Huachuca Area FIRE Partners

Restoring
Healthy Landscapes
and Ecosystems

FIRE MANAGEMENT PLAN 2005

Fire Management Plan

Appleton-Whittell Research Ranch, National Audubon Society
Arizona State Land Department
Babocomari Ranch
Coronado National Memorial, National Park Service
Fort Huachuca, U.S. Army
San Pedro Riparian National Conservation Area, Bureau of Land Management
San Rafael Ranch
San Rafael Ranch State Park, Arizona State Parks
Sierra Vista Ranger District, Coronado National Forest, USDA Forest Service
Southeastern Arizona Preserves, The Nature Conservancy

November 17, 2005

For additional information about this Fire Management Plan or other HAFP activities, contact Brooke Gebow at The Nature Conservancy: 520-803-7953.

Cover photos (top to bottom): Huachuca Mountains, The Nature Conservancy
Air tanker retardant drop, USDA Forest Service
Palominas Fire, Arizona (2004), Gordon Lewis
HAFP field exercise, Arizona (2004), Brooke Gebow

Summary

The Huachuca Area Fire Partners (HAFP) is an alliance of public and private groups in southeastern Arizona's Santa Cruz and Cochise counties. Parties from the Patagonia Mountains on the west to the San Pedro River on the east have come together to manage fire activities over the 500,000-acre borderlands area. The Fire Management Plan is a general framework for landscape-level fire management that does not replace any approved fire management plans of partner organizations. Partner FMPs always take precedent over this framework. The intent of the HAFP is to take on projects that participants are unable to accomplish on their own. This FMP is one result of ongoing collaboration among these landowners:

- Appleton-Whittell Research Ranch, National Audubon Society
- Arizona State Land Department
- Babocomari Ranch
- Coronado National Memorial, National Park Service
- Fort Huachuca, U.S. Army
- San Pedro Riparian National Conservation Area, Bureau of Land Management
- San Rafael Ranch
- San Rafael Ranch State Park, Arizona State Parks
- Sierra Vista Ranger District, Coronado National Forest, USDA Forest Service
- Southeastern Arizona Preserves, The Nature Conservancy

Historically, fire burned frequently in the grasslands and woodlands of southeastern Arizona. Regular fire keeps shrubs out of grasslands, thins forests to remove fire-intolerant trees, increases streamflows, and renews wildlife habitat. Fire also prevents unwanted fire. Burning and other treatments can minimize potential for wildfires by reducing overall quantities of fuels and breaking up contiguous vegetation. The fire partnership aims to work together to let natural fires burn when feasible, suppress unwanted wildfires, conduct prescribed burns, and use non-fire means to reduce fuels around developed areas. HAFP projects will cross political boundaries to manage fire along natural features and roadways.

The benefits of managing for fire on a broad landscape scale such as the Huachuca area are numerous. Foremost are: increased public and fire crew safety, widespread improvement in ecosystem function, and economical execution of fire activities.

The HAFP landscape includes a diverse mix of geologic, hydrologic, and vegetation conditions. Chapter 2 of this plan defines thirteen prominent ecological units that provide a context for understanding fire regimes and resulting management considerations.

Chapter 3 describes three fire management units (FMUs) for the area. The first FMU is the site of suppression and non-fire applications around high risk areas. The second FMU allows prescribed fire in addition to non-fire applications and suppression. The third FMU embraces all management strategies including wildland fire use. Chapter 4 discusses wildland fire operations of the many landowners in the region, particularly how the Coronado National Forest coordinates with other landowners.

Chapter 5 proposes a number of collaborative projects for the HAFP and discusses why the particular projects are priorities. The chapter presents purpose, location, size, timing, cost, and

wildland-urban interface concerns for each project. Each project involves at least two parties from the group and benefits from broader participation.

Chapters 6 through 10 look at the regional environmental issues and compliance concerns facing fire managers in the HAFP planning area. Chapter 6 reviews issues that would likely be the focus of analysis of the proposed HAFP fire program under the National Environmental Policy Act. Chapter 7, written with the assistance of U.S. Fish and Wildlife Service, Arizona Ecological Services office, addresses the responsible protection of sensitive natural resources, with emphasis on requirements of the Endangered Species Act. The analysis for Federally listed species forms the basis of a future programmatic Biological Assessment. The need to protect the region's rich biological diversity is one of the major drivers of this collaboration.

The proliferation of non-native, invasive grasses create other challenges for fire managers. Chapter 8 introduces the most problematic invasives in the planning area, Johnson grass and Lehmann lovegrass. In Chapter 9, the plan acknowledges the long cultural history of the Huachuca area along with important protection measures for the many sites, structures, and objects that remain as evidence of previous residents. Chapter 10 describes the Huachuca region south of the border with Mexico, discusses complications introduced by illegal border crossing, and concludes with a look at the potential for cross-border fire management cooperation.

Chapter 11 identifies the many environmental monitoring efforts taking place throughout the planning area. Regional resource managers have provided their monitoring history on sensitive species, invasive species, fire, range/grazing, border impacts, weather, and water. The chapter also summarizes the monitoring needs of the HAFP fire program, acknowledging the difficulty of acquiring the funding to carry out monitoring projects. The HAFP will creatively apply existing and new monitoring efforts to improve fire management.

Chapter 12 compiles HAFP outreach priorities. An important benefit of the collaboration is communication about fire to all sectors of the public with a unified voice. The chapter identifies key audiences and messages.

Chapter 13 recognizes the many individuals and organizations that have contributed to this fire management plan. This collaborative effort has succeeded because of their expertise, dedication, and hard work in the form of research, decisions, mapping, writing, and editing.

The Huachuca Area Fire Partners thank Tom Dooley, Peter Ffolliott, Lisa Hanson, Bob Lineback, Dean McAlister, Guy McPherson, and Mark Pater for their thorough reviews of this document. Their helpful suggestions have been incorporated into this final version of the FMP (November 17, 2005).

Agreement

The Huachuca Area Fire Partners (HAFP) seek to restore healthy landscapes and ecosystems by managing fire collaboratively as set forth in this Fire Management Plan (FMP). By our signatures, we adopt this FMP on behalf of the organizations we represent. We acknowledge that our partnership is voluntary in nature. The HAFP FMP will complement but not replace our own agency guidelines for managing fire. This FMP reflects our resolve to see fire managed on a landscape scale and work as a safe, ecologically beneficial process in a biologically rich region with diverse owners and users.

Signed:

_____ _____

(Name, title)
Appleton-Whittell Research Ranch
National Audubon Society

Date

_____ _____

(Name, title)
Arizona State Land Department

Date

_____ _____

(Name, title)
Babocomari Ranch

Date

_____ _____

(Name, title)
Coronado National Memorial
National Park Service

Date

_____ _____

(Name, title)
Fort Huachuca Date
U.S. Army, Department of Defense

_____ _____

(Name, title)
San Pedro Riparian National Conservation Area Date
Bureau of Land Management

_____ _____

(Name, title)
San Rafael Ranch Date

_____ _____

(Name, title)
San Rafael Ranch State Park Date
Arizona State Parks

_____ _____

(Name, title)
Sierra Vista Ranger District Date
Coronado National Forest

_____ _____

(Name, title)
Southeastern Arizona Preserves Program Date
The Nature Conservancy

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Introduction

The Huachuca Area Fire Partners (HAFP) bring together public and private collaborators from the San Pedro River on the east through the Patagonia Mountains on the west to manage fire activities over a 500,000-acre area (Figure 1-1). Collaboration among landowners in the planning area began in 1996. The benefits of managing for fire on a broad landscape scale such as the greater Huachuca area are numerous. Foremost are:

- Increased public and fire crew safety
- Widespread improvement in ecosystem function
- Economical execution of fire activities

The collaboration also focuses on efficient communication about fire, responsible protection of sensitive resources, and border issues. The HAFP intend to continue working together on regular updates of this working document.

Historically, fire has burned frequently in the grasslands and woodlands of southeastern Arizona. Regular fire keeps shrubs out of grasslands, thins forests to remove fire-intolerant trees, increases stream flows, and renews wildlife habitat. Fire also prevents unwanted fire. Burning can minimize potential for unwanted wildfires by reducing overall quantities of fuels and breaking up contiguous vegetation. The HAFP have developed this fire management plan (FMP) to guide collaborations on wildland fire use, suppression of unwanted wildfires, prescribed burns, and use non-fire means to reduce fuels around developed and other sensitive areas. The group's projects will cross political boundaries to manage fire along natural features and roadways. This FMP also includes groundwork completed towards participation of Mexican cooperators with the HAFP.

The contents of this plan embody material that applies to all land manager partners. Together the group has defined for the planning area:

- Ecological mapping units and vegetation types
- Fire ecology and history
- Fire management units
- Fire operations summary
- Plan for fuels and ecological treatments
- Inventory of regional operational resources
- Regional environmental issues
- Protection guidelines for listed species, sensitive cultural resources, and unique sites
- International border considerations
- Outreach program

Federal managers and other members of the group have chosen to write their own FMPs. Federal agencies follow an interagency template and subject their plans to NEPA and other compliance requirements. Use of the shared information in this plan is meant to reduce the effort required to produce those individual partner plans. Members may adopt this plan then append it to their own documents or vice versa. At this time the HAFP FMP does not replace any approved partner fire management plans; those plans currently take precedence over this framework. The HAFP FMP is not a decision document but contains information that will be useful for future compliance efforts.

Partners

Partners from many diverse organizations have worked together to produce this FMP, with individuals from the groups listed below taking responsibility for completing chapters. Carol Lambert, Program Coordinator with The Nature Conservancy's (TNC) Southeastern Arizona Preserves Program, has served as the HAFP chair through the production of the plan. No single, large source of funding drove this effort, nor did any particular directive from on high. Members of the group creatively made time to get the work done, and small grants from The Nature Conservancy, National Park Service, and Fort Huachuca financed completion of a number of tasks using students from the University of Arizona or existing staff from partner organizations. The HAFP also hired local (Sierra Vista) communications consultant Lynn Slagle to assist with an outreach plan and review various documents.

Appendix A contains profiles for the land managers in the HAFP planning area that describes land holdings, mission, and fire management direction in more detail. They include:

- Appleton-Whittell Research Ranch, National Audubon Society
- Arizona State Land Department
- Babocomari Ranch
- Coronado National Memorial, National Park Service
- Fort Huachuca, U.S. Army
- San Pedro Riparian National Conservation Area, Bureau of Land Management
- San Rafael Ranch
- San Rafael Ranch State Park, Arizona State Parks
- Sierra Vista Ranger District, Coronado National Forest, USDA Forest Service
- Southeastern Arizona Preserves, The Nature Conservancy

Other partners maintain significant interest or play key fire-related roles in the planning area and the FMP:

- Arizona Game and Fish Department
- Coronado National Forest Supervisor's Office
- Fry Fire District
- Immigration and Naturalization Service
- National Park Service Southern Arizona Office
- Palominas Firewise Community
- Palominas Volunteer Fire Department
- Patagonia Fire Department
- Sonoita-Elgin Emergency Services, Inc.
- The Nature Conservancy Mexico Program
- U.S. Fish and Wildlife Service Arizona Ecological Services Office
- University of Arizona and affiliated organizations
  - Institute for the Study of Planet Earth
  - School of Natural Resources
  - USGS Southwest Biological Science Center/Sonoran Desert Research Station

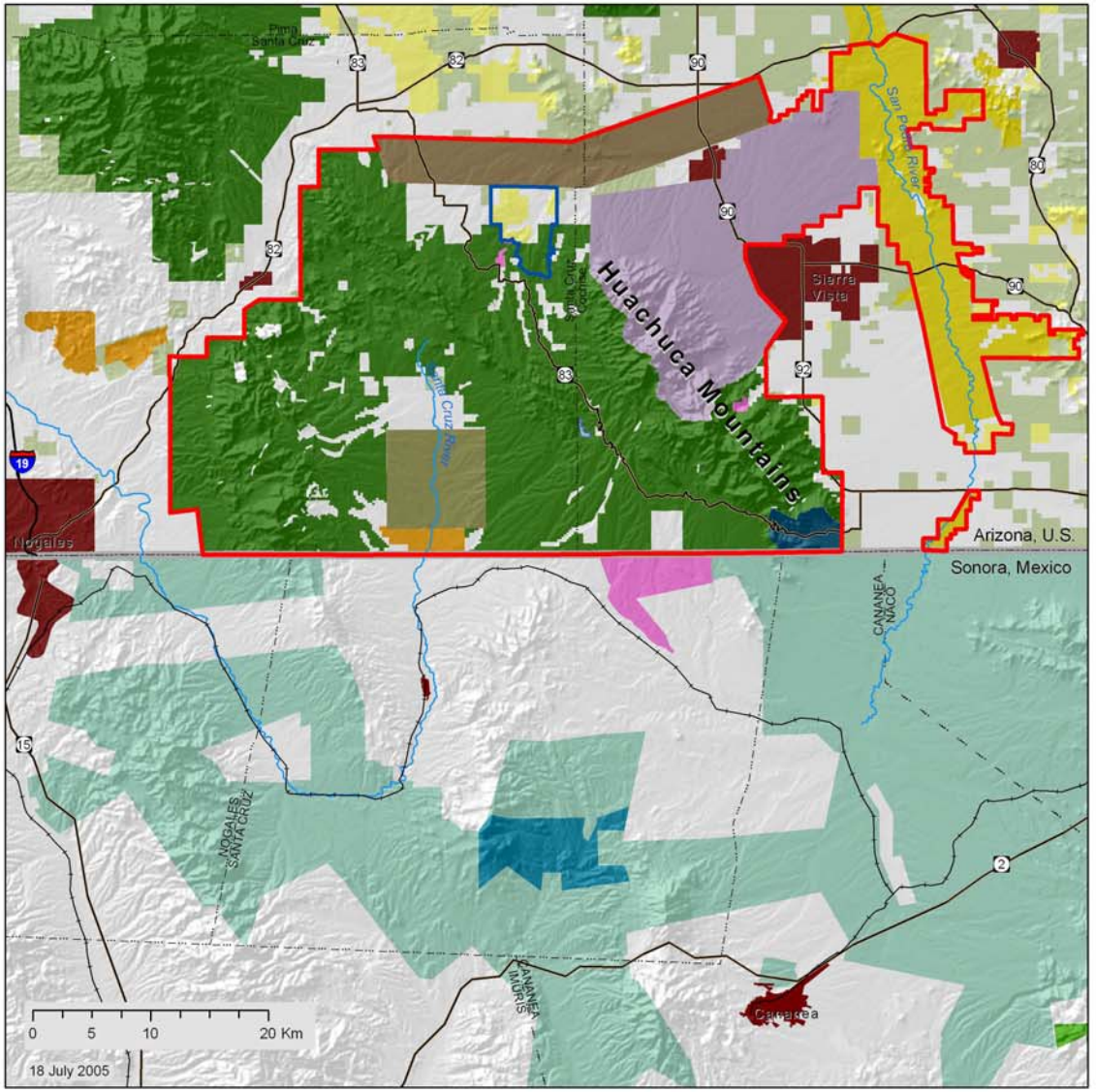
The HAFP also welcome the participation of Mexican landowners and other interested organizations in fire planning activities. For example, the Mexican equivalent of the USDA

Figure 1-1. HAFP planning area

Figure 1-1. HAFP planning area

- HAFP Planning Area
- Urban Areas
- National Park Service, Coronado National Memorial
- U.S. Army, Fort Huachuca
- BLM San Pedro Riparian National Conservation Area
- Bureau of Land Management (BLM)
- U.S. Forest Service, Coronado National Forest
- Arizona State Land
- State & County Parks
- San Rafael Ranch
- Babocomari Ranch
- National Audubon Society (and affiliated lands)
- The Nature Conservancy (and affiliated lands)
- Miguel Hildago Ejido (Communal Land)
- Other Ejidos (Communal Lands)
- Ajos-Bavispe National Forest Reserve & Wildlife Refuge

Private land colored grey



Forest Service, CONAFOR, works with The Nature Conservancy on fire-related projects at its Los Fresnos ranch in Sonora (Figure 1-1). The chapter on Border Considerations goes into more detail on Mexico partnerships.

The land managers of the HAFP currently are responsible for fire management within their boundaries but have traditionally cooperated with one another, especially on fire suppression. The following list summarizes recently stated fire-related goals and objectives that public and private HAFP land managers seek to accomplish.

- Cooperate with other agencies
- Create a mosaic within/ between units
- Create desired conditions
- Decrease runoff and erosion
- Enhance visual resource
- Ensure continuity of training on military lands
- Fuel reduction
- Maintain fire adapted communities
- Minimize land surface disruption
- Improve habitat/enhance resources
- Improve interpretive experience
- Maintain existing wilderness
- Maintain water quality/quantity
- Preserve and protect caves
- Prevent fire along wildland-urban interface
- Protect air quality
- Protect cultural resources
- Protect life, property, resources
- Protect riparian plant communities from fire
- Reduce potential for wildfire hazard (catastrophic fire)
- Restore/sustain ecosystem function
- Use best available science
- Use burn units as natural fuel breaks
- Use fire to reduce density of non-native or invasive plants
- Use mechanical treatments in high-risk areas
- Use prescribed burning in threatened and endangered species habitat
- Use prescribed fire to support riparian restoration
- Use prescribed/wildland fire to achieve goals

Planning area overview

The Huachuca Area Fire Partners planning area lies in Santa Cruz (west side) and Cochise (east side) counties in southeastern Arizona and northeastern Sonora, Mexico (Figure 1-1). The U.S.-Mexico border runs east-west through the southern part of the area, with the overall southern limit roughly corresponding with the Santa Cruz River (west side) and San Pedro River (east side) watershed boundaries in Sonora. Parts of four Mexican counties (municipios) lie within the area; from west to east they are Nogales, Santa Cruz, Cananea, and Naco. HAFP borders are not fixed, rather they evolve as new partners join the effort. The planning area does not currently include the City of Sierra Vista and the patchwork of private and state lands between the San Pedro and the Huachucas north of the international border.

Chapter 2 uses a system of ecological mapping to present a detailed breakdown of the HAFP physical and biological landscape for fire planning purposes. The HAFP area encompasses great topographic variability over about a mile of elevational range—from about 4,000 feet (on the San Pedro Riparian National Conservation Area) to 9,466 feet (Miller Peak in the Huachucas). Prominent features include the Huachuca and Patagonia mountains and their forests and woodlands, the high grasslands of the San Rafael Valley and the headwaters of the Santa Cruz River, the Canelo Hills, the riparian corridor of the southern San Pedro River and its Mexican headwaters, the Elgin-Sonoita grasslands along the Babocomari River drainage, the Mexican loop of the Santa Cruz River on agrarian ejido lands, and expanses of Chihuahuan desert shrubland on the bajadas of Fort Huachuca.

The diversity of the landscape may be attributed to its location in a region commonly referred to as the sky islands or the Madrean Archipelago. Here four ecoregions meet: the temperate Rocky Mountains, the subtropical Sierra Madre Occidental, the lower elevation Sonoran Desert, and the higher elevation Chihuahuan Desert. The name sky islands comes from the prevalence of "island" mountain ranges separated by "seas" of desert and grassland.

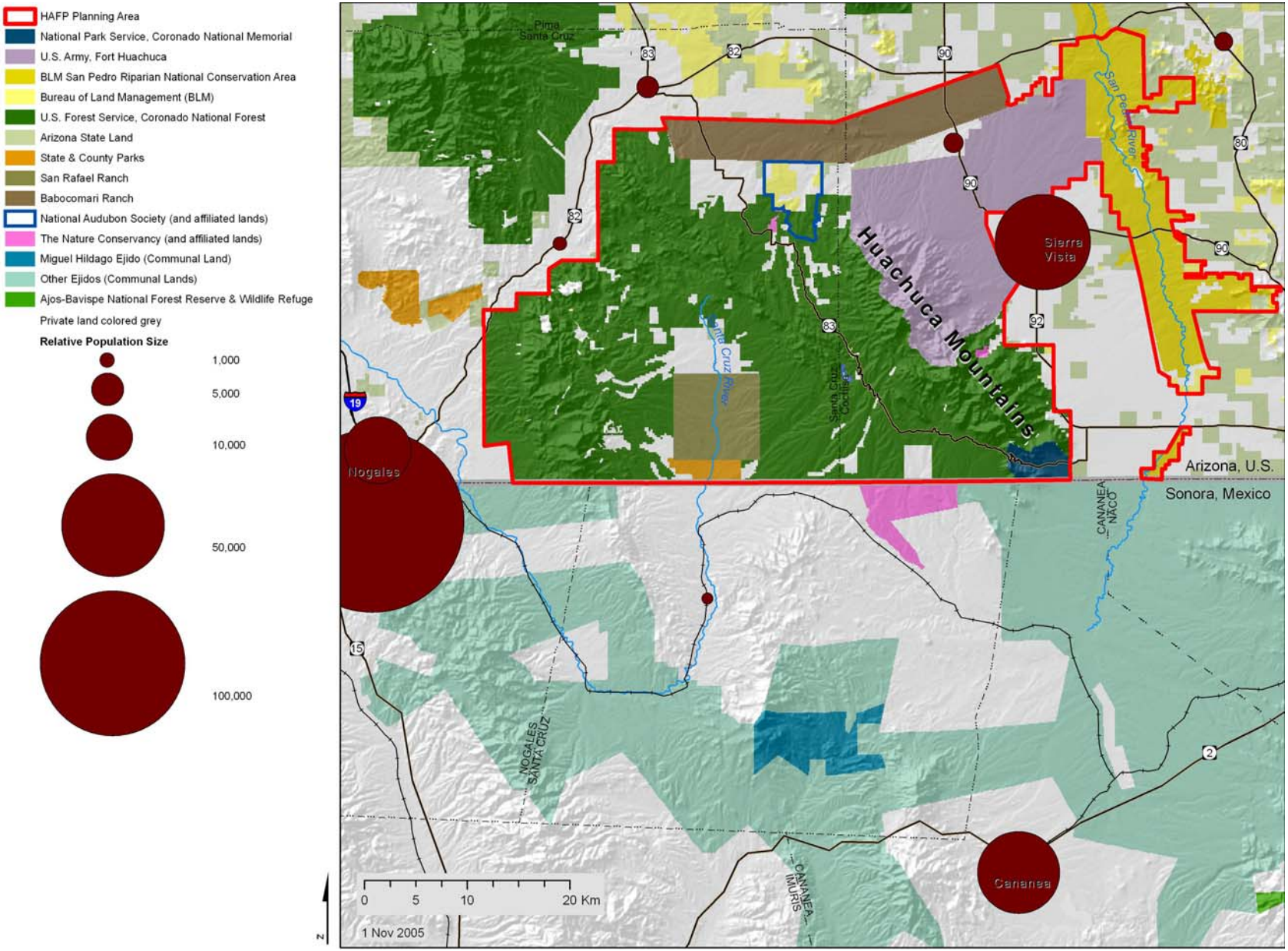
HAFP lands are beautiful, useful, and appreciated by a wide variety of residents and visitors. Figure 1-2 shows areas where people live with estimates of their numbers. This plan places emphasis on planning for fire within the HAFP-area's multiple wildland-urban interfaces (WUI). The Forest Service defines the WUI as a zone where structures and other human developments meet, or intermingle with, undeveloped wildlands.

HAFP goals and objectives

The goals and objectives listed here pertain to the overall mission of the HAFP and were developed in the fall of 2002. Other goals and objectives related to specific elements of the FMP are stated in other chapters:

- Develop, coordinate, and implement an "umbrella" fire management plan (this document) for the Huachuca Area Fire Partners planning area, including undertaking an area-wide consultation with the U.S. Fish and Wildlife Service.
- Ensure that group participation includes all affected stakeholders, including non-governmental organizations, state and Federal agencies, municipalities, counties, local fire departments, private ranchers, wildland-urban interface homeowner associations, and interested public.
- Share human resources and information. Jointly conduct fire operations and develop a permanent "collection" of data, including compiling and maintaining a planning area "fire atlas."
- Develop and implement an outreach strategy designed to educate stakeholders (public and local, state, and Federal agencies) on the benefits to the community/WUI of the development of an area-wide fire management plan, maintaining fire in healthy ecosystems, and conducting prescribed burns and other fuels treatment projects.
- Identify both the financial and human resources necessary to support the group's activities; pursue public/private-funding opportunities.
- Identify those fire-related public policy areas requiring political support and develop a unified effort to influence legislation. Support each individual member's efforts at fire planning and fuels reduction.

Figure 1-2. Relative population sizes near the HAFP planning area



Chapter 2: Fire Ecology and the HAFP Landscape

The HAFP decided, as it restarted efforts to complete this plan, to map the landscape using a single, uniform system. Land managers individually had a multitude of maps that described their landscapes, but seamless coverage across boundaries was not attainable without additional work. Members of the group volunteered to take on the task of creating a new map for the whole planning area. The purpose of the mapping was to divide the landscape into areas meaningfully distinct for fire planning. The names of the mapping units described in this chapter reflect historical rather than current conditions.

Larry Laing (NPS Southern Arizona Office), Dave Gori (The Nature Conservancy), and Tyler Jones (formerly at Fort Huachuca) developed ecological mapping units in a GIS for the entire planning area (Figure 2-1). The units utilize USDA Forest Service General Ecosystem Survey (1991) and Natural Resources Conservation Service STATSGO (State Soil Geographic Database) mapping. They were refined using digital elevation model derived data, geology maps, existing vegetation mapping, expert knowledge and field validation. The team verified unit boundaries (for easily distinguishable types) during three different trips by driving existing roads and checking nearby landscapes or looking at places farther away from good vantage points. For map units 6, 7, and 8, that have similar vegetation, physical characteristics (geology, soils, slopes, for example) became the basis for confirming boundaries. Our effort did not use plot data, but it was based on point observations by experts familiar with the area. Fire regimes are taken primarily from the dendrochronology literature and summarized in the unit descriptions in this chapter. Work based on sedimentation has estimated fire return intervals to be greater than the results generated by dendrochronology studies.

These ecological units provide a context or designating fire regimes and condition classes, and their associated vegetative and hydrologic implications, in response to fire management. In short, they are areas where distinctive fire behavior and effects are expected. Laing et al. (2005) describes the mapping process in greater detail. A next-generation refinement of this classification system is currently underway (2005). The HAFP area is being updated as part of a larger mapping project under a National Park Service-USDA Forest Service interagency agreement. We would expect to see some replication of the units described here in nearby areas, but with increasing distance from this area, climatic factors would contribute to the definition of different units.

