OF COSTS FOR 05 AND 09, $140,400 FOR THE VEGETATION SURVEY.

Comments:

Fiscal Year	Programmed Funds
2002	$50,000.00
2003	$55,000.00
2004	$100,000.00
2005	$140,400.00
2006	$60,000.00
2007	$60,000.00
2008	$110,000.00
2009	$140,400.00
2010	$70,000.00

Project Number: HUAF980014

Project Name: COMPLY WITH BO (AGAVE MANAGEMENT)

Narrative: PROJECT IS REQUIRED FOR COMPLIANCE WITH ESA, 50 CFR 402, AR 200-3, CHAPTER 11. IMPLEMENT AGAVE MANAGEMENT PLAN, AS REQUIRED ON BO, APPENDIX B, PAGE 12, NO 14, AND PAGE 13, NO 19. AGAVE IS PRIMARY FOOD SOURCE THE ENDANGERED LESSER LONG-NOSED BAT. WORK WILL INCLUDE UPDATING AGAVE MANAGEMENT MAPS, DEVELOPING GIS DATABASE, INVENTORY AND MONITORING OF AGAVE STANDS EVERY FIVE YEARS (30K), MAINTAINING SIGNS TO PROTECT ROOSTS AND FORAGING HABITAT (10K), DEVELOP ENVIRONMENTAL AWARENESS MATERIALS AND SUPPORTING FUTURE AGAVE STUDIES (10K). COSTS HAVE INCREASED FROM PREVIOUS SUBMISSION DUE TO INCREASED CONTRACTOR COSTS ASSOCIATED WITH UPDATING AGAVE MAPS, SURVEYING AGAVE STANDS, AND AGAVE STUDIES BEING RESEARCHED BY THE UNIVERSITY OF ARIZONA. INCREASE IN OUTYEAR COST IN FY 04 AND FY 05 IS FOR THE CONTINUANCE OF FIRE RESEARCH ON AGAVE STANDS LOCATED ON THE FORT'S TRAINING RANGES.

Comments:

Fiscal Year	Programmed Funds
2002	$50,000.00
2003	$50,000.00
2004	$90,000.00
2005	$90,000.00
2006	$50,000.00
2007	$50,000.00
2008	$30,000.00
2009	$30,000.00
2010	$30,000.00

Project Number: HUAF980015

Project Name: COMPLY WITH BO(AQUATIC SPECIES MGMT)

Narrative: PROJECT IS REQUIRED FOR COMPLIANCE WITH ESA, 50 CFR 402, AR 200-3, CHAPTER 11, AND IS CURRENTLY STATED IN FH BO, APPENDIX B, PAGE 1, NO 5 (UMBEL) APPENDIX B, PAGE 3, NO 5 (FLYCATCHER) APPENDIX B, PAGE 13 NO 3 MOA. SPECIFICALLY, THE PROJECT WILL INCLUDE INVENTORY AND MONITORING THE POPULATION AND HABITAT OF THE ENDANGERED SONORAN TIGER SALAMANDER (10K), AND ON-POST AND SPRNCA POPULATIONS AND HABITAT OF THE HUACHUCA WATER UMBEL (25K) AND SOUTHWESTERN WILLOW FLYCATCHER (50K). THE INCREASE IN COST IS REQUIRED TO COVER CONTRACTED WORK TO SURVEY, MONITOR, AND PREPARE ANNUAL REPORT FOR ENDANGERED SPECIES ALONG THE 36 MILES OF THE SPRNCA AN ACCORDANCE WITH THE USFWS PROTOCOL.

Comments:

Fiscal Year	Programmed Funds
2002	$30,000.00
2003	$35,000.00
2004	$85,000.00
2005	$85,000.00
2006	$90,000.00
2007	$90,000.00
2008	$90,000.00
2009	$90,000.00

Project Number: HUAF980016

Project Name: IMPLEMENT ESMP (MGT OF CANDIDATE SPECIES)

Narrative: PROJECT IS REQUIRED FOR COMPLIANCE WITH THE ESA, 50 CFR 402, AND AR 200-3, CHAPTER 11, FH BO, DATED OCT 99, APPENDIX B, PAGE 16, NO. 7 /MOA, AND TO FULFILL THE OBLIGATIONS UNDER A FORMAL CONSERVATION AGREEMENT FOR THE RAMSEY CANYON LEOPARD FROG. PROJECT DOCUMENTS CURRENT DISTRIBUTION OF CANDIDATE SPECIES (HUACHUCA SPRNGSNAIL, GOSHAWK, LEMMON FLEABANE, AND RAMSEY CANYON FROG) ON THE INSTALLATION AND DEVELOP MONITORING PROTOCOLS AND GATHER POPULATION DATA. CURRENT MANAGEMENT ACTIVITIES INCLUDE PHYSICAL PROTECTION OF SITES AND WATERSHED MANAGEMENT TO BENEFIT SPECIES AND THEIR HABITATS. MANAGEMENT IS REQUIRED TO PRECLUDE FUTURE LISTING OF THESE SPECIES. SPECIFIC ACTIONS INCLUDE INVENTORY AND MONITORING FOR CANDIDATE SPECIES AND THEIR HABITAT (20K), AND CONDUCTING RESEARCH AND DEVELOPING MONITORING PROTOCOLS (10K). MONITORING PROTOCOLS HAVE NOT BEEN ACCOMPLISHED FOR ALL CANDIDATE SPECIES.