The ecological mapping unit summary in Appendix B lists the fire regime condition class (FRCC) for each type based on historical information, expert opinion, and field reconnaissance. FRCC compares the state of landscape units with a likely historical range of conditions (Schmidt et al. 2002). Although class 3 lands (places with the greatest deviation from the historic range of variability) deserve critical attention, the best and most economical opportunities for maintenance and restoration may lie on class 1 and 2 lands, respectively. Classes are defined as following:

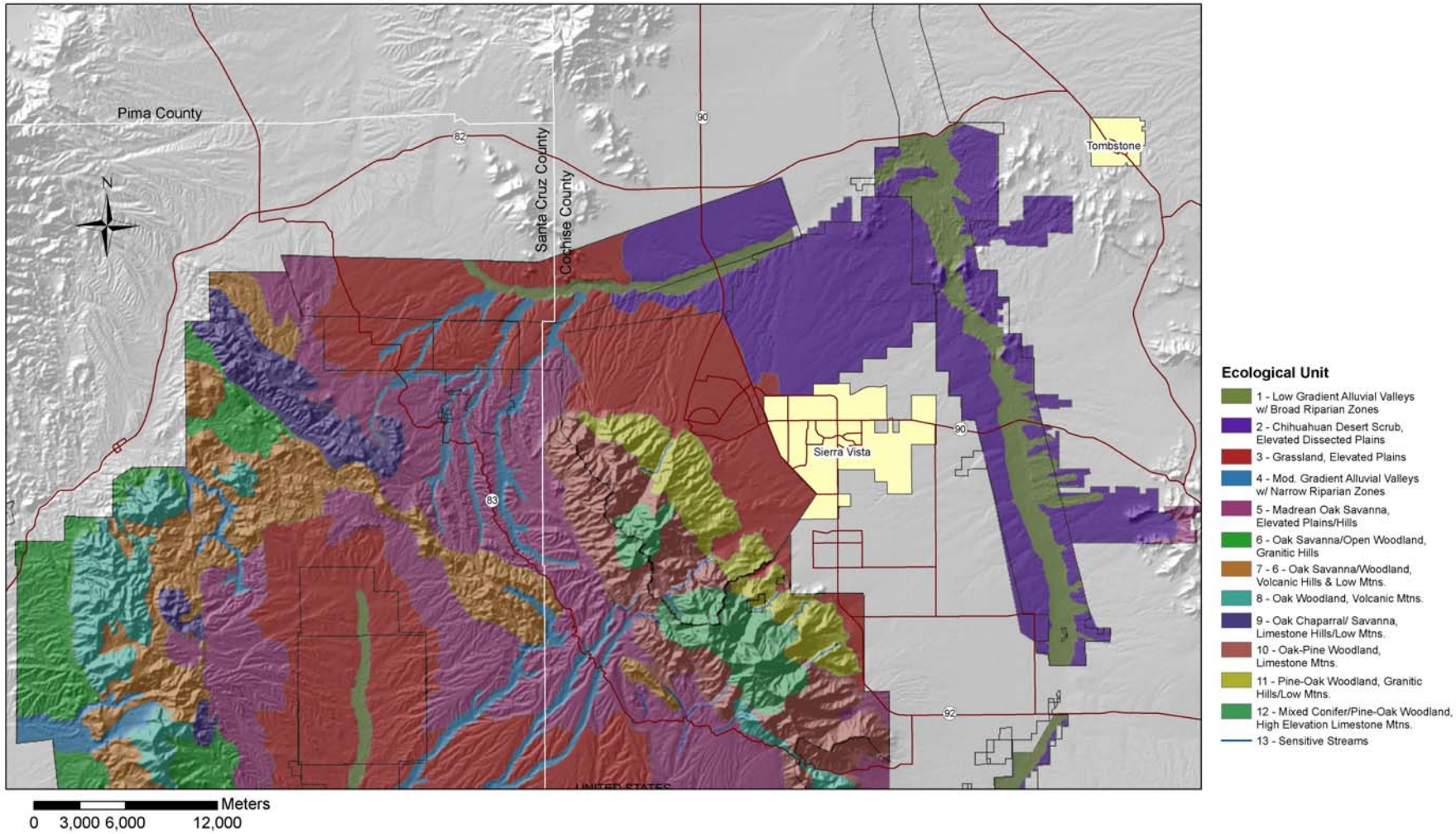
Condition class 1- Fire regimes are within a historical range, and the risk of losing key ecosystem components is low. Vegetation attributes (species composition and structure) are intact and functioning within a historical range. Fires burning in class 1 lands pose little risk to the ecosystem and positively affect biodiversity, soil productivity, and hydrologic processes. Typical management replicates the historical fire regime through periodic application of prescribed fire or through wildland fire use.

Condition class 2- Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals (either increased or decreased). This results in moderate changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been moderately altered from their historical range. Wildland fires burning in class 2 lands can have moderately negative impacts to species composition, soil conditions, and hydrological processes. Typical management requires moderate levels of restoration treatment, such as a combination of prescribed fire with mechanical treatment.

Condition class 3- Fire regimes have been significantly altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been significantly altered from their historical range. Wildland fires burning in class 3 lands may eliminate desired ecosystem components, exacerbate the spread of unwanted non-native species and result in dramatically different ecological effects compared to reference conditions. Typical management requires high levels of restoration treatment, such as mechanical treatments, before fire can be used to restore desired ecosystem function. Intensive efforts, which may include seeding, herbicide application, biomass removal, and other types of rehabilitation, are required for class 3 lands.

Below is a detailed description for each of the 13 ecological types defined for the HAFP planning area. Larry Laing and Dave Gori presented these descriptions as well as a summary table (Appendix B, with desired conditions for each type) to the entire HAFP working group and incorporated comments based on the experience of land managers with particular sites. These units are works in progress, and descriptions are revised as new information becomes available. As a note, scientific names follow the USDA Natural Resources Conservation Service Plants Database (2004) and Felger et al. (2001).

Figure 2-1. Ecological mapping units in the HAFP planning area



Valleys and plains units

Map unit 1: Low gradient alluvial valleys with broad riparian zones

Map unit 1: photo (a)

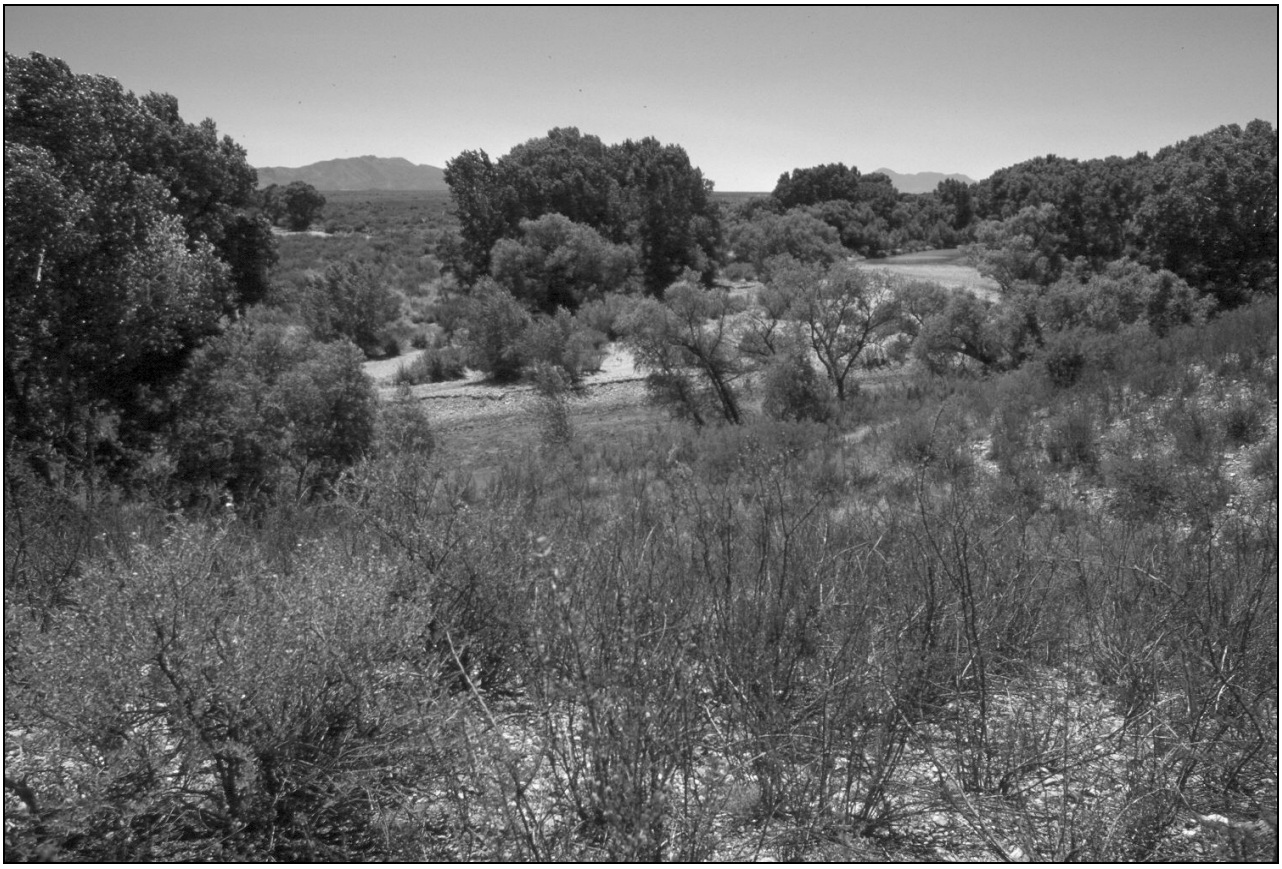
Map unit 1 comprises 27,606 acres or 5.5 percent of the planning area. It dissects older alluvial materials associated with grasslands on elevated plains (map units 2 and 3). It is associated with the main channels of the Santa Cruz, Babocomari, and San Pedro rivers.

Slopes: Valley bottom slopes are mostly less than 2 percent; terrace breaks and valley side slopes are typically short and have slopes less than 30 percent.

Geologic materials: Younger alluvial deposits imbedded in alluvial deposits of Quaternary or Tertiary age (Geologic Map of Arizona 1969).

Landforms: Floodplain and terraces; some valley side slopes.

Vegetation: This unit occurs in broad valley bottoms associated with the Chihuahuan desert scrub and grassland communities. It is characterized by low-gradient, mostly perennial stream systems that, when fully functional, support a relatively wide zone of hydrophytic vegetation on the low terraces and floodplains. Accounts of well developed and broader wetlands and riparian zones were documented by historical accounts and photos (Hastings and Turner 1965). Cienegas and stands of mesquite and sacaton covered large areas interspersed with segments vegetated



Map unit 1: photo (b)

by Fremont cottonwood (*Populus fremontii)* and Goodding's willow (*Salix gooddingii*) dominated communities. Adjacent native grasslands were relatively brush-free, and wildfires were common. Today surface flow has decreased due to declining groundwater tables, some reaches have become entrenched, cienegas have been degraded, and many non-native plants exist.

The better drained upper terraces and valley side slopes are characterized by grasslands dominated by blue grama (*Bouteloua gracilis*), vine-mesquite (*Panicum obtusum*), side-oats grama (*Bouteloua curtipendula*), plains lovegrass (*Eragrostis intermedia*), and three-awns (*Aristida* spp.). Historical vegetation included sacaton (*Sporobolus wrightii*), sedges (family *Cyperaceae*) and other hydrophytic vegetation, which was more extensive on some reaches (Humphrey 1958). Beaver may have played a critical role in maintaining the perennial reaches of these historical riparian systems (photo a). Portions of these streams may be extremely incised as a result of localized grazing and other land alterations which have had an affect on riparian function and resulted, at least temporarily, in the gallery cottonwood-dominated forests associated with the San Pedro River (photo b).

Soils: Soils are typically very deep and fine or moderately fine textured alluvium derived from weathered rocks of various sources (Richardson et al. 1979). Soils associated with low terraces and floodplains show evidence (in the form of relict organic, mottled and reduced layers) of more extensive and pronounced high water tables. They typically have thick clay surfaces overlying heavy clay loam or gravelly clay loam layers, although some textural variations will occur in the alluvial soils. These soils have dark surface and subsurface layers with relatively

high organic matter contents. Lime accumulations occur in the lower soil layers. This unit relates to the more poorly drained (higher water table) portion of map unit Gu – Guest soils in the Soil Survey report.

Precipitation zone: 14-22 inches (USDA Forest Service 1991); 12- 20 inches for dominant soil map unit although this unit receives additional water in the form of runoff from neighboring uplands (Richardson et al. 1979).

Frost-free period/mean annual temperature: 160-250 days/57-64 ºF (Richardson et al. 1979).

Elevation: 3,819 to 4,908 feet with a mean of 4,189; 1,089 feet relief.

Hydrologic characteristics: A combined total of 111.6 miles of streambeds are associated with this unit representing a total stream density of 2.6 miles of stream per square mile. This unit contains 43 miles of perennial streams (38.5% - a density of nearly 1 mile per square mile); the drainage pattern is dendritic.

Fire Ecology/History: There is no history of fire in the wet cottonwood-willow zones, but fires may have spread into riparian corridor from the adjacent uplands (Stromberg and Ortiz-Zuazaga 1998). In some areas, these low elevation riparian zones may not require specialized treatment with fire; it may be best to treat them along with the surrounding vegetation. Although there is incomplete knowledge of the effect of fire on many desert riparian species, some more mesic tree species are fire tolerant (i.e. mesquite, desert willow, and hackberry), resprouting from the root crown (Tratz and Vogl 1977, Armstrong 1980). Burning may stimulate leaf production of sacaton, although recovery after fire depends on the extent of root crown removal by fire (Cox 1988).

Riparian vegetation is dynamic, and distribution and composition reflect histories of fluvial (i.e., flooding) and non-fluvial (i.e. fire, wind) disturbances (Gregory et al. 1991). Although riparian plants are not dependent on fire for renewal, fire may be important for the maintenance of these habitats in combination with other disturbances (Bendix 1994, Reeves et al. 1995). For instance, cottonwood-willow forests are not considered fire-adapted, but mortality in these communities may depend on fire intensity, time of burn, and type of fire (ground fire vs. canopy fire) (Stromberg and Ortiz-Zuazaga 1998). Deciduous riparian zones are major centers of wildlife diversity (Johnson and Jones 1977, Johnson et al. 1985). Fire frequency, fire ecology, and effects of fire on riparian vegetation and wildlife species are poorly understood.

Deciduous riparian zones probably will not be represented by the same fuel models as the surrounding vegetation, because these are usually grassland or Madrean savanna and woodlands. Riparian zones are not necessarily represented by any fuel models; although fuel models 6 or 8 may be considered in certain areas. The riparian corridor may act as a barrier to fire because this zone may be cooler and have higher fuel moisture than the surrounding vegetation, effectively slowing a fire down. However, there are no studies of fuel loads in these zones, and there is potential for fuel loads to be greater than the surrounding area. Riparian areas are viewed separately from the surrounding landscape, which means they are usually not treated, and this may result in a build-up of hazardous fuels. The FRCC in deciduous riparian zones would be a class 1 depending on reach or class 2 depending on presence of invasive species and soil/channel degradation. Specific goals in this vegetation type would be to restore or maintain a desirable

range of plant communities or successional stages over a series of valley segments, which should improve watershed condition and function.

Data on fuel loads and distribution, fuel chemistry and flammability, and fuel moisture are needed from riparian areas to understand and predict fire behavior (Dwire and Kauffman 2003). Because deciduous riparian areas are sensitive (i.e., contain many riparian-obligate plant and animal species), a severe wildfire could have a devastating effect on these areas, and should be managed to reduce those risks.

The upper terraces of these low-gradient alluvial valley zones may be represented by the same fuel models as the surrounding vegetation, which would be either grassland or Chihuahuan desert scrub. There are no studies of fuel loads in these zones. Fire regime condition class (FRCC) would be a class 1 depending on reach or class 2 depending on presence of invasive species and soil/channel degradation. One goal in this ecological unit would be to restore and maintain historical vegetation, which should improve watershed condition and function.

Map unit 2: Chihuahuan desert scrub and grassland mosaic on elevated and dissected plains

Map unit 2 comprises 77,516 acres or 15.5 percent of the planning area. The upper elevations of this unit transition to more mesic grasslands on elevated plains (map unit 3). Broader lower gradient valley bottoms (map unit 1) intersect the lower areas of the unit.

Slope: Generally less than 5 percent; some steeper side slopes associated with draws and drainages up to 35 percent.

Geologic materials: Older mixed alluvium derived from igneous and calcareous sedimentary rocks; Quaternary sediments (Geologic Map of Arizona 1969).

Landforms: Fans and piedmont plains.

Vegetation: Most of this unit is dominated by shrub species, although it interspersed with low elevation grasslands. Common shrub species include creosote bush (*Larrea tridentata*), acacias, (*Acacia* spp.), bursage (*Ambrosia* spp.), tar-bush (*Flourensia cernua*), and velvet mesquite (*Prosopis velutina*). Common grasses include native grasses such as blue grama (*Bouteloua gracilis*), sideoats grama (*B. curtipendula*), cane beardgrass (*Bothriochloa barbinodis*), and bush muhly (*Muhlenbergia porteri*), and non-native grasses, particularly Lehmann lovegrass (*Eragrostis lehmanniana*).

Soils: Very deep, gravelly loamy surfaces; clay accumulations occur in the subsurface layers and are more pronounced when lime is absent; the depth to lime varies from the surface to deep in the soil profile; subsurface gravel and cobble content varies but is mostly less than 35 percent;

this unit strongly correlates with the Bernardino-White House-Hathaway soil association (Richardson et al. 1979).

Precipitation zone: 18-22 inches (USDA Forest Service 1991); 12-20 inches (Richardson et al. 1979).

Frost-free period/mean annual temperature: 160-240 days/57-65 ºF (Richardson et al. 1979).

Elevation: 3,878 to 5,246 feet with a mean of 4,258; 1,368 feet relief.

Hydrologic characteristics: A combined total of 145.78 miles of streambeds are associated with this unit (a total stream density of 1.2 miles of stream per square mile). This unit contains no perennial streams; the drainage pattern is dendritic.

Fire Ecology/History: This unit can be described as a desert scrub community. Although wildfires were never frequent in desert scrub communities, they may have been more common in the 19th century due to greater grassland continuity (Bahre 1985). Factors including historical land uses, fire suppression, and climate change have combined to significantly alter the land surface, resulting in the increased spread of shrubs, loss of inter-shrub soil, and subsequent decreases in herbaceous cover. Conversion of grasslands to shrublands can cause a change in the distribution of soil nutrients, which become concentrated beneath shrubs and lost from inter-shrub spaces (Schlesinger et al. 1990).

Throughout the Southwest, shrubs have invaded former semidesert grasslands that historically may have had frequent fires (Wooten 1916, Leopold 1924, Humphrey 1958, Hastings and Turner 1965). In this map unit, invasive native shrub species include acacia, mesquite, creosote, and tarbush. Fire is considered an important variable in maintaining the structure of grassland vegetation through suppression of woody plant establishment (Cooper 1961, Humphrey 1962, Daubenmire 1968, Wright and Bailey 1982). Fire frequency in Chihuahuan desert scrub areas is estimated to be four to ten years, largely based on historical frequency of grassland fires. These fires are most likely to occur during the late spring (June), prior to the monsoon season, when there is a high frequency of lightning strikes (Humphrey 1958). Mesquite is only moderately affected by fire, depending on tree size and available fuel (Cable 1965).

Estimates of desert shrub fuel loads range from 0.5 to 21 tons/acre; herbaceous fuel loads range from 0.1 to 3 tons/acre (Miller et al. 2003). Surface fuel models predicted to represent this vegetation type using the fire behavior prediction system (FBPS) (Anderson 1982, Hubbard Report 2001) are fuel models 2 and 6 although many areas have very little, if any, surface fuels. Fire regime condition class (FRCC) in this vegetation zone is estimated to be a class 3, although fire hazard may be low. The desired future condition would be a desert shrub and grassland mosaic with more extensive grassland patches and shrub canopy cover at less than 5%. The goal would be to reduce or maintain non-native grasses at current levels. Extensive soil loss and high shrub cover may preclude restoration of desired grassland vegetation in some areas.

Map unit 3: Grassland on elevated plains

The relatively flat map unit 3 comprises 116,429 acres or 23.2 percent of the planning area. The upper elevations transition to the oak/grassland savanna associated with map unit 5 or to steep, rocky areas dictated by bedrock landform control (map units 7 and 10). As is the case with map unit 5, the large alluvial valley bottoms and their associated side slopes are distinguished as map unit 4. The lower boundary of this unit transitions to Chihuahuan desert scrub and drier grasslands (map unit 2) in the northeastern portion of the planning area.

Slope: Generally less than 5 percent; some steeper side slopes associated with draws and drainages up to 35 percent.

Geologic materials: Older mixed alluvium derived from igneous and calcareous sedimentary rocks; Quaternary/Tertiary sediments (Geologic Map of Arizona 1969).

Landforms: Fans and piedmont plains.

Vegetation: The semidesert grassland is floristically diverse, with species composition changing across the geographic area (Abbott 1997). Vegetation structure also varies as result of land-use history and management (Westoby et al. 1989, Burgess 1995). The herbaceous component consists of perennial bunch and sod-forming grasses, annual grasses, and annual and perennial forbs and other graminoids. Prominent native grasses include gramas (*Bouteloua* spp.), tobosa (*Hilaria mutica*), curly mesquite (*Hilaria belangeri*), and bush muhly. Non-native grasses include Lehmann lovegrass and Boer lovegrasses (*Eragrostis chloromelas* or *Eragrostis curvula* var. *conferta*). Interspersed among the grasses are species of *Opuntia, Yucca, Dasylirion, Agave*, and *Nolina* (Bahre 1991). For a more complete list of common grassland species, see Abbott (1997). Native grass species are prevalent in the San Rafael Valley. Invasive species, especially Lehmann and Boer lovegrass are more problematic in the Sonoita-Elgin area and the east side of the Huachucas. Some encroachment of tree and shrub vegetation is occurring at the upper elevations of the unit probably due to lower fire frequencies. Mesquite (*Prosopis* spp.) is

the most common tree, although at higher elevations Arizona white oak *(Quercus arizonica)* and Emory oak *(Quercus emoryi)* are also found (Brown 1982, Wright and Bailey 1982).

Soils: Very deep, gravelly loamy surfaces; clay accumulations occur in the subsurface layers and are more pronounced when lime is absent; the depth to lime varies from the surface to deep in the soil profile; subsurface gravel and cobble content varies but is mostly less than 35 percent; this unit strongly correlates with the Bernardino-White House-Hathaway soil association (Richardson et al. 1979).

Precipitation zone: 18-22 inches (USDA Forest Service 1991); 12-20 inches (Richardson et al. 1979).

Frost-free period/mean annual temperature: 160-240 days/57-65 ºF (Richardson et al. 1979).

Elevation: 4,357 to 5,643 feet with a mean of 4,903; 1,286 feet relief.

Hydrologic characteristics: A total of 228 miles of streambeds are associated with this unit (a total stream density of 1.25 miles of stream per square mile). This unit contains 1.73 miles of perennial streams (0.5%, a density of 0.0095 miles per square mile); the drainage pattern is dendritic.

Fire Ecology/History: Fire historically played a role in shaping grassland structure and function (Bahre 1991, McPherson 1995). Prior to 1880, shrubs were inconspicuous in desert grasslands, suggesting that fires were frequent enough to prevent widespread shrub invasion (McPherson 1995). Currently, based on repeat photography, local observations and other accounts, there are more shrubs found in the grassland than there were historically (Hastings and Turner 1965, Bahre 1985). Although there is controversy concerning the extent to which fire maintains grasslands (i.e. minimizes shrub invasion), it is clear that fire is a key component of the natural disturbance regime in grasslands and that the natural fire regime has been drastically altered (Archer 1994, Bahre 1991, Griffiths 1910, Humphrey 1958, Leopold 1924, McPherson and Weltzin 1997, Abbott 1997).

Historical fire frequencies in southeastern Arizona semi-desert grasslands have been estimated to average 7 to 10 years, with minimum and maximum intervals of 3 and 22 years, respectively, deduced from fire-scarred trees adjacent to grasslands (Wright 1980, McPherson 1995, Kaib et al. 1996). These fires most likely occurred during the late spring (June) prior to the monsoon season, when there is a high frequency of lightning strikes (Humphrey 1958). Fire frequency, structure and function of many grasslands in the region have been altered by several factors including livestock grazing (both historic and current), fire suppression, introduction of non-native grasses (e.g., Lehmann lovegrass and Boer lovegrass), fragmentation due to housing developments and road dissection, and shrub invasions (Wright 1986, Bahre 1991, Bock and Bock 1992).

Herbaceous production is variable based on land use history and presence of Lehmann lovegrass. Herbaceous biomass ranges from 0.1 to 2.5 tons/acre but Lehmann lovegrass production can be greater than 100% higher than native grass production (Wright 1980, Cox et al. 1990, Miller et al. 2003). The FRCC in this unit ranges from class 1 in the San Rafael Valley to class 2 or 3 in many other areas depending on extent of invasive species and shrub/tree encroachment. Fire in grasslands can be modeled using the FBPS fuel model 1or 3

depending on grass species composition and grass height. Potential natural vegetation is predicted to be grasslands dominated by native grasses; however presence of invasive species, especially Lehmann lovegrass, may preclude returning grass-dominated areas to a 20th century status and may actually push native grasslands to an irreversible threshold that would make it difficult to transition to a more desirable ecological state without major human intervention (Anable et al. 1992, Aronson et al. 1993).

Map unit 4: Moderate gradient alluvial valleys with narrow riparian zones

Map unit 4 comprises 21,493 acres or 4.3 percent of the planning area. It dissects older alluvial materials associated with grasslands on elevated plains (map unit 3), Madrean oak savanna plains and hills (map unit 5), some areas of Madrean oak savanna on granitic hills (map unit 6) and Madrean oak woodland on volcanic hills and low mountains (map unit 7). This deciduous riparian zone is found mainly on tributaries of the Santa Cruz and Babocomari rivers, including segments of O'Donnell, Turkey, Parker Canyon, Red Rock, and Harshaw creeks.

Slopes: Alluvial valley bottom gradients mostly range from 2 to 10 percent; valley side slopes vary in steepness but are generally in excess of 20 percent.

Geologic materials: Younger alluvial deposits imbedded in alluvial deposits of Quaternary or Tertiary age (Geologic Map of Arizona 1969).

Landforms: Valley bottom, terraces and side slopes.

Vegetation: Fremont Cottonwood, Arizona sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), velvet ash (*Fraxinus velutina*), and Goodding's willow are associated with low terraces and floodplains. These deciduous riparian zones are typically adjacent to grasslands or Madrean oak savanna and woodland communities. Vegetation structure and composition was maintained by disturbances, including beaver herbivory, and flash flooding.

Soils: The soils associated with the valley floor (Grabe Series) are well-drained and very deep. They formed in recent mixed alluvium. They are sandy loams and loams with varying amounts

of gravel and cobble. The river wash areas are sandier and often have more gravel and cobbles. The side slopes are cut through very gravelly sandy loams and sandy clay loams associated with old alluvial fans. These soils (Casto Series) are typically devoid of lime deposits except in the lower layers. This unit tends to be coarser textured in the western portion of the planning area probably due to the dominance of granitic materials in the area. The soils (Comoro Series) are typified by sandy loams in floodplains and gravelly sandy loams on in smaller drainage ways and fans.

Precipitation zone: 14-22 inches (USDA Forest Service 1991); 11-18 inches for dominant soil map unit (Richardson et al. 1979).

Frost-free period/mean annual temperature: 170-250 days/53-64 ºF (Richardson et al. 1979).

Elevation: 3,773 to 6,086 feet with a mean of 4,915 feet; 2,313 feet relief.

Hydrologic characteristics: A combined total of 97.4 miles of streambeds are associated with Unit 4 (a total stream density of 2.9 miles of stream per square mile). This unit contains 10.37 miles of perennial streams (10.6%, a density of 0.309 miles per square mile); the drainage pattern is dendritic.

Fire Ecology/History: This unit is a moderately wide, mostly deciduous riparian zone. Although there is some overlap in composition with unit 1, the coarser-textured soils and moderate valley gradients subject to flash floods result in more aerated conditions with deeper water tables that favor such species as Arizona sycamore, Arizona walnut, and velvet ash. Dominant tree species and composition vary along an elevation gradient.

Riparian vegetation has been affected by humans more than any other vegetation type mainly due to its proximity to water. Prior to 1870 many deciduous riparian areas maintained a perennial flow and were mostly unchanneled and lined with gallery forests of cottonwoods, willows and sycamores (Bahre 1991).

Fire regime is dictated by the neighboring vegetation, predominately grasslands and oak savanna (map units 3 and 5). Historical fire frequencies in southeastern Arizona semi-desert grasslands have been estimated to average 7 to 10 years, with minimum and maximum intervals of 3 and 22 years, respectively, deduced from fire-scarred trees adjacent to grasslands (Wright 1980, McPherson 1995, Kaib et al. 1996). The oak savanna fire regime is likely similar to that of the neighboring semi-desert grassland.

High plains, hill, and mountain units

Map unit 5: Madrean oak savanna on elevated plains and hills

The low to moderately sloping map unit 5 comprises 94,412 acres or 18.8 percent of the planning area. The lower elevations transition somewhat abruptly to the semidesert grasslands associated with map unit 3. The upper elevation boundary of this unit is also abrupt and is dictated by bedrock landform control. The adjacent units (6, 7, 9 and 10) are steeper and have shallow rocky soils. As is the case with grassland map unit 3, the large alluvial valley bottoms and their associated side slopes are distinguished as map unit 4.

Slopes: Ridges and mesas have low gradients (less than 10 percent); draws and drainages have steep short side slopes commonly up to 40 percent.

Geologic materials: Older mixed alluvium; Quaternary/Tertiary sediments (Geologic Map of Arizona 1969).

Landforms: Dissected high fans and piedmonts – ridges and mesas with steep side slopes where dissected.

Vegetation: Savannas are areas of contiguous grass dominated by widely spaced, mature trees or shrubs. The savanna community is usually restricted to relatively low and dry elevations, but may be found on elevations ranging up to 6,890 feet depending on aspect (i.e., south-facing slopes). Under the historical fire regime, tree canopy cover would be generally less than 10%; canopy cover is currently higher in most areas due to lack of fire (McPherson 1997). Low elevation madrean oak savannas transition into grasslands or desert scrub; higher elevation savanna into Madrean oak woodlands, chaparral, or oak-pine woodlands. Dominant overstory species include velvet mesquite (at the lowest elevation), Emory oak, point-leaf manzanita (*Arctostaphylus pungens*), one-seed juniper (*Juniperus monosperma*), alligator juniper (*J. deppeana*), and Mexican blue oak (*Q. oblongifolia*). Mexican blue oak is generally found in drainages; one-seed juniper occurs at lower elevations than alligator juniper. Common native grasses associated with savannas include gramas, plains lovegrass, bullgrass (*Muhlenbergia emersleyi*), and cane bluestem (*Bothriochloa barbinodis).* Non-native Lehmann lovegrass may be a significant herbaceous component at lower elevations. Many cactus and succulents are present, including agave, prickly pear, pincushion cactus (*Mammalaria* spp.), sotol, beargrass, and yucca.

Soils: Very deep, very gravelly or gravelly loamy surfaces; subsoils are clayey on more stable landscape components such as mesas and ridge tops; subsurface gravel and cobble content tends to be greater than 35 percent especially on narrow ridges and steep side slopes; limey soil layers are not prevalent; strongly associated with the Casto-Martinez-Canelo soil association (Richardson et al. 1979).

Precipitation zone: 18-22 inches (USDA Forest Service 1991); 15-20 inches (Richardson et al. 1979).

Frost-free period/mean annual temperature: 140-200 days/53-57 ºF (Richardson et al. 1979).

Elevation: Ranges from 4,626 to 6,339 feet with a mean of 5,277 feet; 1,713 feet relief.

Hydrologic characteristics: A total of 185.6 miles of streambeds are associated with this unit (a total stream density of 1.26 miles of stream per square mile). This unit contains 5.93 miles of perennial streams (3.2%, a density of 0.04 miles per square mile); the drainage pattern is angular dendritic.

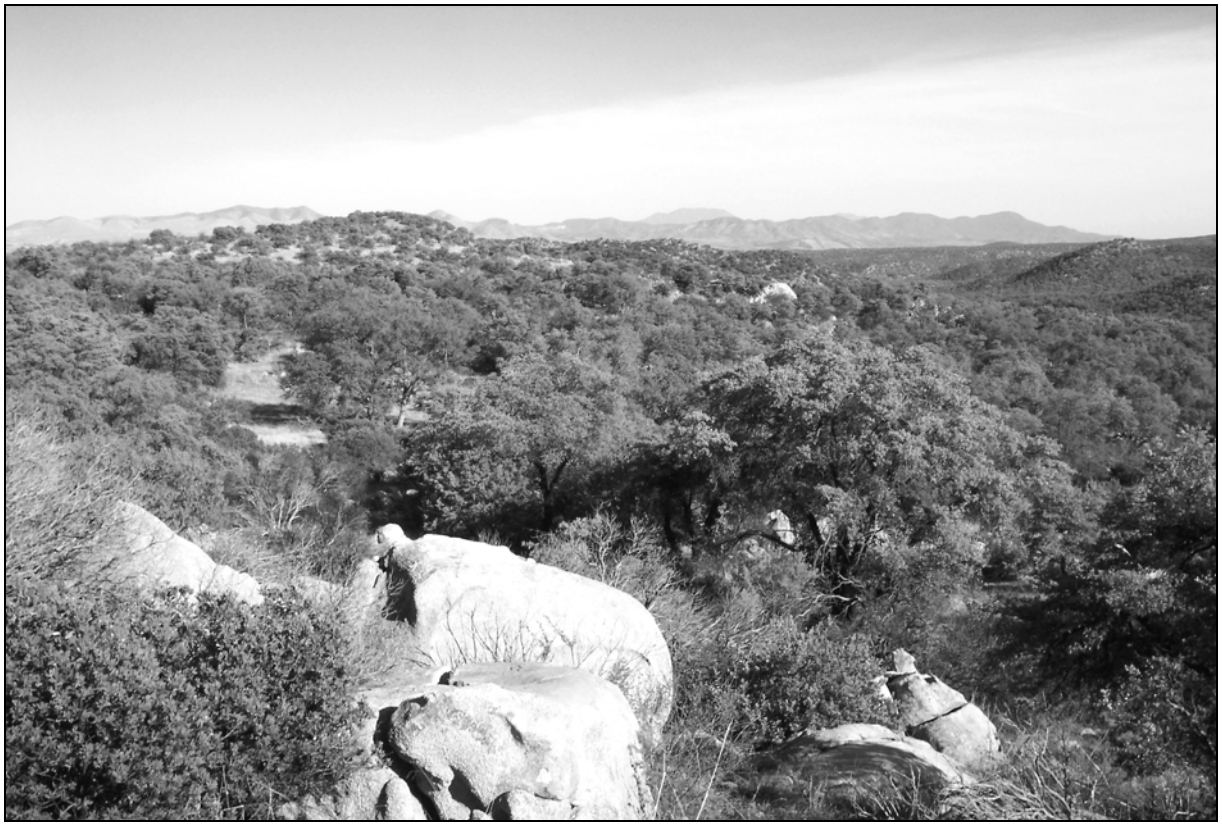
Fire Ecology/History: Semi-desert grasslands and savannas are well adapted to and dependent on periodic fire. Historically, fire was a major factor in the maintenance of oak savannas (Wright and Bailey 1982, McPherson 1992). Frequent fires favored herbaceous plants at the expense of woody plants and infrequent fires facilitated establishment and growth of woody plants (McPherson 1997). Nearly all the species of perennial grasses, forbs, and low shrubs recover quickly after fire. A common feature of these species is that some, if not all, of their growing points are at or below the soil surface and protected from the heat generated by fire.

In this map unit, many areas have likely shifted from savanna to denser oak woodland, due to reduced fire frequency. Fire histories have not been developed on oak woodland species largely because dendrochronological techniques cannot be applied; therefore information about historical fire frequencies has been derived indirectly (Grissino-Mayer 1993, Swetnam and Baisan 1996, Morino 1999). The oak savanna fire regime is likely similar to that of the neighboring semi-desert grassland; historical fire frequencies in southeastern Arizona semi-

desert grasslands have been estimated to average 7 to 10 years, with minimum and maximum intervals of 3 and 22 years, respectively, deduced from fire-scarred trees adjacent to grasslands (Wright 1980, McPherson 1995, Kaib et al. 1996).

Savanna communities can be represented by FBPS fuel models 1 or 3 depending on grass height and species composition (Miller and Yool 2002). Herbaceous fuels may range from 0.2 to 3.0 tons/acre (Miller et al. 2003). Fire regime condition class in oak savannas is mostly a class 3, due to greater tree and shrub densities and increasing prevalence of Lehmann lovegrass. A goal for this community type would be to restore and maintain a canopy cover of 5 to 12% composed mostly of oaks, interspersed with areas of higher tree canopy cover (12 – 30%) in low areas and on steep north facing slopes associated with drainages, and to increase the grass/herbaceous cover. Potential natural vegetation is predicted to be Emory oak with grama grasses, plains lovegrass and cane beardgrass.

Map unit 6: Madrean oak savanna and open woodland on granitic hills



The moderately sloping map unit 6 comprises 24,708 acres or 4.9 percent of the planning area. It is a major component of the western foothills and slopes of the Patagonia Mountains. The lowest elevations of this unit transition to gently or moderately sloping elevated plains and hills dominated by drier grasslands. The upper elevations of the unit adjoin Madrean oak woodlands on hills and mountains (map units 7 and 8) and limestone hills and low mountains (map unit 9).

Slopes: Slopes mostly range from 5 to 40 percent; vertical relief ranges from 50 to about 200 feet (Richardson et al. 1979).

Geologic materials: Pre-Cambrian decomposed granite with areas of alluvium; mostly associated with Pcgr (Precambrian granite) as opposed to the less weathered and younger Tkg (Tertiary and Cretaceous granite). Some areas of volcanic rock (rhyolite and andesite) may be included (Geologic Map of Arizona 1969).

Landforms: Dissected fans and piedmonts; series of narrow-top ridges and long axial waterways that have short side drainage ways (Richardson et al. 1979).

Vegetation: Under the historical fire regime, tree canopy cover is less than 10% in savanna areas and 10-30% in woodland areas with thin soils or substrate discontinuities. (McPherson 1997). Canopy cover currently exceeds 30% in many areas due to lack of fire. Dominant species are the same as in map unit 5.

Soils: This unit is associated with portions of the Caralampi-White House-Hathaway soil association (Richardson et al. 1979). The soils are deep and have gravelly sandy loam, loam and sandy clay loam surface layers. The subsurface layers are typically gravelly or very gravelly sandy clay loam. On more stable landform components such as ridges the subsoils tend to be clayey with less gravel or cobble. Most soils have little or no lime concentrations in the deeper soil layers due to the weathered nature of the parent materials and the age of the geomorphic surfaces; however a small percentage do have strong lime deposits at or near the surface.

Precipitation zone: 14-22 inches (USDA Forest Service 1991); 12-18 inches for soil association (Richardson et al. 1979).

Frost-free period/mean annual temperature: 190-230 days/57-65 ºF (Richardson et al. 1979).

Elevation: 3,852 to 6,375 feet with a mean of 4,541 feet; 2,523 feet relief (GIS analysis).

Hydrologic characteristics: A total of 58.67 miles of streambeds are associated with this unit (a total stream density of 1.52 miles of stream per square mile); this unit contains 3.13 miles of perennial streams (5.3%, a density of 0.081 miles per square mile); the drainage pattern is dendritic.

Fire Ecology/History: Similar to map unit 5.

Map unit 7: Madrean oak open woodland and savanna on volcanic hills and low mountains

The moderately steep map unit 7 comprises 43,254 acres or 8.6 percent of the planning area. The lower elevations typically transition to more gently sloping elevated plains and hills associated with Madrean oak savanna (map unit 5) or grasslands with a shrub component (map unit 6). Steeper rockier areas also dominated by Madrean oak woodland are distinguished as map unit 8. The adjacent limestone areas are mapped as 9 and contain a greater component of chaparral. Large alluvial valley bottoms and their associated side slopes are distinguished as map unit 4.

Slopes: Side slopes mostly range from 15 to 40 percent.

Geologic materials: competent granitic and mixed volcanic rocks, mainly rhyolite and andesite (Geologic Map of Arizona 1969).

Landforms: Hills and mountains.

Vegetation: Dominant overstory species include velvet mesquite at lower elevations, Emory oak, point-leaf manzanita, and alligator juniper. Common native grasses associated with savannas include gramas, plains lovegrass, bullgrass, and cane beardgrass. Many cacti and succulents are present. Oak woodlands are more complex than savannas, exhibiting a mosaic of stand densities influenced by topographic position. Tree canopy cover currently ranges from 10% through 100%; historic canopy covers were generally less than 30% except in areas protected from fire (McPherson 1992, Abbott 1997, Miller et al. 2003).

Soils: Shallow very cobbly, cobbly or gravelly sandy loams; soils are weakly developed but have a thin dark surface layer (possibly related to a more pronounced grass understory in the past); this unit correlates with the less steep, mid- to low elevation portions of the Faraway-Rock Outcrop-Barkerville soil association (Richardson et al. 1979).

Precipitation zone: 14-22 inches (USDA Forest Service 1991); 16-25 inches for soil association (Richardson et al. 1979).

Frost-free period/mean annual temperature: 140-220 days/50-58 ºF (Richardson et al. 1979).

Elevation: Ranges from 4,249 to 6,594 feet with a mean of 5,182 feet; 2,346 feet relief.

Hydrologic characteristics: A total of 69 miles of streambeds are associated with this unit (a total stream density of 1.02 miles of stream per square mile). This unit contains 6.07 miles of perennial streams (8.8%, a density of 0.09 miles per square mile); the drainage pattern is dendritic.

Fire Ecology/History: Oak woodlands are comprised of many evergreen tree species most of which are well adapted to burning. It could be considered a monoculture because there is little variation in stand composition/structure except by aspect. A mosaic is created only when a hot fire burns through it, particularly in areas with high tree density which are likely to sustain stand-replacing fires. All of the evergreen oak species sprout vigorously after fire. Shrubby components like Wright silktassel (*Garrya wrightii*), evergreen sumac (*Rhus choriophylla*), and mountain mahogany (*Cercocarpus* spp.) also sprout after fire. Other species, such as manzanita, have fire scarified seeds which germinate readily following a fire. Manzanita can change the fire regime in an area. It can spread into oak communities under any disturbance regime (fire or cutting). It is persistent, aggressive, and requires repeated treatments (mechanical/burning) to prevent re-establishment. Alligator juniper and madrone (*Arbutus arizonica*) both sprout after fire. The notable exception to these evergreens is Mexican pinyon (*P. discolor*) which, under a certain size, is usually killed by fire. Mexican pinyon regenerates by seed and may require 20 to 30 years to achieve pre-burn densities. Older, larger pinyon trees however, are more resistant to fire (Moir 1982). Presence of mature Mexican pinyon suggests a relatively long fire-free interval.

Tree density in oak woodlands can range from 25 to greater than 1,600 stems/acre (Miller et al. 2003). Areas with higher tree densities and mature trees can become virtually ‘fireproof’ because where Mexican pinyon is the principal tree, fuels are typically light and discontinuous. A combination of Mexican pinyon and alligator juniper with low surface fuels may be extremely resistant to all but wind-driven fire conditions. Shrub, litter, and herbaceous fuels are highly variable depending on stand composition, aspect and substrate.

Because of varying biomass production on different aspects and relatively shallow unproductive soils and rock outcrops, fuels are more discontinuous and fire spread may be hampered (relative to unit 5). Under current conditions canopy closure and moderately steep slopes have created more opportunity for crown fires, which are more difficult to control. Following burns more extended periods of accelerated erosion are possible due to less pronounced herbaceous ground cover and to steeper topography (compared to unit 5, for example).

Although there are no fuel models representing the oak woodland, FBPS fuel models 1 and 6 are typically combined to model fire behavior. FRCC is mostly class 3 due to high tree and shrub densities and increasing prevalence of fire-intolerant species. In some areas that have recently burned the FRCC is a class 1. Desired conditions in the oak woodland are to create more of a mosaic and mitigate fire hazard by treating areas in the wildland-urban interface, which is becoming increasingly complex in certain areas. Potential natural vegetation is predicted to be mostly Emory oak savanna, although some cooler, moister aspects supported oak dominated woodlands; the areas that would have been maintained as savanna are shifting to denser woodlands (field observation) and the woodlands display a more closed canopy probably due to lack of fire disturbance.

Dendrochronology studies have not addressed oak-dominated systems, because oaks do not record fire scars. However, due to continuity of fuels, fire frequency in map unit 7 likely reflects frequencies in adjacent grassland and savanna systems (map unit 5). Fuel discontinuities caused by rock outcrops, thin soils, and lower primary production may increase fire return intervals relative to those assigned to grasslands and savannas in some areas.

Map unit 8: Madrean oak open woodland on volcanic mountains

The steep map unit 8 comprises 19,160 acres or 3.8 percent of the planning area. The lower elevations transition to less steep hills and mountains associated with Madrean oak savanna (map unit 5) or grasslands with a shrub component (map unit 6). This unit represents the steeper rockier areas often associated with map unit 7. Adjacent limestone areas are mapped as 9 and contain a greater component of chaparral.

Slopes: Side slopes mostly range from 40 to greater than 60 percent.

Geologic materials: Competent granitic, rhyolite and mixed volcanic rocks (Geologic Map of Arizona 1969).

Landforms: Mountains.

Vegetation: Dominant overstory species include Arizona white oak (*Quercus arizonica*), Mexican pinyon (*Pinus discolor*), madrone (*Arbutus arizonica*), alligator juniper, netleaf oak (*Quercus rugosa*), and silverleaf oak (*Quercus hypoleucoides*). Trees are generally less than 16 feet in height. Common shrubs associated with oak woodland include pointleaf manzanita, Wright's silktassel, and evergreen sumac. Madrean savanna and possibly chaparral are associated with more xeric (south-facing) sites. Tree canopy cover currently ranges from 10% through 100%; historic canopy covers were generally less than 30% except in areas protected from fire (McPherson 1992, Abbott 1997, Miller et al. 2003).

Soils: Shallow very cobbly, cobbly or gravelly sandy loams; soils are weakly developed but have a thin dark surface layer (possibly related to a more pronounced grass understory in the past); this unit correlates with the steeper, mid- to moderately high elevation portions of the Faraway-Rock Outcrop-Barkerville soil association (Richardson et al. 1979).

Precipitation zone: 14-22 inches (USDA Forest Service 1991); 16-25 inches for soil association (Richardson et al. 1979).

Frost-free period/mean annual temperature: 140-220 days/50-58 ºF (Richardson et al. 1979).

Elevation: Ranges from 4,186 to 7,408 feet with a mean of 5,527 feet; 3,222 feet relief.

Hydrologic characteristics: A total of 30.4 miles of streambeds are associated with this unit (a total stream density of 1.02 miles of stream per square mile); this unit contains no perennial streams; the drainage pattern is dendritic.

Fire Ecology/History: Similar to map unit 7, with more areas with longer return intervals because steeper slopes and abundant rock outcrops may influence fire behavior and the resulting vegetation mosaics (field observation). Potential natural vegetation is predicted to be mixed oak woodlands composed primarily of Emory, Arizona, net-leaf, and silverleaf oak.

Map unit 9: Madrean chaparral and oak savanna on limestone hills and low mountains

The moderately steep map unit 9 comprises 14,845 acres or 3 percent of the planning area. The lower elevations typically transition to more gently sloping elevated plains and hills associated with Madrean oak savanna (map unit 5) and grassland and Madrean oak savanna on granitic hills (map unit 6). This unit occurs in the same landscape setting as Madrean oak woodland on volcanic hills and low mountains (map unit 7) and mountains (map unit 8).

Slopes: Side slopes mostly range from 15 to 40 percent.

Geologic materials: Limestone/dolomite or limestone-dominated Naco Group undivided and Naco Group lower formations (Geologic Map of Arizona 1969).

Landforms: Hills and mountains.

Vegetation: Madrean chaparral is associated with limey soils situated in oak woodland and oak/pine, most often on more xeric (south-facing) sites. Chaparral species include mountain mahogany, Stansbury cliffrose (*Purshia stansburiana*), oaks (shrub form or large trees), Mearns sumac (*Rhus microphylla*), and pointleaf manzanita. Scattered Emory oak and juniper occur throughout the unit. Grasses, including gramas and threeawns are prevalent.

Soils: This unit is characterized by shallow and very shallow, very cobbly loamy soils with areas of limestone rock outcrops; soils are very limey and weakly developed but have a dark surface layer (possibly related to the pronounced grass understory); this unit correlates with the less steep, mid- to low elevation portions of the Tortugas-Rock Outcrop soil association (Richardson et al. 1979).

Precipitation zone: 18 to 22 inches (USDA Forest Service 1991); 16 to 24 inches for soil association (Richardson et al. 1979).

Frost-free period/mean annual temperature: 140 to 220 days/48 to 58 ºF (Richardson et al. 1979).

Elevation: 4,623 to 6,362 feet with a mean elevation of 5,391; 1,739 feet relief.

Hydrologic characteristics: 20.4 miles of streambeds are associated with this unit (density of 0.88 stream miles per square mile); no perennial streams were detected in analysis of this unit; angular dendritic drainage pattern.

Fire Ecology/History: Fire regime is likely similar to that of unit 7. Fire exclusion has resulted in a shift toward a more closed canopy chaparral and savanna, although the change is relatively slow due to soil limitations (high lime) in this unit.

Map unit 10: Madrean oak-pine woodland on limestone mountains

Map unit 10 comprises 30,759 acres or 6.1 percent of the planning area. The west and south boundaries of the unit adjoin less steep hills and plains associated with Madrean oak savanna (map unit 5). Imbedded in this unit are areas mapped as mixed conifer forest on high limestone mountains (map unit 12). On its northeastern boundary it sharply transitions to Madrean oak-pine woodland and forest on granitic lower mountain slopes (map unit 11).

Slopes: Side slopes mostly range from 40 to greater than 60 percent.

Geologic materials: Limestone and other sedimentary rocks (Geologic Map of Arizona 1969); limestone and small areas quartzite, sandstone and shale rocks (Richardson et al. 1979).

Landforms: Mountains.

Vegetation: The oak-pine woodland is a narrow, dense zone with a mixture of tree and shrub species. Historic tree canopy covers ranged between 10 and 40%. Common overstory species include: Arizona white oak, silverleaf oak, net-leaf, Mexican pinyon, Chihuahua pine (*Pinus leiophylla*), and Apache pine (*Pinus engelmannii*). More mesic microsites include: Arizona pine, alligator juniper, and Douglas-fir (*Pseudotsuga menziesii*).

Soils: Shallow very cobbly loams; soils are weakly developed and very limey, but have a thin dark surface layer (possibly related to a more pronounced grass understory in the past); this unit

correlates with the steeper, mid- to moderately high elevation portions of the Tortugas-Rock Outcrop soil association (Richardson et al. 1979) and General Ecosystem Survey unit 476.

Precipitation zone: 18-28 inches (USDA Forest Service 1991); 16-24 inches for soil association (Richardson et al. 1979).

Frost-free period/mean annual temperature: 140-220 days/48-58 ºF (Richardson et al. 1979).

Elevation: 4,990 to 9,452 feet with a mean of 6,407 feet; 4,462 feet relief.

Hydrologic characteristics: A of 46.38 miles of streambeds are associated with this unit (a total stream density of 0.97 miles of stream per square mile). This unit contains 3.02 miles of perennial streams (6.5% - a density of 0.06 miles per square mile); the drainage pattern is angular dendritic.

Fire Ecology/History: The oak-pine woodland is ecotonal between the oak woodland and ponderosa pine or mixed conifer stands, depending on aspect. Stand composition changes from oak-dominated to a more pine-dominated combination with increasing elevation. Based on a fire history constructed in oak-pine woodlands of canyons in southeastern Arizona (including the Huachuca Mountains), southwestern New Mexico and northern Mexico, Kaib (1998) estimated a fire frequency of from 1 to 15 years, with a mean-fire interval (MFI) of 8 years. Individual canyons may have had longer or shorter fire intervals, e.g., Rhyolite Canyon in the Chiricahua National Monument had a fire frequency of 9 to 22 years (MFI 14.6 years) (Swetnam et al. 1989); the Organ Mountains (New Mexico) had a fire frequency of 1 to 3 years (minimum) to 11 to 22 years (maximum) (Morino 1996); and McClure Canyon in the Huachuca Mountains had a fire frequency of 2 to 21 years (MFI 7 years).