Comments:

Fiscal Year	Programmed Funds
1999	$27,562.00
2000	$60,000.00
2001	$60,000.00
2002	$30,000.00
2003	$30,000.00
2004	$30,000.00
2005	$30,000.00
2006	$30,000.00
2007	$30,000.00
2008	$30,000.00
2009	$30,000.00

Project Number: HUAF980018

Project Name: COMPLY W/BO (PROTECT SWWF CRITICAL HABITAT)

Narrative: PROJECT IS REQUIRED BY ESA 50 CFR 402 AND TO FULFILL BO, APPENDIX B, PAGE 16, NO. 6 /MOA WITH SERVICE WHICH STATES, "THE FORT SHALL IMPLEMENT THE EAST RANGE WATERSHED IMPROVEMENT PLAN TO IMPROVE WATERSHED MANAGEMENT ON THE EAST RANGE". EROSION IS A THREAT TO LISTED SPECIES TO INCLUDE CRITICAL HABITAT FOR THE ENDANGERED SOUTH WEST WILLOW FLYCATCHER. EAST RANGE WATERSHED IMPROVEMENT PLAN, INSTALLING EROSION CONTROL STRUCTURES, IMPLEMENTATION INCLUDES ROAD CLOSURE, RESTORATION, MAINTENANCE, AND EROSION MONITORING. PROJECT WOULD INCREASE WATER QUALITY AND RECHARGE WHILE DECREASING SOIL EROSION AND RUNOFF. PROJECT HUAF000003 AND HUAF980009 HAVE BEEN DISCONTINUED AND COMBINED WITH THIS PROJECT WHICH SIGNIFICANTLY INCREASES COSTS FOR THIS PROJECT. CLASS III ECAS FY00 FINDING. FY03-09 FUNDING INCREASED DUE TO POSSIBLE ARCHAEOLOGY SITES THAT MAY BE IMPACTED BY THE EAST RANGE WATERSHED WORK.

Comments:

Fiscal Year	Programmed Funds
1999	$2,493.00
2000	$436,790.00
2001	$120,000.00
2002	$300,000.00
2003	$325,000.00
2004	$325,000.00
2005	$325,000.00
2006	$325,000.00
2007	$325,000.00
2008	$325,000.00
2009	$325,000.00

Project Number: HUAF980020

Project Name: IMPLEMENT INRMP (INVASIVE SPECIES CONTROL)

Narrative: THIS PROJECT IS REQUIRED FOR COMPLIANCE WITH THE FEDERAL NOXIOUS WEED ACT, 7 CFR PART 360.300, AND EO 13112, 3 FEB 99 AND IS A CONSERVATION RECOMMENDATION IN BO, LLNB, PAGE 198 (SECTION 7(a)(1) of ESA). THIS INVASIVE EXOTIC BUNCH GRASS REDUCES HABITAT QUALITY AND IS DETRIMENTAL TO NATIVE SPECIES, BIO DIVERSITY AND ECOSYSTEM FUNCTION. ITS CONTINUED SPREAD IN GRASSLAND HABITATS ON FH INCREASES FIRE POTENTIAL AND THREATENS NEARBY AGAVE POPULATIONS THAT THE ENDANGERED LESSER LONG-NOSED BAT IS DEPENDENT UPON. FURTHER RESEARCH IS NEEDED TO DETERMINE THE EFFECTS OF CURRENT FIRE MANAGEMENT PRACTICES AND LAND USE ACTIVITIES ON LEHMANN LOVE GRASS AND THE EFFECTS LEHMANN LOVE GRASS MAY BE HAVING ON AGAVE DISTRIBUTION AND ABUNDANCE. LEHMANN LOVEGRASS INVASION AND ESTABLISHMENT IN LARGE, MONOTYPIC EXPANSES, IS LIKELY THE GREATEST THREAT TO WATERSHED FUNCTION IN THE GRASSLANDS OF FH, WHERE MILITARY ACTIVITIES ARE CONCENTRATED. WILDLAND FIRE IN LOVEGRASS EXPANSES CAN THREATEN AGAVE STANDS AND THUS INDIRECTLY AFFECT ENDANGERED LLNB THROUGHOUT THE POST. SHEETWASH AND SEDIMENTATION DOWNSTREAM CAN INDIRECTLY AFFECT ENDANGERED WATER UMBEL, PRIMARILY IN THE SAN PEDRO RIVER. CONCLUSIVE, EXPERIMENTAL APPROACH IS NECESSARY TO UNDERSTAND FIRE EFFECTS, AND THE ROLE OF TIMING AND TYPE OF FIRE ON LONG TERM AGAVE VIABILITY, EROSION RATES, AND LOVEGRASS CONTROL. PROJECT WILL BE COMPLETED VIA A CONTRACT WITH THE UOFA, WHO WILL STUDY THE EFFECTS OF FIRE ON LEHMAN'S THROUGH AN EXPERIMENTAL APPROACH.