Fire frequency has declined as a result of aggressive fire suppression, grazing, and other land management activities (Bahre 1991, Covington and Moore 1994, Swetnam and Baisan 1996). High tree densities in oak-pine woodlands indicate the diminished role of fire in these communities. Moderate fire intensity favors pine, while killing less fire-resistant oaks. Oaks are prolific resprouters after disturbance and are favored by low-intensity fires or long fire return intervals (Barton 1999). Fire history research indicates that frequent, low-intensity fires burned through pine and mixed conifer forests before about 1900 and that high-intensity, stand-replacing fires were rare (Swetnam et al. 1999). This fire regime has been replaced by infrequent, high-intensity stand-replacing fires due to buildup of ladder fuels, litter, and woody debris. Frequent fires minimized fuel buildup, removed seedlings/saplings, and promoted an herbaceous understory.

Fuel loads are similar to those measured in ponderosa pine communities (see map unit 12). Oak-pine woodlands are not well represented by fire behavior fuel models but may be represented by FBPS fuel models 6, 8 and 9. The FRCC is typically a class 3 due to high tree and shrub densities, increasing prevalence of fire intolerant species, and replacement of understory herbaceous vegetation by litter, and woody debris. Desired conditions may be to minimize stem density, litter and woody debris in favor of an increase in the grass/herbaceous component.

Map unit 11: Madrean pine-oak woodland on granitic hills and low mountains

Map unit 11 comprises 17,106 acres or 3.4 percent of the planning area. The upper boundaries of the unit adjoin limestone dominated mountains characterized by Madrean oak-pine woodlands (map unit 10) and mixed conifer forests (map unit 12). The lower boundary grades into grassland elevated plains (map unit 3).

Slopes: Side slopes mostly range from 15 to 40 percent.

Geologic materials: Precambrian granitic rocks (Geologic Map of Arizona 1969).

Landforms: Hills and low mountains.

Vegetation: Same as map unit 10.

Soils: This unit is associated with portions of the Caralampi-White House-Hathaway soil association (Richardson et al. 1979). The soils are deep and have gravelly sandy loam, loam and sandy clay loam surface layers. The subsurface layers are typically gravelly or very gravelly sandy clay loam. On more stable landform components such as ridges the subsoils tend to be clayey with less gravel or cobble. Most soils have little or no lime concentrations in the deeper soil layers due to the nature of the parent materials and the age of the geomorphic surfaces; however a small percentage do have strong lime deposits at or near the surface.

Precipitation zone: 16-24 inches (estimate).

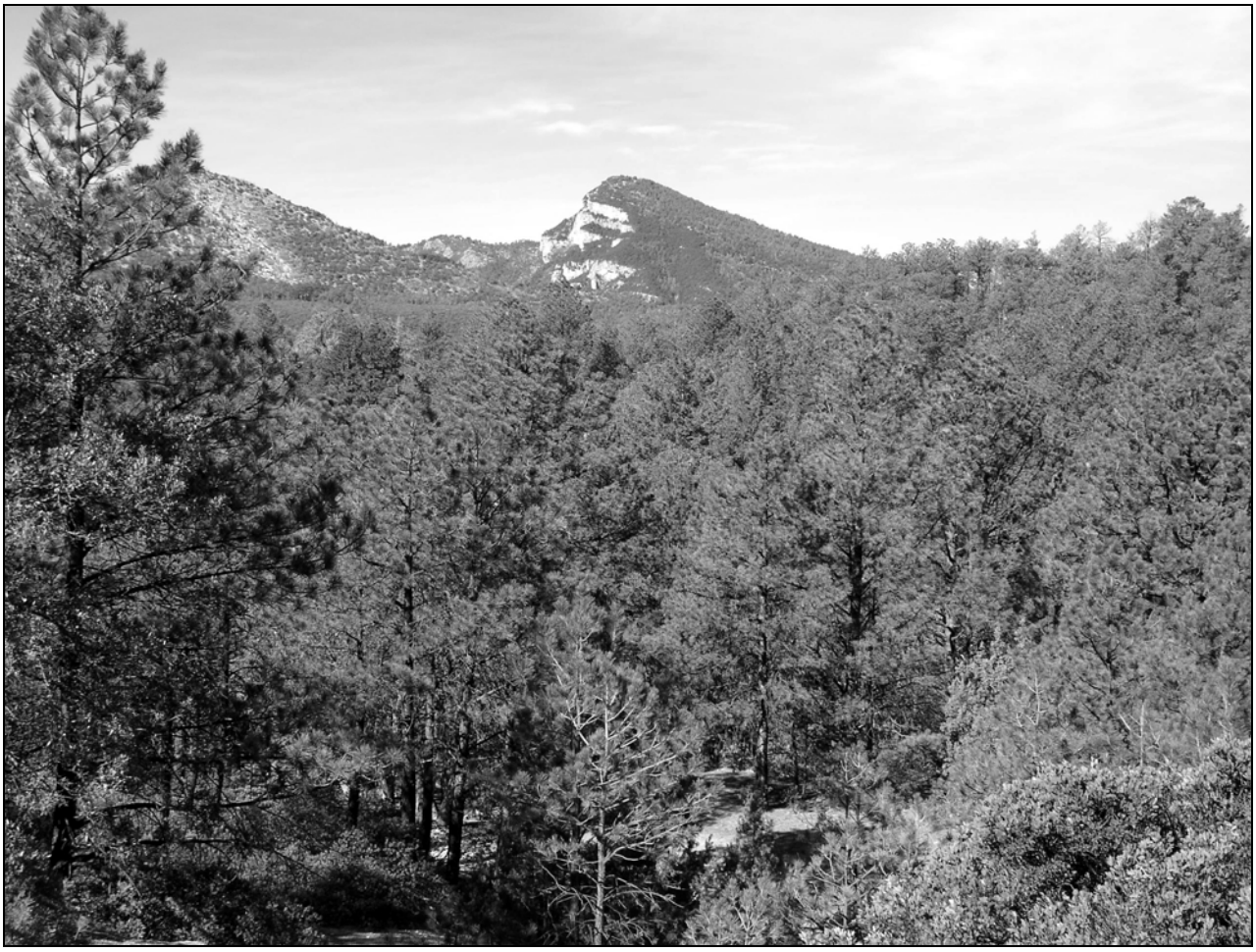
Frost-free period/mean annual temperature: 140-220 days/48-58 ºF (Richardson et al. 1979).

Elevation: Ranges from 4,833 to 8,028 feet with a mean of 5,639 feet; 3,196 feet relief.

Hydrologic characteristics: A total of 29.27 miles of streambeds are associated with this unit (a total stream density of 1.1 miles of stream per square mile). This unit contains no apparent perennial streams; the drainage pattern is dendritic.

Fire Ecology/History: Similar to map unit 10. This unit is not as steep as map unit 10, tends to have deeper soils and less rock outcrops, and less aspect variation resulting in more continuous fuels.

Map unit 12: Madrean pine and mixed conifer forest on high elevation limestone mountains



Map unit 12 comprises 13,725 acres or 2.7 percent of the planning area. This unit represents the higher elevation and dominantly northeast facing limestone influenced areas of the Huachuca Mountains. On warmer aspects and lower elevations of the Huachucas it transitions to Madrean oak-pine woodlands also associated with limestone bedrock (map unit 10). On its northeastern boundary it adjoins Madrean oak-pine woodland and forest on granitic lower mountain slopes (map unit 11).

Slopes: Side slopes mostly range from 40 to greater than 60 percent.

Geologic materials: Limestone and other sedimentary rocks (Geologic Map of Arizona 1969); limestone and small areas quartzite, sandstone and shale rocks (Richardson et al. 1979).

Landforms: Mountains.

Vegetation: The pine community type is composed mainly of Arizona pine with varying amounts of southwestern white pine (*P. strobiformis*), Douglas-fir, silverleaf oak, and Gambel oak (*Q. gambelii*). The mixed conifer type, dominated by white fir (*Abies concolor*), Douglas-fir, and aspen (*Populus tremuloides*), occurs on the more mesic north facing slopes in the uppermost elevations. Conifers can be present at lower elevations in north-facing, more mesic canyons,

while adjacent xeric south-facing slopes may have chaparral species. Lower elevations of the ponderosa pine/mixed conifer forest transition into pine/oak woodlands; however in steep sided canyons, upper slopes could be dominated by oak woodland. Common shrub species include oak species, New Mexican locust (*Robinia neomexicana*), Wilcox's barberry (*Berberis wilcoxii*), Fendler ceanothus (*Ceanothus fendleri*), and mountain snowberry (*Symphoricarpos oreophilus*); common herbaceous species include *Muhlenbergia*, and pine dropseed *(Blepharoneuron tricholepis).*

Soils: Shallow very cobbly loams; soils are weakly developed and very limey, but have a thin dark surface layer (possibly related to a more pronounced grass or grass/forb understory under historical fire regimes); this unit correlates with the steeper, high elevation portions of the Tortugas-Rock Outcrop soil association (Richardson et al. 1979) and General Ecosystem Survey unit 476.

Precipitation zone: 18-28 inches (USDA Forest Service 1991); 16-24 inches for soil association (Richardson et al. 1979).

Frost-free period/mean annual temperature: 140-220 days/48-58 ºF (Richardson et al. 1979).

Elevation: 5,699 to 9,209 feet with a mean of 7,345 feet; 3,510 feet relief.

Hydrologic characteristics: A total of 19.2 miles of streambeds are associated with this unit (a total stream density of 0.9 miles of stream per square mile). This unit contains 0.68 miles of perennial streams (3.5% - a density of 0.032 miles per square mile); the drainage pattern is angular dendritic.

Fire Ecology/History: Many studies have revealed that the current fire regime in ponderosa pine forests and associated woodlands of the southwest is radically different from what existed during pre-settlement times, i.e., prior to extensive Euro-American settlement in the late 1800s (Cooper 1960, Covington and Moore 1994, Swetnam and Baisan 1996). Changes in the fire regime were attributed to decreased frequency of widespread surface fires, effects of human land use, and variation in overall patterns of climate (Bahre 1991). Presettlement stands were often characterized as open and park-like, with well spaced, mature trees, sparse younger trees and abundant herbaceous vegetation (Cooper 1960). Frequent surface fires consumed accumulated needles and grass, maintaining open stand conditions. These fires also prevented establishment of less fire-tolerant tree species. Currently, ponderosa pine dominates the older age classes, but because of lack of fire, less fire-resistant tree species, including southwestern white pine and Douglas fir compete in the younger age classes (Danzer 1998). Much of the ponderosa pine area was logged extensively around the turn of the century (1900). In addition, heavy grazing was deliberately practiced to remove fine fuels in pine woodlands (Leopold 1924). Throughout the 1900s overgrazing, coupled with improved fire-fighting equipment and techniques, aided active suppression of fires until the mid 1970s, when managed fire was reintroduced.

Fire histories are available for pine forests in many of the sky island mountain ranges in the southwest, including the Huachuca Mountains (Danzer 1998, Kaib 1998). These studies have shown that the historical mean fire intervals for the Huachuca Mountains ranged from 3 to 26 years (MFI 8 years), which is similar to that reported for other sky island mountain ranges (Swetnam and Baisan 1996). The last widespread fire in the Huachuca Mountains occurred in 1899. In contrast to the low-intensity, pre-settlement fires, several large crown fires have

occurred within the last 100 years in the Huachuca Mountains. These include the fires in 1977, 1983 and 2002. The potential for fires in this mountain range is high due to lightning and anthropogenic sources. The Huachuca Mountains are a major conduit for illegal human traffic due to their proximity to the Mexican border. Several recent fires were attributed to this traffic. Another factor contributing to potential fire is insect infestation. For the past several years, Arizona has been experiencing an increasing amount of pinyon and ponderosa pine mortality due to native insect outbreaks (http://www.fs.fed.us/r3/resources/health/beetle). Combinations of low tree vigor caused by several years of drought and excessively dense stands of trees have allowed beetle populations to reach epidemic levels. Beetle-killed trees greatly increase the risk for catastrophic fire in these forests.

Little is known about fires in high-elevation mixed conifers in the Huachuca Mountains, although fires are generally less frequent in these systems than in other communities because they tend to be more mesic (Bahre 1991). Studies on other sky islands in the southwestern U.S. and northern Mexico report fire return intervals ranging from 1 to 50 years, with mean return intervals of 7 to 12 years depending on the site. In the White Mountains of Arizona, Dieterich (1983) estimated the fire-return interval to be 22 years. Fires in mixed conifer communities can be light or erratic in wet years or intense and stand-replacing during drought years.

Mixed conifer plant associations can be represented by FBPS fuel models 10 and 11. In the Huachuca Mountains, tree density ranges from 25 to greater than 400 trees/acre; downed woody material in the 0 to 3-inch category ranges from 0.4 to 18 tons/acre; shrub biomass from zero to 15 tons/acre (Miller et al. 2003). FRCCs are typically a class 3 due to greater tree and shrub densities, increasing prevalence of fire intolerant species and replacement of understory vegetation by litter and woody debris. Desired conditions would be to decrease the number of fire-intolerant species and increase the herbaceous component. Fire favors the maintenance of more open pine forest at the expense of less fire tolerant Douglas-fir, white fir and oaks. Large portions of the mixed conifer are Mexican spotted owl habitat, and are vulnerable to stand-replacing fires. The maintenance of the appropriate extent, stand structure, and distribution of such habitat must consider the long-term role of fire in this unit.

Riparian unit

Map unit 13: Sensitive streams

These streams, associated with the Huachuca Mountains, are at too fine a scale to be mapped as polygons and are therefore represented as line segments. They are nested within ecological units 5, 10, 11 and/ or 12 and their characteristics are strongly affected by this context. For example, these relatively narrow stream segments are often overwhelmed by the fire ecology of their surrounding landscape; they may, however, have different fuel and ecological response characteristics than the surrounding uplands. They support intermittent to perennial flows and shallow water tables that, in combination with canyon slopes, produce a relatively mesic environment often supporting a gallery forest of riparian tree species, oaks and conifers. These stream segments are placed in three subcategories based on their associated geologic materials, landform characteristics, and elevation range, as well as their dominant upland plant communities. Photo (a) describes the lower reaches of Huachuca Canyon and Garden, Sawmill, Carr, Ramsey and Miller creeks. Photo (b) includes the upper reaches of Scotia, Bear, Lone Mountain, Oversight, and Sunnyside creeks, as well as Garden and Sawmill creeks. Photo (c) typifies the lower reaches of Sycamore, Lone Mountain, Bear, and Oversight creeks.

Map unit 13: subunit (a)

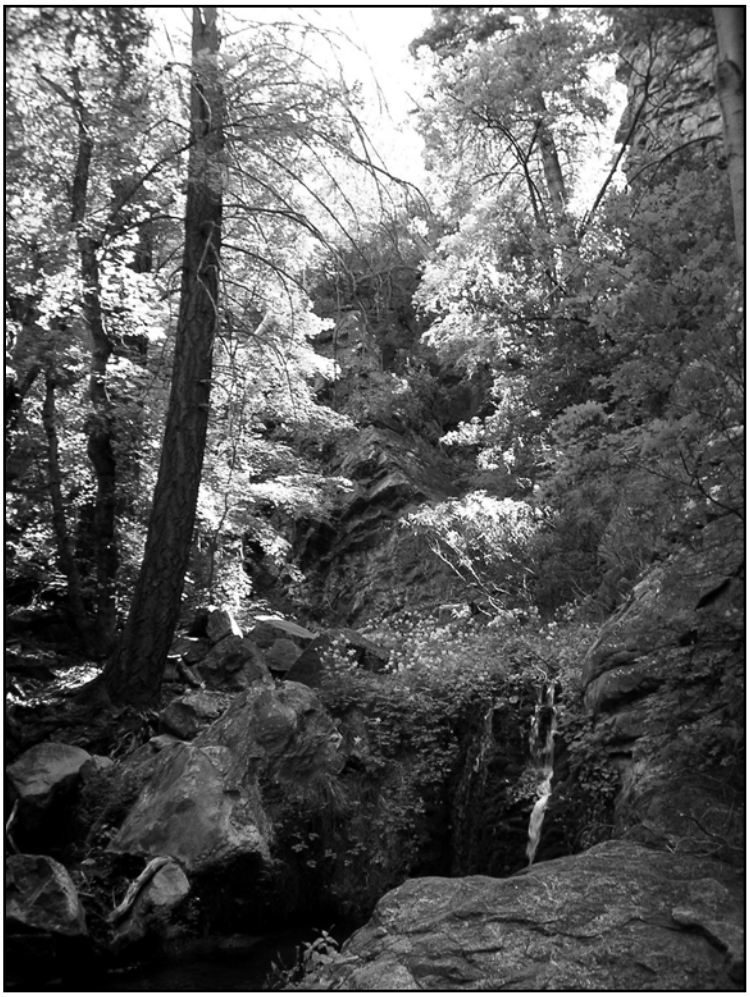
The steam segments in subunit (a) are associated with ecological unit 11 and are strongly influenced by decomposed granite bedrock. The dominant associated upland vegetation is Madrean pine-oak woodland. Approximately 11.2 total stream miles have been mapped. Their flows originate in mostly sedimentary rocks in the steeper mountains above (ecological units 10 and 12). The deeper granitic soils associated with these stream segments benefit water retention in the lower watershed. The inherently low nutrient status imparted by the granite bedrock may be partially mitigated by carbonate rich source areas in the upper watershed. Gradients are moderate to high; steeper gradients typically occur in upstream locations where the foothills intersect the mountains. Means range from 3.4 to 15.7 percent, with a weighted average gradient of 7.3 percent. They occupy low to middle elevations of 5,138 to 6,204 feet, with a mean of 5,472 feet.

These streams often display a bi-modal particle size distribution dominated by sand and stones and/or boulders. These stream segments are mostly moderately confined.

Map unit 13: subunit (b)

The stream segments in subunit (b) are associated with ecological units 10 and 12 and are mostly influenced by limestone and quartzite with some areas of volcanic rocks. The dominant associated upland vegetation is Madrean oak-pine woodland and mixed conifer forest. Approximately 5.4 total stream miles have been mapped. They are dominantly steep and very steep gradients (means range from 2.9 to 12.6 percent, with a weighted average of 6.14 percent). They occur at middle to high elevations. Elevation ranges from 5,223 to 6,581 feet, with a mean of 5,970 feet.

The particle size distribution is mostly cobble, stones and boulders; some reaches have exposed bedrock in the channels. Channel confinement is moderate to very high.



Map unit 13: subunit (c)

The stream segments in subunit (c) are associated with the older alluvial fan deposits of ecological unit 5; due to their proximity to the mountains, ecological unit 10, bedrock is sometimes exposed. The dominant associated upland vegetation is Madrean oak savanna and oak-pine woodland. Approximately 7.1 stream miles have been mapped. These stream segments are found at low and middle elevations, 5,328 to 6,020 feet, with a mean of 5,625 feet. Moderate gradients dominate (means range from 2.3 to 6.6 percent gradient; the weighted average for all stream segments measured was 3.25 percent).

These stream segments are similar to or represent the upper reaches of ecological unit 4 that are too fine to map out at the landscape scale as a polygon. They are transitional to the stream segments represented by subunit (b) that are associated with the bedrock controlled ecological units 10 and 6.

Stream particle size distribution is dominated by larger gravel and small to medium size cobbles although bedrock is occasionally exposed in the transitional areas near the mountains. These channels have moderate confinement.

Vegetation: Major plant associations found dispersed throughout these sensitive stream segments include Madrean oak-woodland, Madrean pine-oak forest, Southwest mixed riparian deciduous forest, and Madrean mixed conifer forest. At lower elevations, the gallery forest is characterized by Fremont cottonwood, willows (*Salix gooddingii*, *S. exigua*, and others), sycamore, Arizona walnut, Alligator-bark juniper (*Juniperus deppeana*), Emory oak, and Arizona white oak. At higher elevations, other species are added to the mix including Chihuahua pine (*Pinus leiophylla*), Arizona pine (*Pinus arizonica*); Apache pine; white fir, Douglas fir; big-toothed maple (*Acer grandidentatum*); Arizona madrone, and net-leafed oak (*Quercus reticulata*). These upper elevation species are most typically associated with the higher elevation subunit (b), but may also occur in the upper portions of subunits (a) and (c) due to locally mesic conditions and cold air drainage influences.

Chapter 3: Fire Management Units

For this plan, fire management units (FMUs) are areas governed by distinct fire management strategies. Boundaries are clear, and procedures are laid out in detail for each FMU. This umbrella plan for the HAFP area designates three FMUs and allows for wildland fire use over much of the area, recognizing that lack of fire has a detrimental effect on some ecosystems. This plan promotes the beneficial use of fire to achieve desired ecological conditions and reduce fuel buildups while simultaneously protecting life, property, and surrounding lands.

The HAFP acknowledges the ongoing effort to streamline fire operations across Federal agencies. The Fire Program Analysis (FPA) project will develop a common, interagency system for wildfire preparedness analysis, planning, and budgeting to coordinate fire management across jurisdictional units. The FPA also evaluates the effectiveness of alternative fire management strategies through time to meet land management goals and objectives. FPA will be driven by quantified performance measures for the full scope of fire management activities. It is a joint initiative among state land departments and the following five Federal wildland fire management agencies:

- USDA Forest Service
- Bureau of Land Management
- National Park Service
- Fish & Wildlife Service
- Bureau of Indian Affairs

The HAFP lies within the FPA Southeast Arizona Fire Planning Unit, part of a larger South West Area that includes Arizona, New Mexico, west Texas, and Oklahoma. While FPA is mainly aimed at optimizing the use of operational resources across agencies, designation of fire management units on a large scale is part of the exercise. How the FPA will coordinate with smaller regional plans is not yet clear. The HAFP FMUs are not currently part of the FPA system.

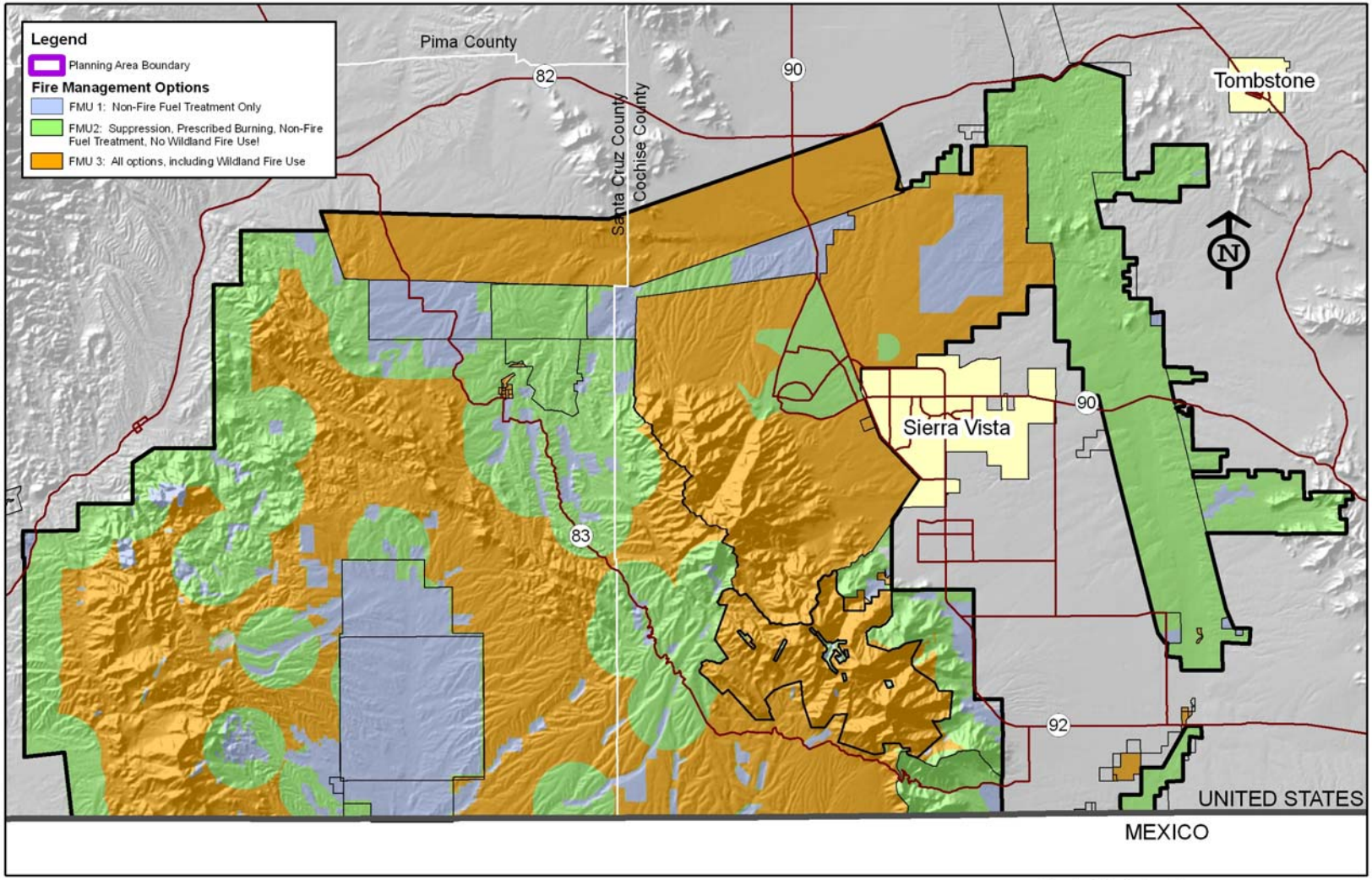
Wildland fire management options

Combinations of four fire management strategies define the HAFP fire management units:

- Wildland fire suppression is applied around high use and developed areas and where certain sensitive resources need protection.
- Prescribed fire is used to reduce fuels in high-risk areas and accomplish ecological goals.
- Wildland fire use allows natural ignitions to burn when they meet predetermined conditions related to safety and ecological goals.
- Non-fire applications—most notably thinning (removal of trees using mechanical equipment) and herbicides—are treatments that are used instead of prescribed burning in areas where fire is inherently unsafe or undesirable given current fuels conditions.

Figure 3-1 maps the HAFP FMUs. To keep the map at a logical scale, the FMUs are defined broadly and may contain sites within them that require special management; these sites will be designated special treatment zones (for example, a wooden historical structure within an area otherwise tolerant of fire) within the larger FMUs.

Figure 3-1. HAFP fire management units



Fire management unit 1 (no fire)

FMU 1 is the site of suppression and non-fire applications around high risk areas because the potential damage from wildland fire or an escaped prescribed fire within that unit would be intolerable (Figure 3-1). Tracts in this category include (1) the Cantonment Area at Fort Huachuca where most of the developments and historic buildings are located (east side of the planning area), (2) the private San Rafael Ranch (south-central), and (3) numerous, scattered, small private inholdings on the Coronado National Forest and BLM San Pedro Riparian National Conservation Area. FMU 1 pieces are delineated as tightly as possible in order to allow fire on much of the landscape to reduce fuels economically and deliver ecological benefits. The San Rafael Ranch may re-evaluate using fire in the future but concern about severe effects of past fires on riparian areas has led to a decision to exclude fire for the present.

Suppression

As described in Chapter 4, suppression remains a major fire management strategy in the HAFP planning area. Realistically, the burgeoning wildland-urban interface plus dangerously high fuel loads in some wooded and forested areas leave only narrow windows for wildland fire use.

Wildland fire suppression has broadened to embrace the concept of Appropriate Management Response (AMR), which denotes a full range of options for managing wildland fires beyond the traditional reaction to contain and control. Instead, managers can opt for confinement of fires within roads and natural fire breaks (e.g. ridgelines, creeks, talus slopes). Confinement may permit fires to burn over time and space to reach those barriers instead of attempting to completely encircle and quickly extinguish fires to keep them as small as possible. AMR options range from aggressive containment and full control, to minimal-impact confinement and aerial monitoring of wildland fires. Cost is also an important factor and justification for choosing AMR alternatives. Resource protection can be considered in choosing AMR response, but cannot be the driving factor in the decision.

The partners manage suppression in ways that minimize unnecessary impacts to resources and developments. Minimum impact suppression tactics strive to minimize landscape alteration and disturbance to natural and cultural resources while safeguarding human lives and property and accomplishing resource-related objectives. Without compromising safety, lines are located where they do the least damage, and use natural firebreaks when possible. Staging areas and helispots are placed where damage to natural and cultural resources is minimized. Agency resource advisors are consulted prior to implementing management tactics.

Non-fire Treatments

Across many parts of the HAFP landscape, some kind of non-fire fuels treatment is desirable. Mechanical, chemical, biological, and manual treatments reduce fuels that might sustain high-intensity fires or threaten structures:

Mechanical: Removal of undesired or excess live and dead fuels though the use of wheeled tractors and crawler-type tractors or vehicles with attached disks and blades that chop up and grind vegetation in place. Mechanically treated material may be left on site or removed. Such treatments may be considered stand-alone or be followed by the burning of debris piles or prescribed burning of the treatment site.

Chemical: Application of chemical agents to kill or restrict the growth of existing vegetation. Chemical treatments can be used to eradicate non-native and/or invasive species. Where fire is allowed, burning might precede herbicide application as plants begin to resprout. Treatments also might be followed by prescribed burning and/or planting of desired vegetation species.

Biological: The use of living organisms to selectively suppress, inhibit, or remove herbaceous and woody vegetation. Plant-eating organisms include insects as well as grazing animals such as goats and sheep.

Manual: The use of hand-operated power tools and hand tools to remove herbaceous and woody vegetation. Plants are cut above ground level or root systems are dug out to prevent subsequent sprouting and regrowth. Hand tools such as the hand saw, axe, shovel, rake, machete, and hand clippers are used in manual treatments, particularly in designated wilderness. Power tools such as chainsaws and power brush saws may also be used. Burning of debris piles or prescribed burning of the treatment site sometimes follow manual treatments.

These treatments on a per/acre basis are generally two to ten times (or even as high as a hundred times) as expensive as prescribed fire.

Fire management unit 2 (prescribed fire)

FMU 2 allows prescribed fire in addition to non-fire applications and suppression. Prescribed fire allows the meeting of resource management and safety objectives on a predictable timetable. Prescribed burning is both a means and an end; prescribed burning pre-treats the landscape to prepare for the return of fire as a natural process, but it also becomes the process when lack of ignitions and restrictive conditions keep wildland fire use from taking place.

These projects are conducted under a strictly defined set of weather and fuel moisture conditions (the “prescription”) and strictly confined to a predetermined area; burn plans govern every detail. Huachuca-area partners have been conducting prescribed burns since the 1970s.

This plan places much of the HAFP wildland/urban interface (WUI) in FMU 2 (see Figure 3-1). The WUI is the zone where human developments meet or intermingle with undeveloped wildlands. Fires have been destroying homes and killing people in this interface since the 1800s; in past decades, dealing with fire in the WUI has been a national priority but not one easily addressed. The eastern slope of the Huachucas is a classic WUI situation, with structures and utilities intermixed with fire-prone, naturally vegetated areas. Protection within the WUI requires both wildland and structural firefighting skills. The decision about which natural resource or piece of property to protect and which to walk away from is a difficult one to make, especially during a wildfire. Ongoing thinning projects in the WUI as well as many of the projects proposed under the auspices of the HAFP (see Chapter 5) may eventually push these areas into a condition where prescribed burning is feasible. Ultimately, it is desirable for these WUI areas to be in a condition that is safe for wildland fire use, as permitted by the 2005 Amendment to the Coronado National Forest Land and Resource Management Plan.

Fire management unit 3 (wildland fire use)

Over half of HAFP lands lie in FMU 3 (Figure 3-1). FMU 3 permits all management strategies—suppression, prescribed fire, non-fire treatments plus wildland fire use. When a naturally ignited wildland fire meets the conditions of a predetermined prescription for fuel reduction or

ecological improvement, it becomes a candidate for fire use. Federal agencies follow the decision criteria (see Table 3-1) contained in the USDA/USDI Interagency Wildland Fire Use Implementation Procedures Reference Guide (2005). The Coronado National Forest includes these decision criteria in its 2005 Wildland Fire Use Implementation Guide. In Table 3-1, a "go" decision results when all the criteria are satisfied and all answers are "no." Because of extensive wildland-urban interface, especially on the east slope of the range, the likelihood of satisfying all the decision criteria is not great. How to reduce fuels in the Huachuca high country remains a dilemma for all the land managers in these mountains on the east side of the HAFP planning area.

Wildland fire use is a step toward restoring natural fire regimes in the region. Pre-settlement fires probably burned for several weeks to a month or more. Similar behavior should be expected if lightning-initiated fires are allowed to burn early in the season. Fire sizes ranged from small and patchy to mountain range-wide. Fuel buildups that are the legacy of the full-suppression era dictate that great caution is still required when considering letting natural ignitions burn. Wildland fire use must be soundly based on management objectives—public and firefighter safety, natural and cultural resources benefits, interagency collaboration—and may include the full range of fire management strategies on a fire's entire perimeter. Ongoing fire use that does not meet predetermined prescriptive elements or fails to meet resource management objectives will be suppressed.

Table 3-1. Wildland fire use decision criteria checklist

Based on the USDA/USDI Interagency Wildland Fire Use Implementation Procedures Reference Guide (2005).

A "go" decision results when all the criteria are satisfied and all answers are "no."

Decision Element	Yes/ No
Is there a threat to life, property, or public and firefighter safety that cannot be mitigated? ▪ If known threats cannot be adequately mitigated, managing the fire as a wildland fire use has potential concerns due to fire location, serious threats to firefighter safety, and potentially significant consequences.	
Are potential effects on cultural and natural resources outside the range of acceptable effects? ▪ Potential outcomes and desired effects are closely correlated with burning conditions and fire behavior. Objectives and constraints include air quality and effects on natural and cultural resources, as applicable. References for objectives and constraints include the unit FMP, unit land management plan, and agency administrator input.	
Are relative risk indicators and/or risk assessment results unacceptable to the appropriate agency administrator? ▪ The third decision element involves an relative assessment of the risk for the fire. The relative risk assessment uses three risk components: values, hazards, and probability. Values are those ecological, social, and economic resources that could be lost or damaged because of a fire. Hazards in wildland fire are made up of the conditions under which it occurs and exists, its ability to spread and circulate, the intensity and severity it may present, and its spatial extent. Probability refers to the likelihood of a fire becoming an active event with potential to adversely affect values.	
Is there other proximate fire activity that limits or precludes successful management of this fire? ▪ This element pertains to other local and regional fire activity, commitments of unit and cooperator resources, specific unit FMP limitations on fire numbers, and availability to fill special skill positions from local resources for this fire. If current fire activity precludes the ability to manage the fire with adequate resources and skill mixes, then the response to this element will be "Yes" and a suppression response indicated.	
Are there other agency administrator issues that preclude wildland fire use? ▪ The final decision element allows agency administrator discretion in the event there are other issues which were unknown to the fire staff and must be considered as part of the decision to manage the fire for resource benefits. Agency administrators will document other issues that precluded management of the fire for resources benefits.	

Chapter 4: Wildland Fire Management

The HAFP planning area is a landscape shaped by frequent fire. Fire history studies (see map unit descriptions in Chapter 2 for background) show or deduce return intervals of a few to a few dozen years for the grasslands, woodlands, and forests of the region, although some investigators (e.g. Baker and Ehle 2003) have recently suggested fires were less frequent. The same studies show those intervals lengthening dramatically beginning in the early 20th century. Enlightenment about the need to let fires burn has come at a time when residential development in the HAFP canyons, foothills, and valleys has made wildland fire use impractical in many places. Fuels treatment projects are planned for vulnerable areas, but their execution depends on proper alignment of politics, funding, and weather. Thus, fire suppression remains the cornerstone of fire management in the region.

Pre-monsoon fires are the most intense and typically have the highest spread rates. In addition to high temperatures, low humidities, high winds, and dry lightning storms, vegetation factors contribute to the intensity of the initial fire season. The perennial, mainly warm-season grasses remain dry and a readily available, significant fuel until July. In addition, the oaks generally drop (and replace) leaves during the spring dry period that occurs from late April through early July.

The second fire season begins with the “true monsoon” onset. Storms are usually well developed by the third week in July and occur almost daily in the mountains. Green-up typically begins during the first two weeks of the season. Although fuel moisture and burning indices are usually lower than in the pre-monsoon season, more ignitions occur during the second season because there are more storms, and consequently more lightning. By August, when thunderstorm activity is very high, soils and woody fuels at upper elevations are typically saturated with moisture, and fire activity declines. When drier conditions return toward the end of September, few thunderstorms are occurring, and fire activity remains low.

Figure 4-1 shows wildfires on record for the planning area; the earliest dates from 1973. Major recent fires are listed in Table 4-1. The disregard of these wildfires for political boundaries was a major motivation for the banding together of the Huachuca Area Fire Partners. In recent years, wildfires have frequently been attributed to undocumented immigrants traveling through the area rather than lightning strikes.

Coronado National Forest role

The Sierra Vista Ranger District of the Coronado National Forest does the heavy lifting in the region, with all other managers except BLM relying on its resources for wildland fire management. The Sierra Vista Ranger District has both a Fire Management Officer (FMO) and Assistant FMO and maintains five engine crews in the region. While area residents are often the source of smoke reports, the Coronado uses lookouts at Red Mountain (in the Patagonia Mountains on the west side of the planning area) and Lemmon Rock (in the Santa Catalina Mountains to the northwest) to detect fires. Red Mountain is generally staffed from April until August. The Coronado also flies the forest twice a day (morning and afternoon) or more frequently during “severity” periods when fires would be predicted to have extreme behavior (usually late May until early June). Neighboring Forest Service districts provide additional suppression resources and support when needed.

When a new wildland fire ignition (start) is detected on, or in proximity to Forest Service lands, it is usually reported by a Forest Service lookout tower or sometimes by a citizen. When a start is

Figure 4-1. Fires on record for the HAFP planning area

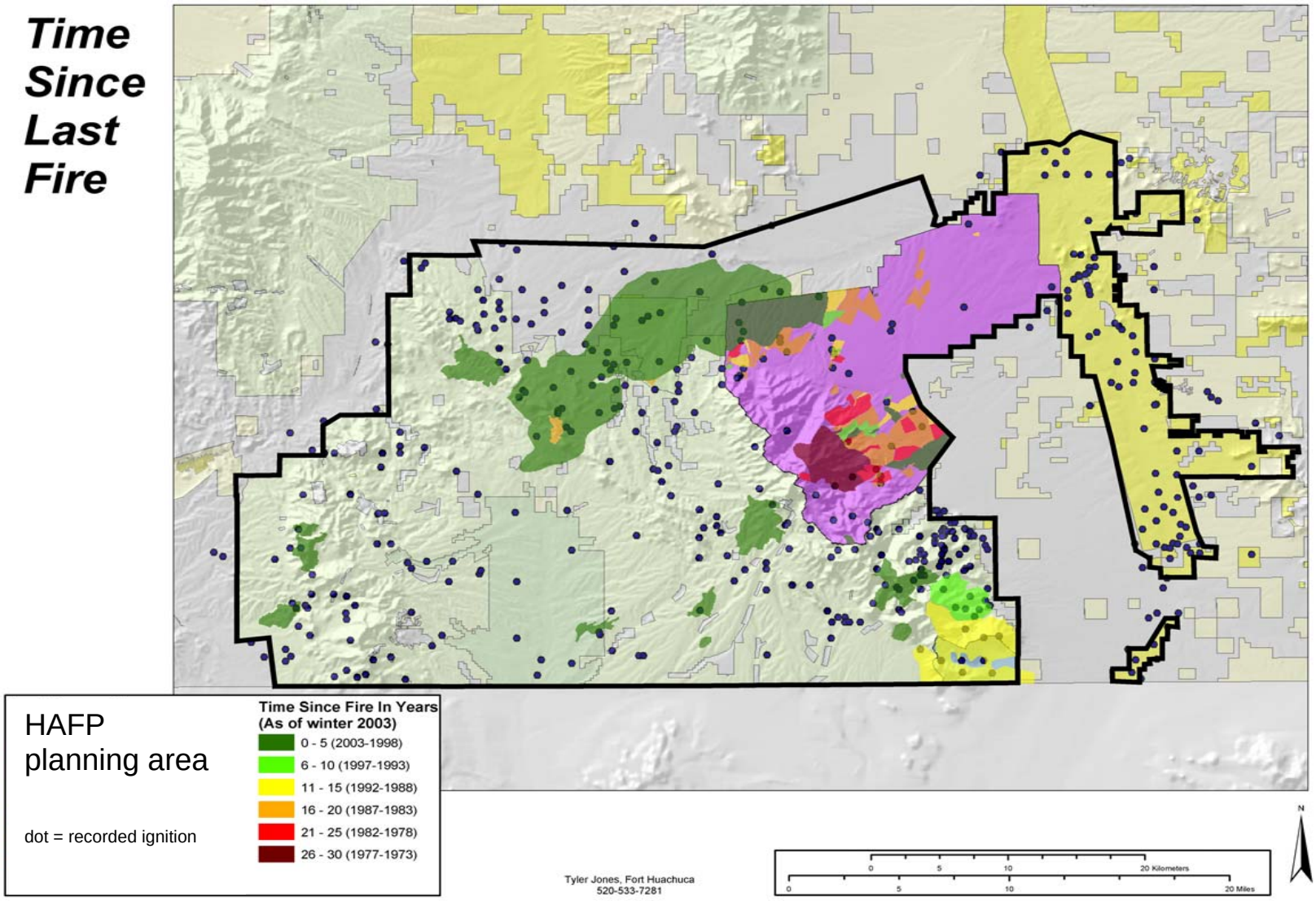


Table 4-1. Recent wildfires greater than 100 acres in the HAFP planning area

Year	Name	Acres
2002	Community	660
	Merritt	2,670
	Mustang	1,600
	Oak Tree	4,470
	Oversite	2,240
	Ryan	38,000
	West Dome	930
2003	Abar	530
	Ash	560
	Border	1,470
	Cimarron	210
	Red Rock	2,760
	West	1,200
	Windmill	380
2004	Montezuma	240
	Tank	180
2005	Aztec	1,300
(As of July 26)	Sunday	370
TOTAL		**59,770**

detected by a lookout, the report is made to the Southeast Zone Coordination Center (dispatch) in Tucson, Arizona. The protocol for reporting a new start includes a legal description of the location of the detected smoke, color and volume of the smoke, and a geographic reference point if possible. The lookout begins the report with a bearing and distance from the tower to the fire. This reporting is done over the Forest Service radio frequency to dispatch and as a matter of practice, all suppression resources and supervisors monitor this frequency during fire season. This monitoring allows for initial movement of resources prior to the formal dispatch procedures.

The formal dispatch procedure is based on closest available resource(s), fire severity indices for the day, and values at risk. Once the legal description is determined or estimated by the lookout and the dispatch center, the dispatchers will reference a pre-established matrix and Forest maps to determine the appropriate level of response. The level of response, or the number and type of suppression resources to be sent, is dictated by the fire severity conditions for the day and the location of the start relative to values at risk. The Forest dispatch maps are color-coded for three levels of dispatch: (1) critical response areas (red) for starts in or in proximity to the Wildland Urban Interface (WUI) or other important values and infrastructure on or near Forest Service lands, (2) elevated response areas (yellow) for starts in proximity to Forest Service infrastructure, facilities, areas containing sensitive resources, and (3) normal response areas (green) for general Forest Service lands with no other significant features or values found in the other two response areas. First, the dispatcher plots the estimated location of the fire on a large map in the dispatch center. That location is referenced against the Forest dispatch maps to determine the response area. That information is then cross-referenced on a matrix against the reported severity indexes to determine the pre-identified types and numbers of resources to dispatch to the new start. From that list of pre-determined resources, the dispatcher will call, on the Forest Service radio frequency, the closest available resources, which report their location daily to dispatch as a matter of practice.

The amount and type of resources dispatched to a new start, therefore, may very greatly depending on the location of the new fire and potential threat to values. Resources typically available in the Forest's dispatch matrix range from single small fire engines (Type VI with a crew of three firefighters) to multiple fire engines, hand crews, helicopters, and air tankers. Each morning of fire season, the number and type of resources available for the day check in with the dispatch center and that information is part of a daily weather forecast and update broadcast to all Forest employees monitoring the Forest Service radio frequency. It is important to note that although the current dispatch matrix was developed with Forest Service resources and lands in mind, the Forest has a long and rich history of interagency cooperation for fire suppression. Efforts are on-going to incorporate formally, other agency resources into the dispatch matrix. As a matter of practice, other agency resource availability is currently tracked and reported to the field as part of the daily morning report. Current practice for dispatching other agency resources is based on a call-when-needed basis. If conditions or on-scene reports indicate a need for more resources beyond the initial dispatch of resources, the dispatch center will call upon our nearby cooperators and agencies for assistance.

Each one of the Forest's suppression resources is staffed with a qualified incident commander (typically an IC type 4 - ICT4), so that each new start will typically have a qualified fire supervisor or IC to develop the initial strategy and tactics for suppression. The first-on-scene IC must go through a size-up process that involves assessment of the terrain, available fuels and fire behavior, available and/or responding resources, suppression objectives, and most importantly, fire fighter and public safety. The initial process for size-up includes some minor documentation

including the tracking of resources, notes on conditions and fire location, safety hazards and mitigation, and a quick situation complexity analysis (Appendix C). Much of this initial size-up is reported to the dispatch center, again over the Forest Service radio frequency so that supervisors and other responding resources can hear the details of the situation at hand. These factors in the initial size-up are constantly monitored by the IC and other fireline supervisors on-scene.

Should fires escalate in complexity and/or difficulty to control, the Forest has more highly qualified ICs available to respond to the fire. The Forest Service operates under the Incident Command System (ICS) which allows for the expansion or contraction of the organization to suppress a fire depending on the size and complexity of the fire. The Coronado National Forest has many ICT4s and ICT3s available, some of which are assigned to the Sierra Vista Ranger District. If a fire's complexity is initially, or grows beyond the first-on-scene IC's (ICT4) ability, a transfer of command is made. This may occur immediately if a more highly qualified IC is on-scene or through a request to have a more highly qualified IC respond to the fire. Currently the Sierra Vista Ranger District's Fire Management Officer (FMO) is qualified at the Incident Commander Type 3 (ICT3) level. For the District and the Forest as a whole, FMOs or Assistant FMOs (AFMO) typically respond to all fires during fire season that are determined or appear to be at the higher end of our dispatch matrix. Many of the Forest's FMOs and some of the AFMOs are qualified at the ICT3 level.

If a higher complexity fire suppression effort begins to decline or lessen in complexity, ICS allows for a smooth transition to a smaller organization and transfer of command to a lesser qualified Incident Commander. This situation is common as suppression efforts are successful and is determined by the constant size-up process and complexity analysis that is done throughout a suppression campaign.

Other partner operations

The Coronado will step in to assist neighboring land managers as outlined below. BLM wildland fire operations are generally self-contained:

Arizona State Parks

Arizona State Parks does not currently have an agency wildland fire policy or management plan. The Resource Management Section has identified a critical need for the development and implementation of integrated resource management plans for each State Natural Area and State Park. The comprehensive resource management plan would address fire as an effective management tool. Arizona State Parks manages the San Rafael State Natural Area that is comprised of a perpetual conservation easement on the San Rafael de la Zanja Land Grant and approximately 3,500 acres in fee simple land. The San Rafael State Natural Area is bounded to the south by the U.S.-Mexico border, the west by the Patagonia Mountains, and the east by the Huachuca Mountains. Private land to the north occupies the rest of the San Rafael Valley. Park staff are wildland fire trained with State Land Department Fire Management Division (Tucson District) as the primary party to assist. To reduce risk of damage to buildings, ASP staff annually drag a fire break around all the buildings. The State Natural Area is equipped with fire fighting gear, one class 6 brush truck, and fire hydrants to the east and west of the historical ranch house. State Parks staff are currently involved in the development of a Comprehensive Management Plan for the San Rafael State Natural Area and will be coordinating with other entitites to determine the use of fire to manage for a grassland ecosystem.

Audubon's Appleton-Whittell Research Ranch (ARR)
The existing ecological fire plan for the northern portion of the Research Ranch is being updated by the Bureau of Land Management (Safford Office), however since 90% of the Research Ranch burned in the Ryan Wildfire of April 2002, no large-scale ecological burns are planned in 2005 or 2006. Research projects that incorporate small burns may be implemented during this time frame, and coordination of these burns will be through the Sonoita-Elgin Emergency Services, Inc. (SEESI). Audubon personnel are working with SEESI to determine preferred actions in case of wildfire. If possible, wildfires will be allowed to burn freely. If suppression is necessary, SEESI will take appropriate action, including notification of additional response crews if needed. The southern portion of the Research Ranch is included in the Coronado National Forest, and fire management responsibility of this area rests with the Forest Service.

Bureau of Land Management (SPRNCA)
The Bureau of Land Management, Fire Management Office in Safford, AZ, is responsible for fuel treatment, prescribed fire, and wildfire suppression in the San Pedro Riparian National Conservation Area. Procedures for responding to wildfire can be described as follows: a BLM fire crew consisting of 3 to 6 individuals, a heavy-duty wildland fire engine, and crew truck (based in Sierra Vista) perform initial attack on reported wildfires in or near the conservation area. Responders attempt to suppress the fire and inform Safford dispatch as to location, size, and severity of the fire. The fire crew supervisor serves as incident commander and may request additional resources (aircraft, additional engine and handline crews, law enforcement, logistical support, etc.) from Safford dispatch. As the size and complexity of the fire increase, incident command may pass to an individual with higher qualifications. Due to the linear pattern and patchy distribution of fuel in the conservation area, wildfires are usually controlled within 24 to 48 hours. Crews usually spend one to seven days monitoring the burn area and mopping up the perimeter.

Fort Huachuca
Wildland fire operations at Fort Huachuca are guided by its 2005 Integrated Wildland Fire Management Plan. On the installation, the responsibility for wildland fire management and training lies within the Fire Department and the Directorate of Public Works, Environmental and Natural Resources Division. The Fire Chief has responsibility for the wildland fire operations, based at Fire Station #2. The Fire Department is generally able to manage fires in lower elevation grasslands and shrublands. The Sierra Vista Ranger District of the Coronado has historically accepted responsibility for fire management in the woodlands and forests above Charlie Break (the name of a fire break running from approximately 5,200 feet elevation at the south end to 7,100 feet at the north end), as governed by a five-year agreement renewed in 2004. When assistance is required, the Fire Chief formally delegates authority to the Forest Service Incident Commander. The Forest Service currently maintains an air tanker base at Fort Huachuca’s Libby Field.

The Nature Conservancy, Ramsey Canyon Preserve
The Nature Conservancy has a 1998 FMP and a 2005 emergency response guide for the 380-acre Ramsey Canyon Preserve. Some 20,000 people a year visit, with March, April, May, and August the peak months. The Fry Fire Department has suppression responsibility for structural and wildland fires on the preserve and adjacent private lands to the east. The Sierra Vista Ranger District of the Coronado National Forest abuts the preserve on the north, west, and south sides; the district can take action on private land when the forest is threatened. Given the small size of

the preserve, wildland fire is likely to move through quickly. A permanent staff of five and numerous volunteers operate the preserve, but there are times when staff are not present. When an ignition is detected on the preserve, the site administrator or other responsible party present is instructed to call 911 and the Sierra Vista District Ranger. The Southeastern Arizona Assistant Preserves Manager or other designee will serve as Resource Advisor for wildland fire resource protection decisions. Other staff or volunteers are assigned jobs that coordinate tracking visitors, managing traffic, and overseeing orderly evacuation, if necessary. The Nature Conservancy will consider allowing naturally ignited wildland fire to burn on both Ramsey Canyon and the unstaffed Canelo Hills preserves.