Comments:

Fiscal Year	Programmed Funds
2002	$95,000.00
2003	$100,000.00
2004	$50,000.00
2005	$50,000.00

Project Number: HUAS010001

Project Name: PREPARE/UPDATE ENMP

Narrative: FUNDS REQUIRED TO UPDATE THE ENVIRONMENTAL NOISE MANAGEMENT PLAN (ENMP) AS REQUIRED BY AR 200-1, PARA 7-2A, 7-2C, 7-2D AND 7-5A, 40 CFR Part 209, AND THE NOISE CONTROL ACT AND QUIET COMMUNITIES ACT, 40 CFR 209. THIS WAS A FY00 ECAS CLASS III FINDING. THE ENMP INCLUDES ENVIRONMENTAL NOISE CONTOURS FOR LAAF, FORT HUACHUCA RANGES AND UNMANNED AERIAL VEHICLES, AND NEEDS TO BE UPDATED TO RELECT CURRENT OPERATIONS AT THESE FACILITIES. THE FUTURE INCREASED OPERATIONS AT SIERRA VISTA MUNICIPAL AIRPORT AND LAAF/UAV SHOULD ALSO BE ADDRESSED IN THE ENMP. THESE TYPES OF NOISE GENERATING ACTIVITIES CAN HAVE LONG TERM SIGNIFICANT IMPACTS BOTH ON CIVILIAN AND FORT HUACHUCA LAND USE PLANNING. THE PRIMARY PURPOSE OF THE ENMP IS TO IDENTIFY EXISTING LAND USE INCOMPATIBILITIES AND PREVENT CONFLICTS, BOTH ON-POST AND OFF-POST. FAILURE TO FUND THIS PROJECT COULD RESULT IN MISSION IMPACT ON TRAINING AREAS. FUNDING INCREASE IS DUE TO AIRPORT EXPANSION WHICH WILL RESULT IN NEW NOISE MONITORING. PLAN WILL EXPIRE IN FEB 2002. FY03 FUNDING MUST BE APPROVED IN ORDER TO BE IN COMPLIANCE. PROJECT INCLUDES $25K FOR NEW NOISE MONITORING.

Comments:

Fiscal Year	Programmed Funds
2001	$25,000.00
2002	$15,000.00
2003	$25,000.00
2004	$25,000.00
2005	$25,000.00
2006	$25,000.00
2007	$25,000.00
2008	$25,000.00
2009	$25,000.00

Project Number: HUAS020001

Project Name: COMPLY W/BO (EFFLUENT RECHARGE)

Narrative: REQUIRED TO COMPLY WITH THE CWA, SDWA, ESA, 50 CFR 402 AND THE 1999 BIOLOGICAL OPINION. BO, APPX A AND MOA, PAGE 3 c(1) REQUIRES THE FORT TO REDUCE NET WATER CONSUMPTION. UNTREATED SEWAGE DISCHARGED TO THE SUBSURFACE HAS THE POTENTIAL TO CONTAMINATE GROUNDWATER. THESE DISCHARGES CONSTITUTE A VIOLATION OF AQUIFER PROTECTION PERMIT. REGULATIONS ESTABLISHED IN AAC R18-9-301 REQUIRE THAT SEWAGE COLLECTION SYSTEMS BE OPERATED AND MAINTAINED TO PROTECT WATER QUALITY THROUGH MINIMIZATION OF EXFILTRATION. ADDITIONALLY, THESE EXFILTRATION LOSSES CONSTITUTE A REDUCTION IN THE QUANTITY OF TREATED EFFLUENT AVAILABLE FOR RECHARGE. FORT HUACHUCA HAS COMMITTED TO REDUCING WATER CONSUMPTION AND MAXIMIZING THE RECHARGE OF TREATED EFFLUENT. CURRENT ESTIMATED LOSSES OF UNTREATED SEWAGE LOSS, REPRESENT AN ANNUAL REDUCTION IN RECHARGE CAPACITY OF 144 AC-FT OR APPROXIMATELY 12% OF THE TOTAL VOLUME OF TREATED EFFLUENT PRODUCED ON FORT HUACHUCA. THE AMOUNT OF UNTREATED SEWAGE CURRENTLY BEING LOST FROM THE CONVEYANCE SYSTEM IS ESTIMATED TO BE IN EXCESS OF 128,000 GALLONS PER DAY. THE DISCHARGE OF UNTREATED SEWAGE ALSO REPRESENTS A VIOLATION OF SOLID WASTE MANAGEMENT RULES ESTABLISHED BY ADEQ AND CODIFIED IN AAC R18-8-063. FAILURE TO FUND WOULD RESULT IN FINES.

Comments:

Fiscal Year	Programmed Funds
2003	$488,000.00
2004	$590,000.00
2005	$529,000.00
2006	$593,000.00
2007	$648,000.00

Project Number: HUAS020005

Project Name: PROGRAM MANAGEMENT SUPPORT (CNS)