Coronado National Memorial

Coronado National Memorial has no FMO; the Saguaro National Park FMO in Tucson advises the Memorial on its fire operations. The Memorial also has a long history of working with the Sierra Vista Ranger District of the Coronado National Forest and in 2004 entered into an interagency agreement to coordinate actions ensuring the Memorial's fire program is adequately prepared. All fires are reported to the superintendent, chief ranger, and resource manager, as well as to the Saguaro National Park FMO. The 2005 fire management plan has determined that all wildland fires will be suppressed using the Appropriate Management Response. The memorial depends on local (Palominas and Fry) fire departments and the Forest Service for initial and extended attacks on fires. Therefore, the Memorial works closely with these agencies in planning, training, preparedness, and other fire management issues. Response times of these agencies to Memorial fires are generally less than one hour depending on resource type, time of year, and fire danger. If a fire threatens to exceed the initial attack capabilities of the Memorial and local cooperating agencies, the Incident Commander will request additional resources from the Southeast Arizona Zone dispatcher. The superintendent will prepare a Delegation of Authority for all extended attacks. The NPS agency representative will work closely with the command staff, and NPS resource advisors will be provided as necessary.

Regional operational resources

Tables 4-2 to 4-5 compile the equipment and personnel resources of the Huachuca Area Fire Partners as of July 2005. Note that private landowners and Mexican agencies are not included in the list.

Table 4-2. Vehicle inventory for HAFP planning area

Vehicle	Type	Max. Cap. (Gal.)	Coronado NF	Fort Huachuca	Border Patrol	Fry FD	Patagonia FD	Palominas FD	Whetstone FD	Huachuca City FD	NPS Coronado	BLM San Pedro	Audubon	TNC Ramsey	AZ State Park
Aircraft	any	any										3			
Helicopter	any	any													
Tender	1	5000+								1					
Tender	2	2500+				1	1	2							
Tender	3	1000+		1		1	1	2	1	1					
Tender	4	1000+													
Engine (Heavy)	1	400+				3		1							
Engine (Heavy)	2	400+													
Engine (Heavy)	3	500+	1			1		1		2					
Engine (Brush)	4	750+										1			
Engine (Brush)	5	500+													
Engine (Brush)	6	200+	4	3		3	3	5	2	1	1	2			1
Engine (Brush)	7	125+													
Pick-up (Brush)	n/a	n/a						1						2	1
ATV	n/a	n/a		2									2	3	
Total			**5**	**6**	**0**	**9**	**5**	**12**	**3**	**5**	**1**	**6**	**2**	**5**	**2**

Table 4-3. Miscellaneous equipment inventory for HAFP planning area

Misc	Max. Cap. (Gal.)	Coronado NF	Fort Huachuca	Border Patrol	Fry FD	Patagonia FD	Palominas FD	Whetstone FD	Huachuca City FD	NPS Coronado	BLM San Pedro	Audubon	TNC	AZ State Park
Tank (Fixed)	Any											2		
Tank (Portable)	300											2		
Pumpkin	5000	2					3	1						
	3000	1	1			1	1		1					
	1500				1									
	1200										1			
	1000				1									
Portable Pump	300												1	
	140				1	1								
	125												1	
	n/a	1	3				1	1	3		3	1	2	
Total		**4**	**4**	**0**	**3**	**2**	**5**	**2**	**4**	**0**	**4**	**5**	**4**	**0**

Table 4-4. Total fire-related personnel in the HAFP planning area

Qualifications	Coronado NF	Fort Huachuca	Border Patrol	Fry FD	Patagonia FD	Palominas FD	Whetstone FD	Huachuca City FD	NPS Coronado	BLM San Pedro*	Audubon	TNC	AZ State Park
Non-fire: Not Red-carded (Support)	3				13				1		2		
Non-fire: Red-carded	10	3		39	15				6	40		9	
Fire: Not-Red carded						26		18					3
Fire: Red-carded (Arduous)	30	35					16		0	40			
Total	**100**	**38**	**0**	**39**	**28**	**26**	**16**	**18**	**7**	**80**	**2**	**9**	**3**

* Safford District Personnel

Table 4-5. Miscellaneous personnel qualifications in the HAFP planning area

Qualifications	Coronado NF	Fort Huachuca	Border Patrol	Fry FD	Patagonia FD	Palominas FD	Whetstone FD	Huachuca City FD	NPS Coronado	BLM San Pedro	Audubon	TNC	AZ State Park
EMT	1			39	9								
Wildland Training		38				26	6	18					
Paramedics				14									
Wilderness Medics				6									
Burn Boss 1	1												
Burn Boss 2	1									1			
IC1													
IC2													
IC3	2				1					4			
IC4	2											3	
Tactical Response Team (TRT)				8									
S-130/190	25			39									

Chapter 5: Collaborative Projects

An important reason for maintaining the Huachuca Area Fire Partners is to carry out activities that cannot be successfully executed by any of the parties alone. This chapter outlines HAFP large-scale fuels and ecological treatments that cross jurisdictional boundaries. Project timing will be guided by the usual constraints: funding, weather, availability of resources, and political climate. Land managers will continue to plan and complete future in-house projects, and the partners will support each other in these efforts, as well. The existence of the HAFP will also assist all partners in communicating with the public about all fire projects.

HAFP project descriptions

Table 5-1 is a preliminary list of projects (as of July 15, 2005) to be undertaken by the Huachuca Area Fire Partners. Locations are shown on Figure 5-1. These projects represent wildland fire use, prescribed burns, and non-fire fuels treatments that require collaboration among group members—for planning, funding, execution, and monitoring results. These projects help achieve general goals for the HAFP landscape:

- Protect wildland-urban interface developments
- Treat gaps left by wildfires, prescribed burns, and mechanical treatments in order to create long, contiguous swaths of thinned vegetation that can slow fires moving on or off them
- Bring areas into a condition that will permit the return of fire without high-severity effects except in grasslands with stand-replacing fire regimes.

Historically most fires in the region burned from late April through late July, during the hot, dry pre-monsoon season and lightning-rich monsoon season. The pre-monsoon fires typically have had the most severe effects and covered the greatest area. The high risk of fire spread beyond control lines has led fire managers to avoid prescribed burning during the late spring-early summer season when the largest areas burned in the past. Personnel to man prescribed fires are generally unavailable mid-summer, when fire season is peaking elsewhere. These factors lead managers to schedule prescribed fires for fall and earlier in the spring. The effects of burning at these times outside the natural fire season are largely unknown.

1. Los Fresnos

Los Fresnos is a ranch on the Sonoran side of the international border south of the Lone Mountain Ranch on the west side of the Huachucas. The Nature Conservancy has purchased Los Fresnos to turn it over to the Mexican conservation organization Naturalia for management. TNC plans about a 500-acre “training” burn on the ranch for late 2005. Following the initial burn, the HAFP is interested in a larger-scale, cross-border grasslands (map unit 3) restoration burn that would treat acreage on both sides. The international burn would involve the Coronado National Forest and The Nature Conservancy. Recent land exchanges to consolidate inholdings on the CNF have added a large parcel of the Lone Mountain Ranch to the burn unit initially proposed. This ownership change may serve as an opportunity to bring another private partner on board.

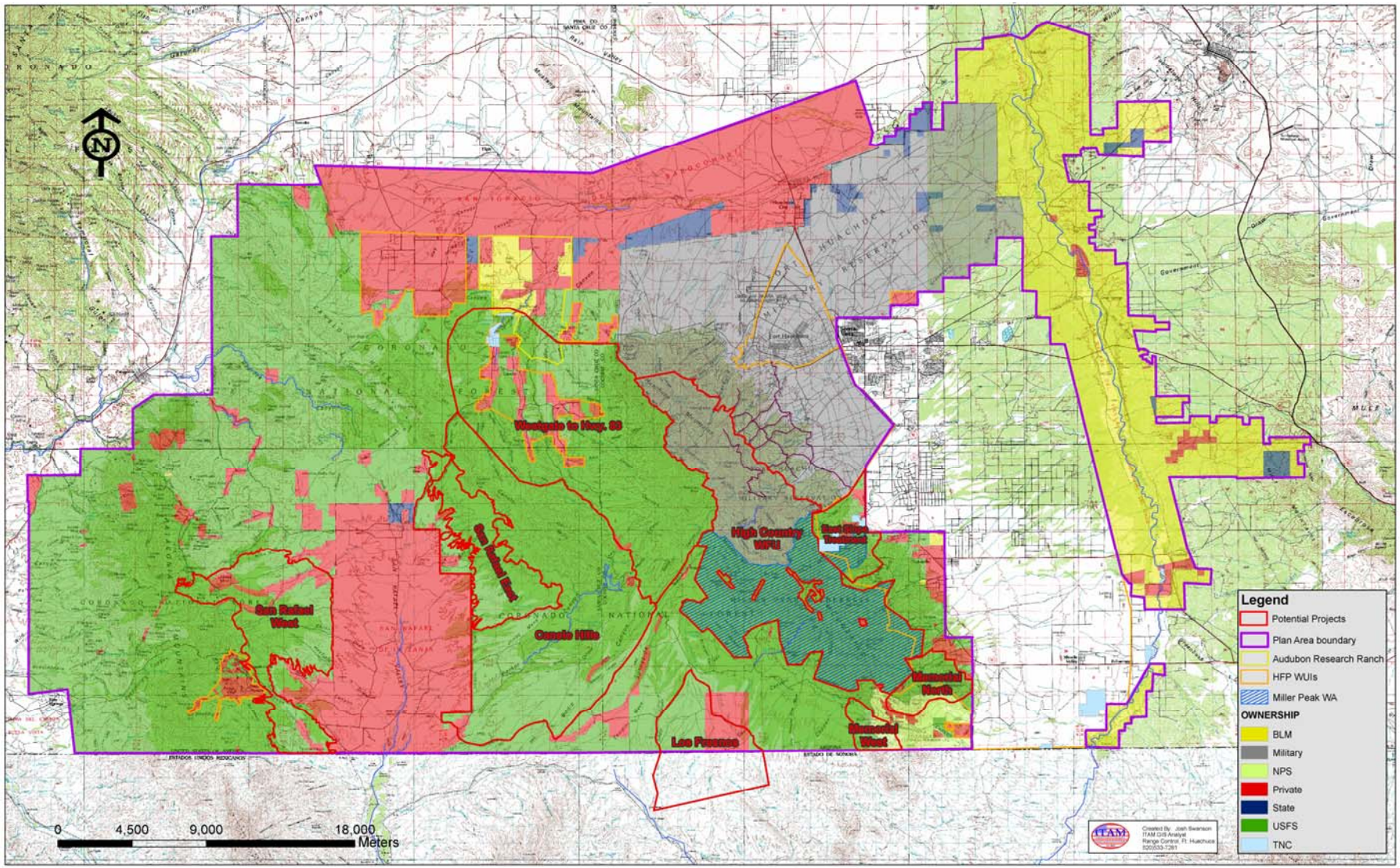
2. Memorial West

Compared with surrounding areas, this CNF/CNM unit at the south end of the HAFP planning area is at greatest risk for high-severity wildfire. Lack of fire for the past 10 years has elevated fuel loads in the oak and oak-pine woodlands (map units 8 and 10) along Coronado National Memorial’s west boundary and the southwestern Huachuca slopes on the Coronado National

Table 5-1. Preliminary project list

Project	Cost	# Acres	Emphasize Fuels Reduction or Eco Benefit?	WUI involved?	Timing	Details/Challenges
1. Los Fresnos: TNC/CNF	low	~2-5k in MX	Eco	minimal	spring '06	TNC needs FMP. Int'l issues? Need Lone Mtn. Ranch support
2. Memorial West: CNF/CNM	~$100/acre	~10k	Eco	partial	spring or fall Phase 1: 2006 or 2007	prescribed burn
3. Memorial North: CNM/CNF	mod+	500-750	Mostly Fuels	extensive	year-round	mechanical treatment followed by prescribed burn
4. Canelo Hills: CNF/ TNC		~50k	Eco + Fuels	minimal	after '07; spring/fall	Size - need to divide; size makes timing tough; heavily used by UDAs; San Rafael private land
5. High County WFU: CNF/ Fort Huachuca	low?	~20k	Eco	no	late fall	T&E compliance needed. Tough to finance because not WUI.
6. West Gate to Hwy. 83: CNF/ Fort Huachuca/ TNC/ ARR	~$1500/acre for mechanical, low for prescribed burn	5k +	Eco + Fuels	partial	year-round	mechanical and prescribed burn
7. East Slope Treatments: CNF/ TNC/ Fort Huachuca	$1500/acre	500	Fuels	extensive	year-round	TNC-USFS; only mechanical
8. San Rafael (West and East): CNF/ private lands	moderate	20k+	Eco + Fuels	partial	year-round	hydro-ax treatment

Figure 5-1. HAFP preliminary projects



Forest. Thinning the oaks with prescribed fire will protect developments at Coronado National Monument from (prevailing) southwest-wind-driven wildfires as well as make fire management safer for the Miller Peak Wilderness. The thinned project area can also slow fires moving on or off the southeastern wilderness boundary. Project challenges include the (1) straight-line international border at its southern edge in rough terrain, (2) generally difficult control boundaries with steep slopes and heavy fuels, and (3) intense fire needed to accomplish thinning objectives. Collaboration with Mexican partners on the Los Fresnos burn (see above) may pave the way for cooperation to ease the control problems along the southern edge of this unit.

3. Memorial North

Ash Canyon would serve as the south-end anchor for the Memorial North fuels treatments on the east slope of the Huachucas. It would protect the Miller Peak Wilderness from east side, low-elevation fires or wind-driven fires from the south. This CNF/CNM burn would fill the gaps left by the 2004 Ash Canyon fire and as a "re-entry" burn would begin to re-establish the historical fire regime in this oak savanna and oak-pine woodland (map units 5 and 10) area. Continued WUI development in Ash Canyon complicates this project and likely will dictate pretreatment—mechanical thinning and burning of smaller areas before burning the 500 to 750-acre unit.

4. Canelo Hills

The southern Canelo Hills area, on the east side of the San Rafael Valley and south of Highway 83, is an expanse of grassland and oak savanna (map units 3 and 5), much of which has not burned in a century. This 50,000-acre unit consists entirely of CNF lands bordered by other CNF lands on all but the west side. The HAFP-partner San Rafael Ranch lies to the west. Fuels have been sparse in recent years on the ranch to the extent that the land may be an effective barrier to fire. The north, east, and south-side boundaries of this unit are all roads. This large and difficult project would require the help of all partners, particularly in building support for acting on such a grand (but hugely economical) scale, and it is proposed that TNC would be a major source of such coordination. While fuels are heavy, the tract has the advantage of very little wildland-urban interface. Burning the Canelo Hills is key to protecting areas to the east and preventing hot, low-elevation fires from running up into the Huachuca high country.

5. High County WFU

Wildland fire use is discussed in more detail in Chapter 3, but this "unit" appears here because of the interagency coordination needed to allow fire to burn in the Huachuca high country. The potential currently exists for high-severity, high intensity fire at high elevations and the spread of that fire into the extensive eastside WUI. Difficult terrain, heavy fuels, and large tracts that have not burned in the 30 plus years of record make mechanical thinning and prescribed fire treatments unsafe and impractical. Most of the projects planned for the lower elevation country on both sides of the Huachucas have as a goal making it safer to allow high-country fires in the CNF Miller Peak Wilderness, on Fort Huachuca, and possibly on the north edge of Coronado National Memorial to burn. These other projects will help prevent hot, lower-elevation fires from spreading onto the oak-pine woodlands and mixed conifer forests (map units 10 and 12) on the mountaintops. They will also help confine high country ignitions—keeping them above the wildland-urban interface while allowing them to do some good.

6. West Gate to Hwy. 83

This large block contains three project divisions. It contains a grassland-oak savanna (map units 3 and 5) area along the Santa Cruz-Cochise county line that is characterized by heavy fuels and

has not burned recently. The unit abuts the north side of the acreage "treated" by the 2002 Ryan fire.

- Prescribed burning on the north end of this unit will buffer homes on CNF inholdings and structures at the west edge of Fort Huachuca from wildfire. The north end also contains the southern edge of the Audubon Research Ranch and TNC's Canelo Hills Preserve.
- Mechanical treatment and prescribed fire in the central Lyle Canyon area will reduce fire threats in a high-occurrence area; 30% of the fires on the CNF Sierra Vista Ranger District occur here. These fires are attributed to activities of private landowners and undocumented immigrants. The location of the Lyle Canyon section is such that it connects the south end of the Ryan Fire with the north end of 2005's Sunday and Cimarron fires. Prescribed fire and mechanical treatments here protect developments on a number of CNF inholdings. The area is dominated by oak savanna (map unit 5); grasses carry fire but dense oak cover contributes to spread and high fire intensities.
- The southern end of this block re-treats the area of the (2002) Merritt fire on the west side of the Huachucas and continues the west side buffer to the north from the CNF Lone Mountain burn unit. Standing dead from the Merritt fire and grasses in this oak savanna and oak-pine woodland area (map units 5 and 10) have resulted in an area highly susceptible to wildfire. Burning this unit under prescription is important for protecting habitats of Federally listed Mexican spotted owl, Huachuca water umbel, Sonora tiger salamander, and Chiricahua leopard frog. Bringing this fire up and over to the top of Garden Canyon on Fort Huachuca would increase its effectiveness in protecting these sensitive resources in that location. The Sunnyside town site inholding is a major WUI consideration for this unit.

7. East Slope Treatments

This project extends the treated band of CNF land on the east slope of the Huachucas to Fort Huachuca. Burns planned on the fort will continue the buffering between low and high country to the north end of the range. This area is heavily developed but is also the site of high fuel loads in pine-oak woodland (map unit 11). Thinning would likely proceed in a strip (south to north) from Carr Canyon, across non-wilderness CNF land, across property belonging to The Nature Conservancy in Ramsey Canyon, again across non-wilderness CNF land, to the Fort Huachuca boundary. This strip would help keep grassland fires driven by daytime up-canyon winds out of the high country and high country fires from burning down into the south end of the Sierra Vista metropolitan area.

8. San Rafael West and East (under consideration)

Chaparral, particularly manzanita encroachment, on CNF oak savanna and woodlands has increased the threat of fire spreading onto neighboring private property. Prescribed burning in these areas encourages more manzanita to germinate. The CNF, in cooperation with private landowners, is considering using the Hydro-Ax tool (basically a chopper-grinder mounted instead of a bucket on a front loader) to chew up manzanita on mid-elevation parcels surrounding the San Rafael Valley. Historical fuel wood harvesting and cutting of timbers for mines from these sites suggest that previously woodland rather than chaparral was present. The experimental mechanical treatment would be monitored to see whether grasses returned instead of chaparral species.

West side of the HAFP planning area

The projects described in Chapter 5 fall into the central and eastern portions of the HAFP planning area. The Patagonia Mountains on the west side are a lower priority because (1) inholdings are mainly abandoned mining operations rather than wildland-urban interface areas, (2) fewer people live in the fire-prone areas, and there is less of a threat of wind-driven fires. Historically there have been few fires in the Patagonias, possibly because of less fuel in most areas. However, as the Patagonia area grows, fire management will become more challenging, particularly on the south side of the town (at the north end of the Patagonia Mountains). In addition, heavy winter rains with associated vegetation growth helped spur the June 2005 Aztec Fire, which demonstrated the challenge of prioritizing HAFP projects.

In-house projects

Partner land managers will continue to plan and execute routine projects that are confined within their boundaries. It is a goal of the group to keep members informed of each other’s activities for coordination of public information and other functions. To this end, Appendix D includes proposed fuel treatment projects located within the HAFP planning area for Fort Huachuca, USDA Forest Service, and Bureau of Land Management. Partners will consult the U.S. Fish and Wildlife Service on future in-house projects on an "as necessary/as needed" basis that is tiered back to the analysis in this plan.

Chapter 6: Regional Environmental Issues

This chapter introduces the environmental issues that require consideration when planning for fire in the greater Huachuca area. It includes a broad, comprehensive list of issues that could possibly relate to fire in the region as well as more detailed discussion of a smaller group of issues that are most likely to affect fire planning and operations. The contents of this chapter are mainly derived from an internal scoping session held by the HAFP on February 20, 2003 and refined at a subsequent meeting May 17, 2003. Compiling these issues is intended to (1) guide HAFP planning towards actions that minimize negative, and maximize positive, environmental effects, (2) assist individual group land managers with National Environmental Protection Act (NEPA) and other compliance requirements, and (3) support public outreach activities.

Using a National Park Service list of NEPA-mandatory and other topics, the group generated the long issues list found in Appendix E. The heading "issues, concerns, opportunities" reflects the possibility of both negative and positive effects of fire management activities.

The group then judged the issues described below as capable of driving fire management actions for the HAFP. Impacts related to these topics may be difficult to minimize or mitigate or require formal compliance procedures unto themselves (sensitive species, cultural resources, air quality). Some are locally very sensitive issues (life and property, community economics and land use, border concerns, recreation and wilderness, aesthetics). Others are tied to critical objectives of land managers (watershed integrity, plant communities, non-native species).

Life and property
Fire is an effective tool for reducing hazardous fuels, but it is also a threat to the public, fire crews, cooperators' staffs, and developed areas. Wilderness-WUI juxtaposition complicates fire management.

Community economics and land use
Property values can be reduced by adjacent burned landscapes, but owners who apply firewise measures can increase values. Local tourist-based businesses may experience temporary declines if visitation drops due to fire-related concerns, but businesses may also benefit from providing supplies and services for fire operations. Fire can improve forage.

Border concerns
Proximity to the international border brings danger to and from illegal entrants (also known as undocumented immigrants or UDIs) and drug operatives in fire project areas and limits use of tactical tools; it also brings opportunities to cooperate with Mexican resource managers on fire projects, particularly training, suppression activities, and prescribed burns. Refer to Chapter 10 for more information on this issue.

Sensitive species
Fire could directly kill or injure listed, rare, or charismatic plants and animals, but fire also promotes reproduction of fire-adapted plants and renews wildlife habitat. Negative short-term effects lead to long-term gain, in many cases. Refer to Chapter 7 for more information on this issue.

Non-native species
Fire may aid invasion and spread of non-native species but may also prove to be a control tool. Refer to Chapter 8 for more information on this issue.

Cultural resources
Historic structures, fire sensitive landscapes, and artifacts may incur fire damage, while fire may help reduce surrounding hazardous fuels and maintain the historic scene. Refer to Chapter 9 for more information on this issue.

Watershed integrity
Fire can remove vegetation from slopes and cause increased erosion and downstream sedimentation until plants regrow. Removing vegetation also changes soil moisture regimes and flows in springs and streams. Fire can also cause short-term changes in soil and water chemistry. Long-term, fire will decrease woody vegetation and increase herbaceous vegetation which should result in decreased water run-off and soil erosion and increased infiltration (diffuse aquifer recharge).

Air quality
Smoke alarms nearby residents and can be a health hazard, barrier to visibility, or regulatory problem during fires. To the extent possible prescribed burning and wildland fire use take place only under optimal smoke dispersal conditions. The presence of smoke is temporary, and public education can get out the message that tolerating smoke from prescribed burning and wildland fire use reduces likelihood of large, smoke-generating wildfires.

Plant communities
Fire may change the character of unique habitats within the planning area, but fire may also return plant communities to historic species compositions and structures. Widespread, high-severity fires can lead to vegetation type conversion.

Recreation and wilderness
Fire activities may temporarily interfere with recreational use of planning area lands, but long-term fuels reduction and ecological benefits ultimately can make recreation safer and more enjoyable. Fire operations can disrupt wilderness values, but presence and effects of fire help maintain the integrity of wilderness.

Aesthetics and scenery management
During fire operations equipment noise and smoke disturb visitors and nearby residents. Burnt landscapes are unattractive to many people, but education about the benefits of fire can help build tolerance and even appreciation. Agency scenery management goals are a consideration for fuels treatment projects and suppression activities.

Effects of Climate Change
We are not sure how climate change will affect the outcomes of the fire activities planned for this area. In this region, wetter winters and drier summers may lead to more stand-replacing fires at the highest elevations. Wet winters produce abundant, fire-carrying fine fuels. Hotter and drier summers leave woody vegetation highly vulnerable to destruction by insects and fire.

Chapter 7: Sensitive Natural Resources

This chapter introduces the unique sites and listed species that affect fire management activities in the HAFP planning area. One of the advantages of the partnership is the potential to collectively produce and share information about these resources which can simplify compliance activities.

Unique sites

Protection of riparian areas, caves, and mines will safeguard many of the sensitive species found in the HAFP planning area. Riparian areas include, but are not limited to, the San Pedro Riparian NCA, Babocomari River, Canelo Hills, Patagonia Mountains, and the wet canyons of the Huachuca Mountains. The caves and mines include, but are not limited to, locations where bats and other sensitive species reside.

Riparian-wetland areas

Concerns relative to fire for riparian, wetland, and aquatic habitats include but are not limited to loss of cover, shade, and thicket habitat as well as sedimentation from erosion of burned areas. According to the Bureau of Land Management, riparian areas are “inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and which, under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (USDI 1998). Lakeshores and stream banks are typical riparian areas, while ephemeral streams or washes that do not host vegetation dependent upon free water in the soil are excluded. Conservation measures for suppression activities in riparian areas and aquatic habitats include:

- Fire suppression actions in riparian areas should apply minimum impact suppression tactics to minimize damage to stands of native vegetation and soils from wildfire or suppression operations. To the extent possible, retain large, downed woody materials and snags that are not a hazard to firefighters.
- Fire suppression and rehabilitation in riparian corridors will be coordinated with a Resource Advisor.
- Site-specific implementation plans that include project areas with Federally listed aquatic or riparian-obligate species will specify fire management objectives and wildland fire suppression guidance, taking into account the special concerns related to these species.
- In riparian areas, use natural barriers or openings in riparian vegetation where possible as the easiest, safest method to manage a riparian wildfire. Where possible and practical, use wet firebreaks in sandy overflow channels rather than constructing firelines by hand or with heavy equipment.
- Construction or development of a crossing for motorized vehicles across a perennial stream will not be permitted, unless an established road already exists or where dry, intermittent sections occur.
- Avoid the use of fire retardants or chemical foams in riparian habitats or within 300 feet of aquatic habitats, particularly sites occupied by Federally listed species. Apply operational guidelines as Stated in the *Interagency Standards for Fire and Fire Aviation Operations*

2005 (or updates), "Environmental Guidelines for Delivery of Retardant or Foam Near Waterways," Chapter 8 (pp. 8-13 through 8-15) (USDA Forest Service 2005).

- Priority for placement of fire camps, fire staging areas, and aircraft landing or refueling sites will be outside riparian areas or river/stream corridors.
- When using water from sources supporting Federally listed species, care must be taken to ensure adverse impacts to these (and other) species are minimized or prevented. Unused water from fire abatement activities will not be dumped in sites occupied by Federally listed aquatic species to avoid introducing non-native species, diseases, or parasites.
- If water is drafted from a stock tank or other body of water for fire suppression, it will not be refilled with water from another tank, lake, or other water source that may support non-native fishes, bullfrogs, crayfish, or salamanders.
- Use of containment systems for portable pumps to avoid fuel spills in riparian or aquatic systems will be required.