Narrative: STAFF REQUIREMENTS FOR ENVIRONMENTAL PROGRAM MANAGEMENT UNDER THE COMPLIANCE PILLAR WITH THE TOTAL MANAGEMENT REQUIREMENT DISTRIBUTED AMONG ALL PILLARS ARE AS FOLLOWS: (VENC, $798,409.29) COMPLIANCE, (VEPP, $34,163.31) POLLUTION PREVENTION, AND (VENN, $432,735.31) CONSERVATION. THE PURPOSE IS TO ACQUIRE AND MAINTAIN AN ADEQUATE STAFF TO ACCOMPLISH ENVIRONMENTAL PROGRAM MANAGEMENT AS REQUIRED BY AR 200-1, PARA 1-20A, AND 1-27A. SALARIES, BENEFITS, (AND TRAVEL, OFFICE SUPPLIES, EQUIPMENT, SERVICES AND AWARDS) ARE NEEDED FOR 17 CIVIL SERVICE IN JOB SERIES, 0028, 0816, 0486, 0193, ETC., PERFORMING MULTI-REGULATORY MEDIA TASKS, INCLUDING, RCRA, IRP, CAA, NEPA, CULTURAL AND NATURAL RESOURCES IN FY 2000, 2001. TRAVEL INVOLVES STAFF VISITS, MEETINGS, AND CONFERENCES EXCEPT WHERE CONFERENCES ARE USED FOR, OR IN LIEU OF, TRAINING. THE ESTIMATES ARE BASED ON CURRENT PAY TABLES. IF NOT FUNDED, THE INSTALLATION WILL LACK ADEQUATE STAFF TO MANAGE ENVIRONMENTAL REQUIREMENTS BASED ON FEDERAL, STATE, AND LOCAL REGULATIONS, AND AGREEMENTS, INCLUDING CONSENT ORDERS, BO/MOA AND REGULATORY COMPLIANCE IN A REASONABLE MANNER.
A64a = 2.75 ($71,625), A64b = 1.5 ($276,877), A66a = 1.0 ($35,813), A66b = 2.0 ($64,251), A66c = 1($71,625), A66d = 3.5 ($132,433), A66e = .50 ($23,875), A66f = 1 ($35,813), A67 = .50 ($23,875), A66 = 4.5 ($209,887) (Equipment, TDY, Training $14,692.09) TOTAL WY = 18.25

Comments:

Fiscal Year	Programmed Funds
2003	$430,363.00
2004	$430,363.00
2005	$452,343.00
2006	$457,523.00
2007	$457,523.00
2008	$457,523.00
2009	$457,523.00

Project Number: HUAS030005

Project Name: IMPLEMENT INRMP (ENVIRONMENTAL AWARENESS)

Narrative: THIS PROJECT IS REQUIRED TO COMPLY WITH SIKES ACT, AND AR 200-3. DUE TO SIGNIFICANCE OF NATURAL RESOURCES AT FORT HUACHUCA, THE INSTALLATION MUST IMPLEMENT THE INTEGRATED NATURAL RESOURCE MANAGEMENT PLAN. SPECIFICALLY, THE DEVELOPMENT OF ENVIRONMENTAL AWARENESS PROGRAMS ARE REQUIRED TO SUPPORT ARMY TRAINING IN THE FIELD, RANGE, AND TRAINING AREAS ON POST.

Comments: PROJECT IAW AEC/TRADOC COMMENTS

Fiscal Year	Programmed Funds
2002	$30,000.00
2003	$30,000.00
2004	$30,000.00
2005	$30,000.00
2006	$30,000.00
2007	$30,000.00
2008	$30,000.00
2009	$30,000.00

Project Number: HUAS91-020

Project Name: COMPLY W/BO (MONITOR SPOTTED OWL/PEREGRINE FALCON)

Narrative: THIS PROJECT IS REQUIRED TO MONITOR THE MEXICAN SPOTTED OWL, A FEDERALLY THREATENED SPECIES, A KNOWN RESIDENT ON FORT HUACHUCA. THE MONITORING IS REQUIRED TO COMPLY WITH THE MEXICAN SPOTTED OWL RECOVERY PLAN, ENDANGERED SPECIES ACT, 50 CFR 402 AND AR 200-3, CHAPTER 11 AND FH BO, APPENDIX B, PAGE 6, NO 2 (SPOTTED OWL), APPENDIX B, PAGE 4 (PEREGRINE FALCON)/MOA. PEREGRINE FALCONS HAVE NESTED ON FORT HUACHUCA AND THEIR POPULATIONS WILL CONTINUE TO BE MONITORED PER FH BO/MOA. THE SPOTTED OWL RECOVERY PLAN HAS BEEN COMPLETED. $30K IS REQUIRED FOR MONITORING SPOTTED OWL; $30K IS FOR FURTHER REQUIRED SURVEYING IDENTIFIED IN THE FH BO, FOR THE PEREGRINE FALCON. THIS PROJECT IS NOT RECOMMENDED FOR DELETION, THERE IS A NEED FOR CREDIBILITY OF ECAS.

Comments:

Fiscal Year	Programmed Funds
2002	$20,000.00
2003	$40,000.00
2004	$60,000.00
2005	$60,000.00
2006	$60,000.00
2007	$60,000.00
2008	$60,000.00
2009	$60,000.00
2010	$60,000.00

Project Number: HUAS950025

Project Name: IMPLEMENT ESMP (SPOTTED OWL DEMOGRAPHICS)

Narrative: INSTALLATIONS ARE REQUIRED TO HAVE ENDANGERED SPECIES MANAGEMENT PLANS IAW THE SIKES ACT, 16 USC 670 ET SEQ AND 50 CFR 402. THE INVESTIGATION OF POPULATION DEMOGRAPHICS OF FEDERALLY THREATENED SPOTTED OWLS WILL CHARACTERIZE HABITAT USE AND FEEDING, JUVENILE DISPERSAL AND SURVIVAL (50K), IN ORDER TO PROVIDE SPECIFIC INFORMATION IN ACCORDANCE WITH THE RECOVERY PLAN AND FOR THE ESMP IMPLEMENTATION. THE PROJECT WILL FILL A CRITICAL INFORMATION GAP ABOUT HABITAT QUALITY AND POPULATION VIABILITY, AND MAY CONTRIBUTE TO THE DE-LISTING PROPOSAL FOR THIS REGION. PROJECT WOULD BE ACCOMPLISHED BY CONTRACTING WITH LOCAL MSO RESEARCHERS WHO WOULD USE RADIO TELEMETRY TO DETERMINE HABITAT USE, DISPERSAL, AND SURVIVAL AND ANALYZE OWL PELLETS FOR FOOD ITEMS. THIS WAS A FY00 ECAS CLASS II FINDING.

Comments:

Fiscal Year	Programmed Funds
2002	$50,000.00
2003	$50,000.00
2004	$60,000.00
2005	$60,000.00
2006	$60,000.00
2007	$60,000.00
2008	$60,000.00
2009	$60,000.00
2010	$60,000.00

Project Number: HUAS96

Project Name: IMPLEMENT ESMP (MOUNTAIN FRONT RECHARGE)

Narrative: REQUIRED FOR COMPLIANCE WITH ENDANGERED SPECIES ACT, 50 CFR 402. EFFORT TO RECHARGE GROUND WATER TO AVOID POSSIBLE INDIRECT EFFECT ON ENDANGERED SPECIES DOWNSTREAM. PROMISED MITIGATION UNDER EIS AND BIOLOGICAL ASSESSMENT. INCLUDES DESIGN, SITE INVESTIGATIONS, ETC. $100K OF FY04 FUNDING IS TO ADD ADDITIONAL RECHARGE BASINS. ADDITIONAL BASINS WILL BE IDENTIFIED AND CONSTRUCTED UNTIL 1000 ACRE FEET OF URBAN STORM WATER RUNOFF RECHARGE OCCURS.
$400K OF FY04 FUNDING IS TO INSTALL MONITORING INSTRUMENTATION FOR EAST RANGE RECHARGE PROJECT SO DATA WILL BE AVAILABLE TO SHOW SUCCESS OF RECHARGE INITIATIVE. PREVIOUS FUNDING HAS BEEN FOR SITE ASSESSMENT AND CONSTRUCTION OF BASIN IN CANTONMENT WHICH IS ONGOING. FAILURE TO FUND WOULD RESULT IN VIOLATION OF MOA WITH USF&WS, AND COULD RESULT IN A JEOPARDY OPINION. (PROJECT HUAF01001 HAS BEEN COMBINED WITH THIS PROJECT).
FY 2005 AND BEYOND FUNDING IS TO ADD ADDITIONAL BASINS UNTIL PROMISED MITIGATION OF 1000 ACRE FEET OF URBAN STORM WATER RUNOFF RECHARGE OCCURS.

Comments: PROJECT IS TO SATISFY MITIGATION COMMITMENTS. USF&WS CONSULTATION IRRELAVENT
THIS IS AN INDEPENDANT MITIGATION COMMITMENT FROM RPMP EIS AND BA, AS DISCUSSED IN NARRATIVE (TAS)
INSTALLATION COMMITED TO RECHARGE PROJECTS IN RECENT MOA WITH USF&WS TO AVOID JEOPARDY OPINION (RLA)

Fiscal Year	Programmed Funds
2002	$400,000.00
2003	$150,000.00
2004	$500,000.00
2005	$150,000.00
2006	$150,000.00
2007	$100,000.00
2008	$100,000.00
2009	$100,000.00
2010	$100,000.00

Project Number: HUAS960001

Project Name: IMPLEMENT INRMP

Narrative: THIS PROJECT IS REQUIRED TO COMPLY WITH ESA, 50 CFR 402, SIKES ACT,HABITAT MANAGEMENT REQUIREMENT OF EO 13112 (INVASIVE SPECIES) EO 13186 (MIGRATORY BIRDS), ECAS FY98 FINDING NUMBER NR-TS-01, AND AR200-3 AND BO/MOA. DUE TO SIGNIFICANCE OF NATURAL RESOURCES AT FORT HUACHUCA, THE INSTALLATION MUST START IMPLEMENTING THE INTEGRATED NATURAL RESOURCES PLAN WHICH WAS COMPLETED IN 2001. SPECIFIC ACTIVITIES INCLUDE, EXOTIC SPECIES MANAGEMENT, MANAGEMENT OF SPECIES OF SPECIAL CONCERN AND HABITAT MANAGEMENT FOR GAME AND NON-GAME SPECIES, WHICH ARE RECURRING REQUIREMENTS. PROJECT ALSO INCLUDES GIS CAPABILITY (CLASS 3 ECAS FY98 FINDING, NR-TS-07) AND DATABASE MANAGEMENT, AND PARTNER IN OVER-FLIGHT ACTIVITIES. INRMP DUE BY NOV 2001, IAW THE SIKES ACT. INRMP WILL BE REDONE EVERY FIVE YEARS AFTER BEING PUBLISHED. CLASS II ECAS FY00 FINDING.

Comments: PROJECT IAW AEC/TRADOC COMMENTS.