The following conservation measures apply for wildland fire use, prescribed fires, and the proposed vegetation treatments (mechanical, chemical, biological) within riparian, wetland, or aquatic habitats:

- All conservation measures for wildland fire suppression (above) also apply to fuels treatment activities (prescribed fire; mechanical, chemical, and biological treatments) in riparian, wetland, and aquatic habitats.
- Fire management treatments within or adjacent to riparian and aquatic habitats will be designed to provide long-term benefits to aquatic and riparian resources by reducing threats associated with dewatering and surface disturbance, or by improving the condition of the watershed and enhancing watershed function.
- For priority fire/fuels management areas (*e.g.*, wildland-urban interface areas) with Federally listed species or designated critical habitat downstream, HAFP biologists and other resource specialists, as appropriate, in coordination with U.S. Fish and Wildlife Service and Arizona Game and Fish Department, will determine:

  a) The number of acres and the number of projects or phases of projects to occur within one watershed per year.

  b) An appropriately sized buffer adjacent to perennial streams in order to minimize soil and ash from entering the stream.

Caves and Mines

The HAFP planning area contains numerous caves and abandoned mines. These unique sites warrant protection to preserve prehistoric human artifacts and to provide habitat for local flora and fauna—the topic of this chapter.

Coronado Cave is an example of a cave in the HAFP planning area that hosts a variety of species. A diverse community arthropods (beetles, millipedes, spiders, and crickets) and mammals (coatimundis, ringtails, and bats) has adapted to the cave. Many of these animals usually do not venture far into the cave but stay near the entrance where there is adequate light. Several bat species have been observed in the cave. Bats depend on the dark, quiet cave environment for sleeping and hibernation (NPS 2000). For example, the lesser long-nosed bat relies upon caves and mines for roosting.

Conservation measures for fire activities in these sites may include:

- Mechanically pre-treating the vegetation around the entrances to caves and mines. Chemical retardant and/or foam agent use near caves and abandoned mines is a management consideration. Aerial or ground application of retardant or foam should be restricted within 300 feet of caves and abandoned mines with water, in accordance with the *Interagency Standards for Fire and Aviation Operations*.

Threatened and endangered species

The HAFP planning area sits within the unique sky island region—"home to 4,000 plant species, more than half of all the breeding birds in North America, and one of the world's most diverse populations of reptiles and mammals (Wildlands Project 2005)." The HAFP acknowledge this diversity and the prevalence of sensitive species. Thus, the bulk of this chapter is devoted to providing the basis for a programmatic Biological Assessment (BA) for HAFP projects. U.S. Fish and Wildlife Service worked with the HAFP to compile the Federally listed species for the planning area (Table 7-1).

Background biology is presented here for each of those species, along with conservation measures for HAFP projects (see Table 5-1 in Chapter 5) that may affect Federally listed species or their habitat. Appendix F contains broader lists of sensitive species for project areas and includes plants and animals with special designations from the Forest Service, BLM, and State of Arizona. The discussion of each species concludes with a "determination of effects," in compliance with the Endangered Species Act (ESA). All HAFP actions on Federal land must "insure that any action authorized, funded, or carried out by [a Federal agency] is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species" (ESA 1973). In general, the long-term beneficial effects of the proposed projects are anticipated to outweigh any short-term adverse effects on the habitats of sensitive species. In accordance with Section 7 of the ESA, the "determination of effects" summarizes fire management impacts on sensitive species in the following manner:

- No effect – the proposed action will not affect a listed species or designated critical habitat.
- May affect – the proposed action may have effects on listed species or designated critical habitat. When the Federal agency proposing the action determines that a "may affect" situation exists, then they must either initiate formal consultation or seek written concurrence from the Services that the action "is not likely to adversely affect."

  a) Is not likely to adversely affect – the appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial.

  b) Is likely to adversely affect – the appropriate finding in a Biological Assessment (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (see definition of "is not likely to adversely affect"). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species.

Table 7-1. Species of concern within the HAFP planning area

Species	Status	HAFP Planning Area Habitat
Species that may travel through the area but are not likely to be adversely affected by fire activities		
Jaguar *(Panthera onca)*	E	Madrean woodland
Species that occur in wet places generally protected from direct effects of fire but susceptible to post-fire sedimentation		
Canelo Hills ladies tresses *(Spiranthes delitescens)*	E	cienegas in the Canelo Hills
Huachuca water umbel *(Lilaeopsis schaffneriana* ssp. *recurva)*	E	San Pedro River and wetlands throughout planning area; 3,500-6,500 feet
Chiricahua leopard frog (*Rana chiricahuensis*)	T	canyons with perennial water and stock tanks; 3,300-9,000 feet
Sonora tiger salamander (*Ambystoma tigrinum stebbensi*)	E	south end of Canelo Hills; 4,000-6,300 feet
Gila topminnow *(Poeciliopsis occidentalis occidentalis)*	T	small streams, springs, cienegas below 4,500 feet with aquatic vegetation and debris for cover; Santa Cruz drainage
Spikedace (*Meda fulgida*)	T	San Pedro River- historic habitat
Loach minnow (*Tiaroga cobitis*)	T	San Pedro River- historic habitat
Gila chub (*Gila intermedia*)	E	smaller streams, cienegas, impoundments on west side of Huachucas; 2,000-3,500 feet
Huachuca springsnail (*Pyrgulopsis thompsoni*)	C	possibly in wetlands throughout planning area; 4,500-7,200 feet
Species that would be affected if riparian habitat burned		
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	San Pedro River
bald eagle *(Haliaeetis leucocephalus)*	T	seen at Parker Canyon Lake
western yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	C	San Pedro River and possibly riparian woodlands throughout area
Species requiring careful project-by-project consideration		
Pima pineapple cactus *(Coryphantha scheeri* var. *robustispina)*	E	far west side of planning area

Species	Status	HAFP Planning Area Habitat
Lesser long-nosed bat *(Leptonycteris curasoae yerbabuenae)*	E	cave/mine roosts, *Agave palmeri* foraging areas
Mexican spotted owl (*Strix occidentalis lucida*)	T	closed-canopy, uneven-aged forest stands and canyons, 4,100 to 9,000 feet
Lemmon fleabane (*Erigeron lemmonii)*	C	crevices and ledges of rock faces in canyon bottoms within pine-oak woodlands, Huachuca Mountains, 6,300 to 7,300 feet

E = Endangered: Species is in danger of extinction throughout all or a significant portion of its range.
T = Threatened: Species is likely to become endangered within the foreseeable future.
C = Candidate species: U.S. Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act, but development of a listing regulation is precluded by other higher priority listing activities.

Jaguar

History & Background
The jaguar was listed as endangered in the United States on March 28, 1972 (37 FR 6176) without critical habitat. Non-United States populations were also listed as endangered at the same time. The listing was extended on July 22, 1997 (62 FR 39147 39157). The primary range of jaguar is the coastal plains and tropical forests of Central America, South America, and Mexico. Although there are no known breeding jaguar populations in the U.S., individuals do cross into Texas, New Mexico, and Arizona (Cockrum et al. 1976). The Arizona Game and Fish Department website (www.azgfd.gov) mentions the most recent sightings in 2001, 2003, and 2004 at undisclosed locations south of Tucson. Other sightings occurred in 1996 in the Baboquivari and Peloncillo mountains. The Jaguar Conservation Team, a partnership of government agencies, private landowners, and nongovernmental organizations, investigates these and other sightings as a component of their jaguar protection efforts.

Conservation Measures
All eight proposed HAFP projects (Table 5-1) take place in potential jaguar habitat.

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats to eliminate adverse effects to jaguars that may occur in dense riparian habitats.
- Maintain dense, low vegetation in major riparian or xero-riparian corridors. Locations will be identified in site-specific burn or other treatment plans.

Determination of Effects
Jaguars may travel through the planning region in Chihuahuan desert scrub up through mixed conifer/pine oak woodlands but the likelihood of one occurring in the HAFP planning area is low. In addition, fire is not likely to affect them directly due to their mobility. Fire may indirectly affect them by restricting their travel corridors and foraging cover. A localized change in jaguar prey patterns across the landscape may occur as prey forage is burned and re-sprouts later in the growing seasons following fires. The effects of prescribed burns to jaguar prey species are anticipated to be insignificant and the prey species are expected to recover from short-term decreases in cover and forage, especially as habitat re-sprouts post-burn. Because jaguars have a

large home range and are highly mobile, small prescribed burn projects are anticipated to have insignificant effects on any jaguars that may be found in the HAFP planning area; however, if jaguars are found within the area, the HAFP will reinitiate consultation. Because of these factors, our effect determination for the jaguar is may affect, is not likely to adversely affect.

Canelo Hills ladies tresses

History & Background
The Canelo Hills ladies tresses was listed as an endangered species on January 6, 1997 (62 FR 665 689). Populations of this orchid can be found in scattered locations in the upper Babocomari and Santa Cruz river watersheds. The Nature Conservancy (TNC) Canelo Hills Perserve is one of four known locations for this orchid. Its placement on the endangered species list stems from its inherent rarity and from the threats to its habitat by dewatering, erosion, and a lack of natural disturbance.

In general, the species occurs in microsites subject to little scouring, with low composition and moderate water availability. However, most canyons in the Huachuca Mountains are too steep to support the “cienega-like” conditions required by this species. Given that most populations are small and isolated, the species is subject to demographic, genetic, and environmental stochasticity.

In the early 1990s, TNC suspected that an accumulation of dried vegetation in orchid habitat at the Canelo Hills Cienega was inhibiting emergence and sexual reproduction. TNC staff set up plots and experimentally burned them in 1991, 1993, and 1996 based on the McClaran and Sundt (1992) study and anecdotal observations indicating a population decline. Monitoring between 1994 and 1999 showed orchid declines on unburned plots while numbers on the burned plots increased independently of precipitation. In addition, the season of the burn and years since the previous burn were also noted as significant. These limited results suggest that cool season burns increase the number of Canelo ladies tresses while hot season burns decrease the population size. Nonetheless, further studies are necessary to confirm the suitability of cool season prescribed fires.

Conservation Measures
HAFP project six (Table 5-1) includes known locations of Canelo Hills ladies tresses.

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats.
- Avoid and suppress hot-season fires in the Canelo Hills Cienega.

Determination of Effects
In addition to collecting, catastrophic, stand-replacing fires and subsequent runoff and erosion of hillsides and canyon bottoms threaten the species today. Even well planned prescribed fires will likely result in poor downstream conditions. The preparation work of prescription fire (e.g., hand and dozer lines) may have short-term negative direct effects. However, prescribed fire should improve riparian habitat in the long term by lowering the frequency of high-intensity, stand-replacing fires and replacing them with low-intensity ground fires.

Fire suppression actions may directly and indirectly affect the species. Direct effects include the possibility that the species may be trampled in attempts to control a burn, either wild or

prescribed. Erosion of fire-bared upland areas and sedimentation in the cienega habitat are indirect effects, as well as retardant run-off from suppression activities. Because of these factors, our effects determination for the Canelo Hills Ladies Tresses is may affect, is likely to adversely affect.

Huachuca water umbel

History & Background
The Huachuca water umbel was listed as an endangered species on January 6, 1997 (62 FR 665 689). Populations are generally found in along riparian stream banks and cienegas and associated vegetation within Sonoran desert scrub, grassland or oak woodland, and conifer forest between 3,500 and 6,500 feet. Critical habitat has been designated from Hereford Bridge north to the mouth of Clifford Wash along the San Pedro River and in a portion of the Huachuca Mountains. The species seems to require an intermediate level of flooding frequency to keep competition manageable, but populations can be destroyed when floods are too frequent and intense. Plants are found in unshaded or shaded sites. They require perennial water, gentle stream gradients, small to medium-sized drainage areas, and (apparently) mild winters. Usually found in water depth from 2 to 6 inches, but occasionally in 10 inches. Given that most populations are small and isolated, the species is subject to demographic, genetic, and environmental stochasticity.

Conservation Measures
HAFP projects five and six (Table 5-1) include known locations of Huachuca water umbel.

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats.
- Map known locations and potential habitat for plant populations to facilitate planning for wildland fire use, prescribed fires, and vegetation treatments, and to ensure protection of these populations during fire suppression.
- HAFP will coordinate with U.S. Fish and Wildlife Service (FWS) to delineate buffer areas around plant populations prior to prescribed fire and vegetation treatment activities. HAFP will coordinate with FWS during any emergency response and wildland fire use activities to ensure protection of plant populations from fire and fire suppression activities.
- During fire suppression, wildland fire use, and prescribed fire in habitat occupied by Federally listed plant species, no staging of equipment or personnel will be permitted within 328 feet (100 meters) of identified individuals or populations. Off-road vehicles will also not be allowed within the 328-foot buffer area, unless necessary for firefighter or public safety or the protection of property, improvements, or other resources. One of the primary threats to many of these plant species is trampling/crushing from personnel and vehicles.
- No prescribed burning will be implemented within 328 feet of identified locations or unsurveyed suitable habitat for Federally listed and sensitive plant populations unless specifically designed to maintain or improve the existing population.

Determination of Effects
Catastrophic, stand-replacing fires and subsequent runoff and erosion of canyon bottoms is probably the greatest threat to the species today. Even well planned prescribed fires will likely result in poor downstream conditions. The preparation work of prescribed fire (e.g., hand and dozer lines) may have short term negative direct effects. However, prescribed fire should

improve riparian habitat in the long term by lowering the frequency of high-intensity, stand-replacing fires and replacing them with low-intensity ground fires.

Fire suppression actions may directly affect the species. Umbel plants may be trampled in attempts to control a burn, either wild or prescribed. Retardant drops may have direct effects, and washing of retardant downstream, indirect effects. Erosion of upstream or upslope areas and subsequent sedimentation are indirect effects, as well as retardant run-off from suppression activities. Because of these factors, our effects determination for the Huachuca water umbel is may affect, is likely to adversely affect.

Pima pineapple cactus

History & Background
The Pima pineapple cactus was listed as an endangered species on September 23, 1993 (58 FR 49875 49880). This cactus grows in alluvial basins or on hillsides in semi-desert grassland and Sonoran desert scrub. Soils range from shallow to deep, and silty to rocky, with a preference for silty to gravely deep alluvial soils. The plant occurs most commonly in open areas on flat ridge tops or areas with less than 10-15% slope. Populations of Pima pineapple cactus are found from 2,300 to 4,500 feet elevation in Pima and Santa Cruz counties, Arizona and northern Sonora, Mexico. The range extends east from the Baboquivari Mountains to the western foothills of the Santa Rita Mountains. The northernmost boundary is near Tucson. Potential habitat for this species is difficult to estimate due to its habitat requirements and the topographic complexity within its range. Populations tend to be patchy, widely dispersed and highly variable in density. In addition, associated habitat types are not uniformly distributed throughout the plant's range. The cactus is found at the western edge of the HAFP planning area.

Conservation Measures
No proposed HAFP projects are located near known locations of Pima pineapple cactus. Future projects that are located near the species will consider the following measures:

- Conduct intensive surveys to locate and mark (with GPS) all Pima pineapple cactus in the proposed action area.
- Clear (cut and remove all fuels) a three to five-foot radius of vegetation from each Pima pineapple cactus to protect it from fire and radiant heat.
- Monitor all Pima pineapple cactus post-burn for effects from fire.

Determination of Effects
The direct death of individuals is troublesome. The alteration of habitat and native fire regimes, though, possibly poses a greater direct mortality threat to the species. The ability of the cactus to withstand fire in native grass may be different from its ability to withstand fire in monotypic stands of non-native grasses. The invasion of Lehmann lovegrass combined with fire is a threat to Pima pineapple cactus populations. Lehmann lovegrass stands support higher fuel loads, generate more intense heat, and can burn more often than native grasslands, with the potential result of higher mortality of Pima pineapple cactus located in Lehmann lovegrass stands.

The species may also suffer from direct effects caused in wildfire suppression activities such as trampling. Clearing the area around cacti will minimize or avoid the adverse impacts of fire. Wildfires, particularly those that occur in Lehmann-dominated areas, are still potentially

dangerous and may serve to spread the non-native grass further. Because of these factors, our effects determination for the Pima pineapple cactus is may affect, is likely to adversely affect.

Southwestern willow flycatcher

History & Background
The southwestern willow flycatcher, a subspecies of willow flycatcher, was listed as an endangered species on February 27, 1995 (60 FR 10693 10715). The bird occurs in dense riparian habitats along streams, rivers, and other wetlands where cottonwood, willow, boxelder, tamarisk, Russian olive, buttonbush, and arrow weed are present. The species is endangered primarily due to riparian habitat reduction and degradation. Nests are found in thickets of trees and shrubs about 13-23 feet in height, among dense and homogenous foliage. Habitat occurs at elevations below 8,500 feet. Historically the flycatcher was found throughout most of the southwest. However, the species has been extirpated from much of its historic range and approximately 900 to 1,100 breeding pairs currently exist (U.S. Fish and Wildlife Service 2002-b). Remnant populations survive in historic locations. Individuals in Arizona are found in several areas including the lower San Pedro River. The upper San Pedro reaches within the fire planning area have historically served mainly as migration rather than breeding habitat.

Critical habitat for the southwestern willow flycatcher was designated in 1997, remanded in 2001, then proposed again on October 12, 2004. The newly proposed critical habitat includes 376,095 acres within the 100-year floodplain of various rivers and streams of southern California, southern Nevada, southwestern Utah, south-central Colorado, Arizona, and New Mexico. The proposed critical habitat does not include the San Pedro Riparian National Conservation Area.

Conservation Measures
No proposed HAFP projects are located near known locations for the southwestern willow flycatcher. Future projects that are located near the species will consider the following measures:

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats.
- Except where fires are active in occupied habitat, minimize low-level helicopter flights during the breeding season (April 1 – September 30). Approach bucket dip sites at a 90-degree direction to rivers to minimize flight time over the river corridor and occupied riparian habitats. Locate landing sites for helicopters at least ¼ mile from occupied sites to avoid impacts to willow flycatchers and their habitat.
- Minimize use of chainsaws or bulldozers to construct firelines through occupied or suitable habitat except where necessary to reduce the fuel loads of occupied habitat or other important habitat areas that would otherwise be burned.
- Implement activities to reduce hazardous fuels or improve riparian habitats (prescribed burning or vegetation treatments) within occupied or unsurveyed suitable habitat for southwestern willow flycatchers only during the non-breeding season (October 1 - March 31).
- Avoid developing access roads that would result in fragmentation or a reduction in habitat quality. Close and rehabilitate all roads that were necessary for project implementation.

- Prescribed burning will only be allowed within ½ mile of occupied or unsurveyed suitable habitat when weather conditions allow smoke to disperse away from the habitat when birds may be present (breeding season April 1 - September 30).
- Vegetation treatment projects adjacent to occupied or unsurveyed suitable habitat will only be conducted when willow flycatchers are not present (October 1 - March 31).

Determination of Effects
The San Pedro Riparian National Conservation Area serves as an important migration corridor for the species. Destruction of this riparian area habitat due to fire will likely affect the species. Increased soil erosion as a result of fire may result in amplified stream channelization and sedimentation, which may alter riparian habitat. There are also direct effects of retardant and bucket drops, backburning, hand and dozer lines, and noise disturbance in flycatcher habitat. However, due to its mobility, direct effects from fire are expected to be limited to breeding areas. Because of the lack of nesting habitat or documented nesting in the planning area, our effects determination for the southwestern willow flycatcher is may affect, but is not likely to adversely affect.

Bald eagle

History & Background
The bald eagle was listed as a threatened species on March 11, 1967 (32 FR 4001). It ranged throughout the contiguous U.S., Canada, and northern Mexico, but the historic distribution in Arizona and New Mexico is unknown. Nonetheless, a small resident population of approximately 40 pairs nests along the Salt, Verde, Gila, Bill Williams, Agua Fria, San Pedro, and San Francisco rivers and along Tonto and Canyon creeks. Eagles prefer nesting in isolated tall trees, on cliffs, or on pinnacles, with a commanding view of the area and in close proximity to water. Bald eagles also winter throughout the state of Arizona, with at least 200 to 300 found each year. In southern Arizona, though, they are rarely observed as the species is usually found along seacoasts, lakes, and rivers. The uncommon southern Arizona observations are usually those of wintering birds. In the Huachuca area, wintering eagles have been observed at Parker Canyon Lake on the west side of the Huachucas.

Conservation Measures
HAFP project four (Table 5-1) includes known locations of bald eagle.

- No human activity within ¼ mile of known bald eagle winter roost areas between October 15 and April 15.
- No helicopter or aircraft activity or aerial retardant application within ½ mile of bald eagle winter roost sites between October 15 and April 15.
- Conduct prescribed burn activities in a manner that will ensure winter roost sites are more than ½ mile from downwind smoke effects.
- Provide reasonable protective measures so fire prescription or fuels treatment will not consume dominant, large trees as identified by the Resource Advisor within ½ mile of known roosts of bald eagles. Pre-treatment efforts should provide reasonable protection of identified roosting trees.

Determination of Effects
Habitat loss and degradation are the greatest threat to the species. Thus destruction of riparian area due to fire will likely affect the species. Increased soil erosion as a result of fire may result in amplified stream channelization and sedimentation, which may alter riparian habitat. However, due to its mobility, no direct effects from fire are expected to occur—unless a bird is knocked off a perch by a bucket drop or retardant. Instead, the above indirect effects of fire and fuel thinning may impact bald eagle prey, such as fish and other birds. In addition, noise disturbance associated with suppression and prescribed fire projects may have an indirect effect. Because of these factors, our effects determination for the bald eagle is may affect, is not likely to adversely affect.

Lesser long-nosed bat

History & Background
The lesser long-nosed bat was listed as an endangered species on September 30, 1988 (53 FR 38456 38460). The species inhabits mainly desert scrub in the U.S. portion of its range. Altitudinal range is 1,600-11,500 feet. The bat roosts in caves, abandoned mines, and unoccupied buildings at the base of mountains where agave, saguaro, and organ pipe cacti are present. It forages at night on nectar, pollen, and fruit of paniculate agaves and columnar cacti (though no columnar cacti occur in the HAFP planning area). The species ranges from central Arizona and southwest New Mexico through much of Mexico to El Salvador. In southeastern Arizona, they are seasonal (April - September) residents. While the Arizona Game and Fish Department (2003) presumes that population sizes have declined, recent studies throughout southern Arizona indicate that lesser long-nosed bat populations are increasing (Yar Petryszyn, *pers. com.*). For example, Sidner (2005) reports that populations increased significantly betwen 1989 and 2004 at Fort Huachuca.

The loss of roosts and foraging habitat would threaten population sizes. Despite the relatively large number of individuals remaining, a reduction of maternity roosts is a concern for this species. Any loss of foraging habitat is also believed to be a concern for the bat. Many of the agaves that the species relies upon are threatened by an increase in woody plant and grass competition and the replacement of frequent, low-intensity ground fires with infrequent, high-intensity fires.

Considerable evidence exists for the interdependence of this species and certain agaves and cacti (particularly the Palmer and Parry agave). Experience with fires in southeastern Arizona has shown that fires damage or destroy approximately 5-20% of agaves. Coupled with habitat destruction and roost disturbance, the loss of a key food source could unfavorably affect the species. Additionally, fire has been shown to encourage the growth of Lehmann lovegrass, which competes with agaves for resources and may cause fire intensity and frequency to increase.

Conservation Measures
HAFP projects two, five, six, and seven (Table 5-1) include known locations of lesser long-nosed bat.

- Instruct all crew bosses (wildfire suppression, wildland fire use, prescribed fire, and vegetation treatments) in the identification of agave and the importance of their protection.

- Prior to implementing any fuels treatment activities (prescribed fire, non-fire vegetation treatments), pre-project surveys will be conducted for paniculate agaves that may be directly affected by fuels management activities.
- Protect long-nosed bat forage plants—high concentrations of agaves—from wildfire and fire suppression activities, and from modification by fuels treatment activities (prescribed fire, non-fire vegetation treatments), to the greatest extent possible. "Agave concentrations" are contiguous stands or concentrations of more than 200 plants per acre. Avoid driving over plants, piling slash on top of plants, and burning on or near plants. Staging areas for fire crews or helicopters will be located in previously disturbed sites, if possible.
- No seeding/planting of non-native plants will occur in any wildfire rehabilitation site or fuels treatment site with paniculate agaves.
- A mitigation plan will be developed by the HAFP in coordination with the U.S. Fish and Wildlife Service for prescribed fires or fuels management projects (mechanical, chemical, biological treatments) within 0.5 miles of bat roosts or in areas that support paniculate agaves. The mitigation plan will ensure that effects to bat roosts and forage plants are minimized and will include monitoring of effects to forage plants. The U.S. Fish and Wildlife Service will approve the plan.
- Protect agave food sources with a 3 to 5-mile buffer around roost sites.
- Prevent access to known roosts.
- Avoid off-road travel in agave management areas.
- In the event of wildfire, monitor bat take, roost site disturbance, and acres burned in agave management area and report to U.S. Fish and Wildlife Service.

Determination of Effects
Fire suppression actions, such as trampling, burning agaves, and damaging agaves with slurry drops, may be a source of indirect effects that harm the species' food source. However, given the mobility and population of the lesser long-nosed bat, direct effects of fire are limited. A further reduction of fire effects would occur with the application of the above conservation measures, as well. Because of these factors, our effects determination for the lesser long-nosed bat is may affect, but is not likely to adversely affect.

Mexican spotted owl

History & Background
The Mexican spotted owl was listed as a threatened species on March 16, 1993 (58 FR 14248 14271). The subspecies (*Strix occidentalis lucida*) occurs in varied habitat, consisting of mature montane forest and woodland, shady wooded canyons, and steep canyons at an elevation range of 4,100 to 9,000 feet. In forested habitat, uneven-aged stands with a high canopy closure, high tree density, and a sloped terrain appear to be key habitat components. The owl can also be found in mixed conifer and pine oak vegetation types. Generally nests in older forests of mixed conifer or ponderosa pine/Gambel oak type. The nests are found in live trees, snags, and on canyon walls. Of the subspecies that were known to exist in the United States between 1990 and 1993, 91% occur on lands administered by the USDA Forest Service.