Fiscal Year	Programmed Funds
1997	$35,000.00
1998	$144,736.00
1999	$44,419.00
2000	$140,000.00
2001	$140,000.00
2002	$150,000.00
2003	$125,000.00
2004	$125,000.00
2005	$160,000.00
2006	$160,000.00
2007	$160,000.00
2008	$160,000.00
2009	$160,000.00

Project Number: HUAS960002

Project Name: COMPLY WITH BO (WATER CONSERVATION PROGRAM)

Narrative: REQUIRED TO MAINTAIN A FLOW OF WATER THROUGH THE SAN PEDRO RIPARIAN NATIONAL CONSERVATION AREA AND PREVENT AQUIFER DRAWDOWN IN VIOLATION OF ESA, 50 CFR 402.01 (A), 402.10 AND 402.12 AND THE FH BO, APPENDIX A, /MOA. USF&WS CONTENDS FORT IS ADVERSELY IMPACTING TWO ENDANGERED/THREATENED SPECIES FROM PUMPING GROUND WATER. THIS PROJECT IS REQUIRED TO IMPLEMENT WATER CONSERVATION MEASURES SUCH AS WATERLESS URINALS, COMPOSTING TOILETS, LEAK DETECTION SURVEY, CONSERVATION EDUCATION, WATERSHED IMPROVEMENT AND DESERT LANDSCAPING. THIS PROJECT IS REQUIRED TO ADDRESS ECAS FINDING #NR-020-001, AND AN AUGUST 1997 LETTER TRADOC CHIEF OF STAFF THAT COMMITS FORT HUACHUCA TO IMPLEMENT WATER CONSERVATION MEASURES. THIS IS NOT A POLLUTION PREVENTION PROJECT. UNTIL DESIGN FUNDS ARE RECEIVED, NO FIRM COST ESTIMATES CAN BE FURNISHED. OVERALL STRATEGY FOR MITIGATION FOR EIS AND BIOLOGICAL OPINION IS WATER CONSERVATION (THIS PROJECT), EFFLUENT REUSE AND RECHARGE, AND MOUNTAIN FRONT RECHARGE. PROJECT HUAS970007, COMBINED WITH THIS PROJECT. IN FY00, OVER 166 MILLION GALLONS OF WATER WAS SAVED DUE TO IMPLEMENTATION OF WATERWISE PROGRAM, EXTENSION OF POTABLE WATERLINE TO AEROSTAT, LRC FILTRATION SYSTEM, DESERT LANDSCAPING AND WATERLESS URINALS, AND LEAK DETECTION SURVEY/REPAIRS.

Comments: EXPENDURES FOR OUTYEARS INCLUDE METERED FAUCETS IN ADMIN AREAS (30K), LOW-FLOW SHOWERHEADS (10K), WATERLESS URINALS (50K), HORIZONTAL WASHERS FOR BARRACKS (100K), WATERWISE EDUCATION (30K), INCREASE COST DUE TO LEAK DETECTION SURVEY (80K).

Fiscal Year	Programmed Funds
2002	$300,000.00
2003	$308,000.00
2004	$300,000.00
2005	$300,000.00
2006	$500,000.00
2007	$400,000.00
2008	$200,000.00
2009	$200,000.00
2010	$200,000.00

Project Number: HUAS960003

Project Name: COMPLY WITH BO (FIRE MANAGEMENT)

Narrative: PROJECT IS REQUIRED FOR COMPLIANCE WITH ESA, 50 CFR 402, AND FH BO, APPENDIX B, PAGE 1, NO. 2 (UMBEL), APPENDIX B, PAGE 2, NO 1 (FLYCATCHER), APPENDIX B, PAGE 7, NO 15 (SPOTTED OWL), APPENDIX B, PAGE 16, NO. 4(IMPLEMENT PLAN)/MOA, TO AVOID ADVERSE HABITAT MODIFICATION OR TAKE THROUGH CATASTROPHIC WILDFIRES ORIGINATING FROM TRAINING OR RECREATION. PROJECT IS NEEDED TO PROTECT 1 THREATENED, 3 ENDANGERED, AND 4 CANDIDATE SPECIES ON FORT HUACHUCA AND CRITICAL HABITAT FOR THE UMBEL ON POST AND THE SOUTHWESTERN WILLOW FLYCATCHER ON NEARBY LANDS. ACTIVITIES INCLUDE PREPARING FIRE PRESCRIPTIONS, USING PRESCRIBED BURNS, MECHANICAL FUEL REDUCTION, FIRE MONITORING, FIREBREAK MAINTENANCE, UPDATE THE FH FIRE MANAGEMENT PLAN. INCREASE COSTS IS FOR THE DEVELOPMENT OF MITIGATION AND MONITORING PLANS, AND COORDINATION WITH VARIOUS STATE AND FEDERAL AGENCIES. THESE ACTIVITIES WILL IMPLEMENT THE FH FIRE MANAGEMENT PLAN, AS REQUIRED IN BO/MOA. CLASS III ECAS FINDING.

Comments:

Fiscal Year	Programmed Funds
2002	$120,000.00
2003	$120,000.00
2004	$160,000.00
2005	$160,000.00
2006	$160,000.00
2007	$170,000.00
2008	$170,000.00
2009	$170,000.00
2010	$170,000.00

Project Number: HUAS960010

Project Name: COMPLY WITH BO (MOA WITH FOREST SERVICE)

Narrative: THIS PROJECT IS REQUIRED FOR COMPLIANCE WITH THE ENDANGERED SPECIES ACT, 50 CFR 402, AND FH BO, APPENDIX B, PAGE 15 NO. 1/MOA, TO ENSURE HABITAT FOR MEXICAN SPOTTED OWL, HUACHUCA WATER UMBEL, AND SONORA TIGER SALAMANDER IS NOT DESTROYED. INSTALLATION PERSONNEL LACK THE TRAINING AND EQUIPMENT TO FIGHT FIRES IN RUGGED MOUNTAINOUS TERRAIN. IAW MOA THIS INCLUDES SLURRY BOMBING, FORREST FIRE SUPPORT ETC. PREVENTION AND CONSERVATION MEASURES WERE CONSIDERED BUT WOULD NOT PRECLUDE THE NEED FOR SUCH SUPPORT FOR WILD FIRES, LIGHTENING STRIKE FIRES, ETC.

Comments:

Fiscal Year	Programmed Funds
2002	$25,000.00
2003	$25,000.00
2004	$25,000.00
2005	$30,000.00
2006	$30,000.00
2007	$30,000.00
2008	$30,000.00
2009	$30,000.00
2010	$30,000.00

Project Number: HUAS960011

Project Name: COMPLY WITH BO (LESSER LONG-NOSED BAT MANAGEMENT)

Narrative: REQUIRED FOR COMPLIANCE WITH ENDANGERED SPECIES ACT, 40 CFR 402, AND FH BO, APPENDIX B, PAGE 9, LESSER LONG NOSE BAT SECTION/MOA. ENDANGERED SPECIES MANAGEMENT PLAN IS BEING FINALIZED AND IMPLEMENTATION OF MANAGEMENT ACTIONS IS REQUIRED. LESSER LONG NOSED BAT FORAGES AND ROOSTS ON FORT HUACHUCA. TRAINING ACTIVITIES ARE MANAGED TO MINIMIZE IMPACT ON SPECIES, BUT BOTH TRAINING AND RECREATION ACTIVITY HAVE IMPACT WITHOUT ACTIVE PROGRAM MANAGEMENT. PROJECT NUMBER HUAS91-018 HAS BEEN COMBINED WITH THIS PROJECT. THE ONLY OTHER BAT PROJECT BESIDES THIS ONE IS THE AGAVE MANAGEMENT PLAN IMPLEMENTATION. SPECIFIC ACTIVITIES INCLUDE MAINTENANCE OF ALARM SYSTEMS AT BAT ROOSTS (5K)(ECAS FY 98 CLASS 3 FINDING), ANNUAL SURVEY AND REPORT FROM LESSER LONG NOSE BAT EXPERT (25K) AND RESEARCH ON BAT FORAGING, HABITAT (20K), USE, ETC. WORK WILL BE COMPLETED BY CONTRACTING WITH U OF A AND EEC. THIS IS A CLASS II ECAS FY00 FINDING.

Comments:

Fiscal Year	Programmed Funds
2002	$35,000.00
2003	$50,000.00
2004	$50,000.00
2005	$40,000.00
2006	$40,000.00
2007	$40,000.00
2008	$40,000.00
2009	$40,000.00
2010	$40,000.00

Project Number: HUAS960012

Project Name: IMPLEMENT ESMP (BIOLOGICAL ASSESSMENTS)

Narrative: REQUIRED FOR COMPLIANCE WITH ENDANGERED SPECIES ACT, 50 CFR 402 AND NEPA, 40 CFR 1500-1508. LAW REQUIRES ASSESSMENT OF FORT HUACHUCA IMPACT ON LISTED SPECIES ON FORT HUACHUCA AND SPRNCA, THIS INCLUDES THE SOUTHWEST WILLOW FLYCATCHER, MEXICAN SPOTTED OWL, AND LESSER LONG-NOSED BAT, SONORA TIGER SALAMANDER AND HUACHUCA WATER UMBEL. FUNDING IS REQUIRED TO PERFORM BASELINE BIOLOGICAL ASSESSMENTS ON DOWNSTREAM FISH, SOUTHWEST WILLOW FLYCATCHER, HUACHUCA WATER UMBEL AND SONORA TIGER SALAMANDER. FUNDING IS FOR A BA FOR OUTYEAR PROJECTS WHICH INCLUDE RECHARGE PROJECT SUPPORT TO MINIMIZE TES IMPACT, AND RESITE FOR AMMUNITION SUPPLY POINT. PROGRAMMATIC CONSULTATION ON FH'S MISSION WAS COMPLETED AND LITTLE ADDITIONAL CONSULTATION IS EXPECTED IN THE NEAR FUTURE.

Comments:

Fiscal Year	Programmed Funds
1997	$162,000.00
1998	$40,600.00
1999	$75,000.00
2000	$10,000.00
2001	$10,000.00
2002	$10,000.00
2003	$10,000.00
2004	$10,000.00
2005	$10,000.00
2006	$10,000.00
2007	$10,000.00
2008	$10,000.00
2009	$10,000.00

Project Number: HUAS960014

Project Name: IMPLEMENT ESMP(SUBSURFACE SURVEYS)

Narrative: REQUIRED TO COMPLY WITH THE ESA, 50 CFR 4002. CONCERN IS THAT GROUNDWATER PUMPING FROM FORT HUACHUCA MAY IMPACT SAN PEDRO RIVER AND EFFECT DOWNSTREAM T&E SPECIES. REQUIRED TO DEFINE THE HYDROLOGY FROM WELLS TO THE RIVER. INITIAL INDICATIONS FROM 1ST PHASE SEISMIC SURVEY ON PART OF EAST RANGE INDICATE EXISTING WATER MODELS ARE INCORRECT. THIS PROJECT IS REQUIRED TO GIVE FORT HUACHUCA SUFFICIENT DATA TO DETERMINE APPROPRIATE MITIGATION MEASURES FOR OUTYEAR FUNDING. FUNDING INCLUDES WELL MONITORING ACTIVITIES (80K, STREAM GAUGE MAINTENANCE AND OPERATION (12K, AND MICROGRAVITY TESTING OF THE BASIN'S WATER TABLE SURFACE (10K), AND TO ESTABLISH TWO ADDITIONAL MONITORING SITES ADJACENT TO FORT HUACHUCA/SAN PEDRO NCA BOUNDING IN TRAINING AREA (70K) FH BO APPENDIX A, PAGE 3 NO VII MOA STATES "...THE ARMY WILL CONTINUE TO SUPPORT HYDROLGEOLOGIC RESEARCH IN THE WATERSHED TO GAIN A BETTER UNDERSTANDING OF THE HYDROLOGY..."

Comments:

Fiscal Year	Programmed Funds
2002	$100,000.00
2003	$100,000.00
2004	$100,000.00
2005	$100,000.00
2006	$100,000.00
2007	$100,000.00
2008	$100,000.00
2009	$100,000.00
2010	$100,000.00

Project Number: HUAS970001

Project Name: COMPLY W/BO (EFFLUENT RECHARGE)

Narrative: FUNDING FOR FY 2002 RECEIVED. WORK NOT YET COMPLETED. FUNDING FOR FY 2003 AND BEYOND NOT REQUIRED.
REQUIRED TO COMPLY WITH 40 CFR 402. REQUIRED TO MAINTAIN A FLOW OF WATER THROUGH THE SAN PEDRO RIPARIAN NATIONAL CONSERVATION AREA PER 16 USC SECTION 460xx. THIS IS A SIGNIFICANT DEMONSTRATION PROJECT WHICH IS URGENTLY REQUIRED FOR FORT HUACHUCA TO COMPLY WITH THE ESA AND DEFEND AGAINST EXPENSIVE LAWSUITS. FORT HUACHUCA CURRENTLY USES 2500 ACRE FEET PER YEAR GROUNDWATER. THE ENTIRE PROJECT HAS THE POTENTIAL TO RECHARGE REGIONAL AQUIFER WITH 1000 ACRE FEET OF GROUND WATER PER YEAR. LAWSUITS CAN BE EXPECTED CONCERNING FORT HUACHUCA'S WATER USAGE AND ITS EFFECT ON ENDANGERED SPECIES. FT HUACHUCA'S GROUNDWATER PUMPING IS POTENTIALLY IMPACTING THE WATER TABLE IN THE SAN PEDRO RIVER WHICH WOULD ADVERSELY IMPACT 3 ENDANGERED SPECIES. THE MCA PROJECT INCLUDES A SERIES OF PIPELINES, PUMPS, METERS, AND CATCH BASINS, TO REINJECT THE TREATED EFFLUENT WATER INTO AREAS WHERE IT WILL PERCOLATE BACK INTO THE GROUND AND REPLENISH THE GROUNDWATER AQUIFER. (CONTINUED IN COMMENTS)

Comments: EPA REQUIRED NARRATIVE (CONT). UNLESS A MAJOR PROJECT TO RECHARGE THE UNDERGROUND AQUIFER CAN BE IMPLEMENTED, OUR COMPLIANCE WITH THE ESA AND COMPLIANCE WITH THE 16 USC SECTION 460, AND ABILITY TO DEFEND AGAINST ESA LAWSUITS IS QUESTIONABLE. MCA PROJECT: PN 46756

Fiscal Year	Programmed Funds
2000	$6,000,000.00
2002	$5,900,000.00

Project Number: HUAS970009

Project Name: IMPLEMENT INRMP (REGIONAL LANDSCAPE PLANNING)

Narrative: PROJECT IS LEGACY PROJECT. IN ADDITION TO COMPLIANCE WITH THE ESA, PROJECT IS ALSO REQUIRED BY SIKES ACT, DUSD(ES) MEMO AND DOD CONSERVATION INSTRUCTION 4715.3. THIS PROJECT CONSISTS OF UNIVERSITY AND CONSERVATION ORGANIZATIONS WHICH WOULD ADDRESS DIFFERING SCENARIOS OF DEVELOPMENT IN THE FORT HUACHUCA AREA WHICH WOULD IMPACT FLOW IN THE SAN PEDRO RIVER AND ENDANGERED SPECIES SUCH AS SW WILLOW FLYCATCHER, SPIKEDACE, ETC. THE ENDANGERED SPECIES PORTION WOULD BE INCLUDED AS PART OF THE MODELLING AND GEOGRAPHIC INFORMATION SYSTEM. OUTCOME WOULD BE VARIOUS SCENARIOS INCLUDING TIMING OF CONSERVATION STATEGIES AND THE IMPACT ON BIODIVERSITY. COST ESTIMATE IS BASED ON USACERL. PROJECT IS NOT COMPLETE. WE HAVE NOT RECEIVED A FINAL REPORT. FUNDING IN OUTYEARS IS FOR KEEPING THE MODELS CURRENT.

Comments:

Fiscal Year	Programmed Funds
1998	$456,000.00
1999	$700,000.00
2000	$445,000.00
2001	$250,000.00
2002	$200,000.00
2003	$250,000.00
2004	$250,000.00
2005	$250,000.00
2006	$250,000.00
2007	$250,000.00
2008	$250,000.00
2009	$250,000.00