The historic range of the Mexican spotted owl covers much of the southwestern U.S. and its present range is thought to be similar. Populations in Arizona are patchily distributed and occur

in all but the arid southwestern portion of the state or much of the lowland riparian zones. The Arizona resident owls occur in distinct localities that correspond to isolated forested mountain systems, canyons, and in some cases steep, rocky canyon lands.

The U.S. Fish and Wildlife Service designated 8.6 million acres of critical habitat on August 31, 2004. The final designation includes habitat in Arizona, Colorado, New Mexico, and Utah on Federal lands. Critical habitat is located in the HAFP planning area: the Huachuca Mountains/ Canelo Hills area (west and south of Sierra Vista) includes the Coronado National Forest and Coronado National Memorial, and Coronado National Forest land in the Patagonia Mountains area (south of Patagonia). Fort Huachuca, though, is excluded because it has an Integrated National Resource Plan (INRMP). Given the existence of this plan, the Fort is removed from the critical habitat area pursuant to section 4(a)(3) of the Endangered Species Act. Wildland-urban interface project areas, State, and private lands are also not designated as critical habitat (Federal Register 2004).

Conservation Measures
HAFP projects three, five, six, and seven (Table 5-1) include known locations of Mexican spotted owl.

The following conservation measures have been adapted from the Biological Opinion for the 2005 Chiricahua National Monument Fire Management Plan:

- Consult local biologists when making decisions about fire use and suppression.
- Restrict prescribed fire and wildland fire use to low- (preferably) and moderate- (when necessary to achieve goals) intensity burns in oak woodland, pine-oak, oak pine woodland, and mixed conifer vegetation types.
- As a first entry burn, conduct low-intensity prescribed fire and wildland fire use within and immediately adjacent to the Mexican spotted owl (MSO) protected area centers (PACs) to consume surface fuels in order to reduce risk of catastrophic fire. Develop prescriptions that target jackpotted fuels and that will meet desired objectives. Manually reduce fuels that may contribute to a catastrophic fire. As a re-entry burn, conduct low- to moderate-intensity prescribed fire and wildland fire use within and immediately adjacent to the PACs to consume dead and downed fuels as well as to clear understory vegetation that may contribute to a catastrophic fire.
- Minimize heat impacts to the MSO and known and possible nest sites by conducting low-intensity prescribed burns and wildland fire use that will have slow rates of spread and low flame lengths in the most sensitive areas. Keep high flame lengths away from areas immediately below known and possible nest sites by varying ignition patterns, excluding those areas from ignition, rearranging fuels to facilitate low-intensity burning, and burning in cooler months where fire behavior is less extreme.
- Conduct prescribed fire, wildland fire use, and mechanical thinning treatments to minimize effects on reproduction; avoid actions with known potential for negative effects.
- Use prescribed fire and wildland fire use to maintain and enhance MSO habitat inside and outside of the PACs by varying the management prescriptions to (a) reproduce natural disturbance patterns; (b) maintain all species of native vegetation in the landscape, including early seral species; (c) allow natural gap processes to occur, thus producing horizontal variation in stand structure; and (d) promote the growth of additional large oaks and pines by

thinning out understory vegetation through the use of moderate-intensity burning and by pre-treating large trees (ringing, foam, limbing).

- Follow the MSO Recovery Plan (U. S. Fish and Wildlife Service 1995) pine-oak forest habitat structure guidelines in setting project objectives: (a) minimize cutting of trees and snags larger than 18 inches dbh, and avoid altogether cutting trees or snags larger than 24 inches dbh (exceptions can be made when absolutely necessary for safety reasons) and (b) thin trees measuring up to 9 inches dbh. The Recovery Plan specifies retaining a majority of down logs measuring greater than 18 inches at midpoint diameter; logs greater than 16 inches at midpoint diameter will be retained, given larger diameter logs are not very common. Treatments should result in increased cover of grasses and forbs one year out.
- Monitor fire behavior and long-term effects on vegetative/habitat characteristics for adaptive management.
- Delineate maximum manageable areas (MMAs) to avoid impacts to sensitive areas. An MMA is a large perimeter around a smaller prescribed burn unit within which fire is allowed to spread before suppression action must be taken. It is not actively ignited during the prescribed burn, and it allows for setting up the trigger points that will drive management actions based on resource values.
- Adhere to Arizona Department of Environmental Quality air quality standards. Use small-scale ignition to reduce temporary smoke impacts to the MSO. Limit the number of acres burned per day as well as the burn duration to mitigate smoke hazards. Ensure that transport winds are favorable to move smoke up and away from the PACs.
- Locate staging areas and other fire "activity centers" more than a mile from designated PAC boundaries.
- Carry out thorough rehabilitation of areas within and immediately adjacent to the PACs affected by suppression actions.
- Avoid aircraft flight closer than 1,000 feet from any designated PAC boundaries.
- Limit retardant/water drops on the perimeter of and within the PACs. Do not drop retardant or water on known or suspected nests.
- Notify a local biologist if MSO are discovered during fire operations, and adjust activities to minimize impacting reproduction. Fire crewmembers will neither approach nor haze any owls they find.
- Survey known PACs in the Huachuca Mountains, Canelo Hills, and Patagonia Mountains.
- Survey any PAC that year for MSO status before implementing a prescribed burn or mechanical thinning in or adjacent to that PAC. In addition, collect post-treatment data to provide important information on how the owls respond to the treatment.

Determination of Effects

Fire threatens to destroy or alter nesting and roosting habitat, which is critical to maintaining a healthy population. Though not necessarily lethal, habitat loss and nesting failure (before owls lay eggs) due to fire adversely affect owl populations. The direct loss of Mexican spotted owl nesting and roosting habitat caused by a wildfire is of great concern, especially if fires occur during the breeding season. Avoiding prescribed fires during the breeding season (March 1 through August 31) would eliminate some of these issues, however wildfires within owl habitat

during the breeding season may result in the direct death of adult and young owls. Death may also occur due to loss of nest and roost trees caused by crown fires. If a wildfire occurs in such habitat during the breeding season, the fire may result in the loss of owl nests as well as young owls, which may not be able to fly to safety.

In addition, the effect of smoke on adult and young owls is largely unknown. Smoke may directly affect the health of owls or the ability of owls to forage successfully, and therefore may affect the ability of adults to survive and/or successfully fledge young. In a study at Saguaro National Park, Willey (1998) notes that Mexican spotted owl "activity centers showed a trend to decrease in size in response to fire" while fire effects on home-range size and location were inconclusive. Willey attributes these findings to the type of prescribed fire in the study. "No fires were conducted within the north slope mixed conifer vegetation community where owl nests and roosts were primarily located" (Willey 1998). A study with a larger and more intense prescribed fire in roost habitat would likely yield more complete information on the response of Mexican spotted owls to fire. Fuels treatments in owl habitat will likely help decrease any catastrophic effects of wildfires.

Additional direct and indirect effects to owls may also result from the actions taken to suppress the fire. Noise from all air operations, especially low-flying aircraft dropping water or retardant, can contribute to the disturbance of the species. Low-level flights have the greatest potential to disturb owls, because the aircraft move slowly and are relatively noisy. The species could also be impacted through death or injury by water or retardant drops if nests or roosts receive direct hits. In addition, increased edge effects along fire lines are also of concern as they can influence habitat dynamics. Because of these factors, our effects determination for the Mexican spotted owl is may affect, is likely to adversely affect.

Chiricahua leopard frog

History & Background
The Chiricahua leopard frog was listed as a threatened species on June 13, 2002 (67 FR 40789 40811). The frog is an inhabitant of cienegas, pools, livestock tanks, lakes, reservoirs, streams, and rivers at elevations of 3,281 to 8,890 feet in central and southeastern Arizona, including Santa Cruz and Cochise counties. The species has been extirpated from about 75 percent of its historic localities in Arizona and New Mexico.

Potential habitat includes all historic sites and most permanent water sources; however, much of this habitat may be unsuitable for re-colonization due to non-native predators and habitat degradation.

Conservation Measures
HAFP projects one, four, five, six, seven, and eight (Table 5-1) include known locations of the Chiricahua leopard frog.

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats.
- For fire management sites with habitat for the Chiricahua leopard frog, unsurveyed sites will be considered occupied unless surveyed prior to project implementation.

- Before treatment projects, install sediment traps, as specified by a Resource Advisor, upstream of tanks and ponds occupied by Chiricahua leopard frogs in order to minimize the amount of ash and sediment entering the water.
- Inform all personnel performing fire management activities at any creek crossing of the potential presence of Chiricahua leopard frogs, their status, and the need to avoid impacts to the frog and its habitat.
- Except as needed in emergency situations to abate immediate fire threat or loss of life or property, no water will be drafted for fire suppression from bodies of water known to be occupied by the Chiricahua leopard frog.

Determination of Effects
No studies on the effects of fire and fire suppression activities have been conducted but likely direct and indirect effects are death and habitat degradation through increased soil erosion, run-off, channel scouring, sediment build up, and elimination of ground cover. Increased water temperatures may also have direct and indirect effects. For example, fire activities may decrease vegetative canopy cover over water bodies. The loss of this shade could increase water temperatures dramatically, resulting in direct mortality to individuals or local populations of Chiricahua leopard frogs.

Other threats to the species include competition with introduced non-native aquatic species and diseases. Humans and their equipment (for example, scooped water from contaminated sources) can act as vectors, spreading disease, viruses, and fungi, as well as introducing non-native species such as bullfrogs to leopard frog habitat. These stresses could lead to mortality of Chiricahua leopard frogs.

In addition, fire retardant may directly and indirectly harm populations. Although amphibians may be less sensitive to the ammonia of fire retardant than fish, prolonged exposure to elevated levels of ammonium compounds have been shown to have minimal to moderate effects on the survival and development of amphibian embryos and larvae (Jofre and Karasov 1999). Possibly more important is sodium ferrocyanide, an ingredient in retardant, which is used as a corrosion inhibitor. This substance has been shown to be highly toxic to fish and amphibians at very dilute concentrations, especially when exposed to sunlight (Burdick and Lipschuetz 1950, Little and Calfee 2000). Little and Calfee (2000) reported that fire retardants with sodium ferrocyanide, under natural light conditions were highly toxic to southern leopard frogs and boreal toads compared to treatments using the same chemical formulations without sodium ferrocyanide or without exposure to sunlight. Sodium ferrocyanide is oxidized in the presence of ultraviolet radiation, releasing higher concentrations of free cyanide (U.S. Fish and Wildlife Service 2004-a). Because of these factors, our effects determination for the Chiricahua leopard frog is may affect, is likely to adversely affect.

Sonora tiger salamander

History & Background
The Sonora tiger salamander *(Ambystoma tigrinum stebbensi)* was listed as an endangered species on January 6, 1997 (62 FR 665 689) and is easily confused with the more widely distributed non-native barred tiger salamander *(Ambystoma tigrinum mavortium).* Historically, the Sonora subspecies probably inhabited springs, streams, backwaters, and cienegas containing a permanent or nearly permanent water source in the area of San Rafael Valley, Arizona and

Sonora, Mexico. Typical habitat ranges in elevation from 4,000 to 6,300 feet. However, only 50 sites located within a 19 mile radius of Lochiel, Arizona have been identified as breeding areas. All sites are within the headwaters of the Santa Cruz and San Pedro rivers. These include sites in the San Rafael Valley, and the foothills of the Patagonia and Huachuca mountains, located in Santa Cruz and Cochise counties, Arizona, and Sonora, Mexico. Confirmed historical and extant Sonora tiger salamander populations all have resided in cattle tanks and impounded cienegas. Terrestrial salamanders probably spend much of the year in rodent burrows, rotted logs, and other moist cover sites. Small, isolated populations are subject to environmental, genetic, and demographic stochasticity. No critical habitat has been designated.

Conservation Measures
HAFP projects one, two, four, five, six, and eight (Table 5-1) include known locations of the Sonora tiger salamander.

The overall goal of conservation for the Sonora tiger salamander is to minimize the likelihood of sediment or ash flow into salamander habitats and to hasten the recovery of watersheds after fire activities, such as thinning and burning.

- Avoid aquatic habitat disturbance during suppression activities whenever possible.
- Consider the spatial distribution and contiguous size of planned burn areas in order to reduce the effects of peak flow change on channels.
- Construct waterbars in firelines, especially on steep hillsides.
- Avoid intense fire on sensitive soils, which may promote water repellency, nutrient leaching, and erosion.
- Retain or plan for sufficient ground cover to prevent erosion of the burned site.
- Modify desired fire behavior prescription relative to burn unit location on watershed.
- Reduce fuel loading in drainage channels and nearby woodland areas to protect aquatic habitat.
- Limit the creation of new access routes to those needed for suppression activities and only where other alternatives are not available. Any routes to or in the vicinity of salamander breeding sites created during fire activities should be obliterated or made impassable after the fire is out to prevent further use by the public.
- Rest burned areas from grazing for the first two summer growing seasons (July, August, and September) following implementation of the final phase of any planned fires, or such areas should be rested until grass production has increased by 200 pounds per acre. No grazing during July, August, and September should occur in burned areas between phases.
- Areas of significant human activity during fire operations, such as fire crew camps, landing strips, and equipment staging areas, shall not be located on or adjacent to salamander breeding sites and should be located at least 1,650 feet away from such sites unless absolutely necessary for fire suppression. Such areas of human activities should also be kept to the minimum area possible and should be located in previously disturbed sites whenever possible.
- Secure a buffer of at least 300 feet around tanks during pretreatment.

In addition to fire-related conservation measures, recovery actions also include: the protection and enhancement of salamander habitat, control of non-native predators, control of the transport of salamanders, approaches to minimize frequency of die-offs, monitoring, research, public education, and adaptive management (U.S. Fish and Wildlife Service 2002-a).

Determination of Effects
No studies concerning the effects of fire upon the Sonora tiger salamander have been conducted. Nonetheless, the species is subject to several threats related to fire and fire control. For example, habitat alteration due to sedimentation, ash run-off, and erosion are all associated with fire and fire suppression activities. Kerby and Kats (1998) report that "wildfire may indirectly affect aquatic systems by altering the surrounding terrestial habitat. Fires may cause loss of vegetation, producing soil instability and landslides that change stream geomorphology (Minshall el al. 1989)." As a result, changes to food sources due to habitat changes may have an indirect effect on salamanders (Kerby and Kats 1998). Equipment and personnel may serve as disease vectors, and fire suppression methods may introduce or remove non-native predators, as well.

In addition, the application of fire retardant may directly and indirectly pose possible risks to salamander populations. Although amphibians may be less sensitive to the ammonia of fire retardant than fish, prolonged exposure to elevated levels of ammonium compounds have been shown to have minimal to moderate effects on the survival and development of amphibian embryos and larvae (Jofre and Karasov 1999). Possibly more important is sodium ferrocyanide, an ingredient in retardant, which is used as a corrosion inhibitor. This substance has been shown to be highly toxic to fish and amphibians at very dilute concentrations, especially when exposed to sunlight (Burdick and Lipschuetz 1950, Little and Calfee 2000). Little and Calfee (2000) reported that fire retardants with sodium ferrocyanide, under natural light conditions were highly toxic to southern leopard frogs and boreal toads compared to treatments using the same chemical formulations without sodium ferrocyanide or without exposure to sunlight. Sodium ferrocyanide is oxidized in the presence of ultraviolet radiation, releasing higher concentrations of free cyanide (U.S. Fish and Wildlife Service 2004-a).

The loss of breeding sites is more serious than the loss of individual salamanders. If stock tank breeding grounds are degraded or destroyed, it is likely that barred tiger salamanders or other subspecies (in use as fishing bait), will replace the Sonora tiger salamander. Because of these factors, our effects determination for the Sonora tiger salamander is may affect, is likely to adversely affect.

Gila topminnow

History & Background
The Gila topminnow was listed as a threatened species on March 11, 1967 (32 FR 4001). This species occurs in small streams, springs, and cienegas below 4,500 feet elevation, primarily in shallow areas with aquatic vegetation and debris for cover. The Gila topminnow can tolerate relatively high water temperatures and low dissolved oxygen. Historically, this species was common throughout the Gila River drainage in Arizona, New Mexico, and Mexico. Currently, most of the remaining native populations are found in the Santa Cruz River system.

Conservation Measures
No proposed HAFP projects are located near known locations of the Gila topminnow. Future projects that may be located near the species will consider the following measures:

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats.
- Conduct prescribed burns such that no more than one-half of the watershed of each Gila topminnow natural or reintroduction site is burned in a two-year period (excluding buffers to the streams and/or spring habitats) and repeat treatments at greater than two-year intervals.
- Monitor for fish kill, where practical, immediately following the first runoff event after prescribed fires in the watersheds containing Gila topminnows.
- When considering which creek crossings to use for fire management activities, avoid crossings that are known to be occupied by Gila topminnow, when possible.
- Develop mitigation plans in coordination with the U.S. Fish and Wildlife Service for each fire management project (prescribed fire; vegetation treatments) that may adversely affect the Gila topminnow. Mitigation plans for prescribed fire will limit to the extent practicable the possibility that fire would spread to riparian habitats. Mitigation plans will be approved by the U.S. Fish and Wildlife Service.
- Cooperate with the U.S. Fish and Wildlife Service and Arizona Game and Fish Department to identify site-specific measures, such as prescribed fires in grassland vegetation types to improve watershed conditions, to protect populations of Gila topminnow from other resource program impacts.
- Avoid the use of fire retardant near streams and other water bodies. According to the Coronado National Memorial Fire Management Plan, the chemical components of fire retardant pose potential impacts on animals using those water sources. These impacts are related to direct application to streams and ponds (USGS 2000), although indirect impacts from filtration into water tables and standing water in caves and mines could occur. These indirect impacts are well documented; however, possible toxic components are buffered during filtration through surrounding soil and parent material. Cyanide and other chemicals may have an indirect effect if they run into rivers, streams, or ponds.

Determination of Effects

The species is subject to numerous direct or indirect effects of fire, both prescribed and wild (Gresswell 1999). The cause of direct fire-related fish mortalities has not been clearly established (Gresswell 1999). Fatalities are most likely during intense fire in small, headwater streams with low flows (less insulation and less water for dilution). In these situations, water temperatures can become elevated or changes in pH may cause immediate death (Cushing and Olson 1963). Spencer and Hauer (1991) documented 40-fold increases in ammonium concentrations during an intense fire in Montana.

Indirect effects of fire include ash and debris flows, increases in water temperature, and increased nutrient inputs, and sedimentation (Swanston 1991, Bozek and Young 1994, Gresswell 1999). Ash and debris flows can cause mortality months after fires occur when barren soils are eroded during monsoonal rain storms (Bozek and Young 1994, Brown et al. 2001). Fish suffocate when their gills are coated with fire particulate matter, they can be physically injured by rocks and debris, or they can be displaced downstream below impassable barriers into habitat occupied by non-native fishes. Ash and debris flows or severe flash flooding can also decimate aquatic invertebrate populations that the fish depend on for food (Molles 1985, Rinne 1996, Lytle 2000). In larger streams, refugia are typically available where fish can withstand the short-

term adverse conditions; small headwater streams are usually more confined concentrating the force of water and debris (Pearsons et al. 1992, Brown et al. 2001).

Increases in water temperature occur when the riparian canopy is eliminated by fire and the stream is directly exposed to the sun. After fires in Yellowstone National Park, Minshall et al. (1997) reported that maximum water temperatures were significantly greater in headwater streams affected by fire than in reference (unburned) streams and often surpassed tolerance levels of fish. Warm water can lead to increases in disease, lowered reproductive potential, and change in the food supply, as well (Bjornn and Reiser 1991, Minshall 1984, Wiederholm 1984, Roy et al. 2003). Finally, increased soil erosion as a result of fire and associated suppression actions (e.g., the contruction of control lines by hand or dozer) may result in amplified stream channelization and sedimentation, which may alter the species habitat.

In addition, the Gila topminnow is likely to react adversely to fire retardant, which may be used to control a burn. Fire retardants contain ammonium compounds that are typically toxic to fish (Gaikowsky et al. 1996, Buhl and Hamilton 2000). Possibly more important is sodium ferrocyanide, an ingredient in retardants, which is used as a corrosion inhibitor. This substance has been shown to be highly toxic to fish and amphibians at very dilute concentrations, especially when exposed to sunlight (Burdick and Lipschuetz 1950, Little and Calfee 2000). Little and Calfee (2000) reported that fire retardants with sodium ferrocyanide, under natural light conditions, were highly toxic to amphibians compared to treatments using the same chemical formulations without sodium ferrocyanide or without exposure to sunlight. Sodium ferrocyanide is oxidized in the presence of ultraviolet radiation, releasing higher concentrations of free cyanide (U.S. Fish and Wildlife Service 2004-a). Because of these factors, our effects determination for the Gila topminnow is may affect, is likely to adversely affect.

Spikedace

History and Background

The spikedace was listed as a threatened species on July 1, 1986 (51 FR 23769 23781). The fish is found in moderate to large perennial streams, where it inhabits moderate to fast-velocity waters over gravel and rubble substrates. Specific habitat 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. Recurrent flooding helps the spikedace maintain its competitive edge over invading non-native species. Typically occupied streams are found under 6,000 feet in elevation. The spikedace was once common throughout much of the Gila River drainage above Phoenix, Arizona, including the Gila, Verde, Agua Fria, Salt, San Pedro (extirpated from the upper section), and San Francisco rivers in Arizona. There are no records of the spikedace in the Santa Cruz River.

In 2004, the 9th Circuit Court remanded critical habitat designation, including the BLM San Pedro Riparian National Conservation Area (SPRNCA) location. Nonetheless, the SPRNCA may be re-proposed as a critical habitat in the future. Any future attempts to reestablish the spikedace, though, will likely be complicated by the high concentrations of non-native fish, amphibians, and invertebrates present in the SPRNCA.

Conservation Measures

There are no conservation measures because of the current absence of the species in HAFP project areas or the Huachuca Area Fire Partners planning area. If a future HAFP project were

located near the species habitat, conservation measures would be similar to those listed for the Gila topminnow.

Determination of Effects
The current absence of the species in Huachuca Area Fire Partners planning area leads to the determination that fire activity will have no effect on the spikedace.

Loach minnow

History & Background
The loach minnow was listed as a threatened species on October 28, 1986 (51 FR 39468 39478). The fish is a bottom dweller of small to large perennial creeks and rivers, typically in shallow turbulent riffles with cobble substrate, swift currents, and filamentous algae. Found below 8,000 feet elevation. Recurrent flooding is instrumental in maintenance of quality habitat. The loach minnow was once common throughout much of the Gila River system north of Phoenix, Arizona, including the Gila, Blue, Tularosa, White, Verde, Salt, San Pedro (now extirpated from the upper section), and San Francisco rivers in Arizona and New Mexico. There are no records of the loach minnow in the Santa Cruz River. Present populations are geographically isolated and often inhabit the upstream ends of their historic range.

In 2004, the 9th Circuit Court remanded critical habitat designation, including the BLM San Pedro Riparian National Conservation Area (SPRNCA) location. Nonetheless, the NCA may be proposed as a critical habitat and re-introduced in the future. Any future attempts to reestablish the loach minnow, though, will likely be complicated by the high concentrations of non-native fish, amphibians, and invertebrates present in the NCA.

Conservation Measures
There are no conservation measures because of the current absence of the species in HAFP project areas or the Huachuca Area Fire Partners planning area. If a future HAFP project were located near the species habitat, conservation measures would be similar to those listed for the Gila topminnow.

Determination of Effects
The current absence of the species in Huachuca Area Fire Partners planning area leads to the determination that fire activity will have no effect on the loach minnow.

Gila chub

History & Background
The Gila chub was listed as an endangered species on November 2, 2005 (70 FR 66664 66723). Gila chub commonly inhabit pools in smaller streams, cienegas, and artificial impoundments ranging in elevation from 2,000 to 3,500 feet. Gila chub are highly secretive, preferring quiet deeper waters, especially pools, or remaining near cover including terrestrial vegetation, boulders, and fallen logs. Adults are often found in deep pools and eddies below areas with swift currents. Young-of-the-year inhabit shallow water among plants or debris, while older juveniles use higher velocity stream areas. The historic range of the chub likely included suitable habitat throughout the entire Gila River basin, except the Salt River drainage above Roosevelt Lake. While the Gila chub has been recorded in approximately 30 rivers, streams, and spring-fed

tributaries throughout the Gila River basin in southeastern Arizona, only 29 populations of Gila chub remain; all but one are small, isolated, and threatened.

Loss or degradation of habitat (dewatering and changes in stream morphology and substrate) are the chief explanations for the decline of these fish. Non-native species, particularly green sunfish (*Lepomis cyanellis*—predators) and crayfish (*Oronectes virilis*—competitors) are also significant threats to the Gila chub. Sunfish were first observed in O'Donnell Creek in the Canelo Hills in 1990. The Nature Conservancy (TNC) began a planning a creek restoration project in 1998 after data for the 1994-1997 period indicated sharp declines in chub numbers and reproduction and increases in sunfish. In 2002 TNC, USDA Forest Service, and Arizona Game and Fish Department removed native fish, applied poison to the stream to eliminate non-native species, and then replaced the natives. The project has not been an overwhelming success; followup surveys have found only handfuls of native fish while green sunfish and crayfish persist.

On November 2, 2005, the U.S. Fish and Wildlife Service established the critical habitat for the Gila chub in seven Arizona watershed areas. In the HAFP planning area, critical habitat includes 6.2 miles of creek in O'Donnell Canyon from the confluence of Turkey Creek upstream to the confluences of Western, Middle, and Pauline Canyons. Second, an additional 3.9 miles of Turkey Creek is also designated from Turkey Creek to the confluence with O'Donnell Creek upstream to the Arizona Highway 83 crossing. Various areas with the historic presence of Gila chub, like the upper San Pedro River and Babocomari River, were not proposed for critical habitat.

Conservation Measures
HAFP project one (Table 5-1) includes known locations of the Gila chub. Though the project area includes Mexican lands not under the jurisdiction of the U.S. Fish and Wildlife Service, the following measures will be carried out nonetheless:

- Implement the Conservation Measures for fire management activities in riparian and aquatic habitats for occupied reaches and critical habitat.
- When considering which creek crossings to use for fire management activities, avoid crossings that are known to be occupied by Gila chub, when possible.
- Cooperate with the U.S. Fish and Wildlife Service and Arizona Game and Fish Department to identify site-specific measures, such as prescribed fires in grassland vegetation types to improve watershed conditions to protect populations of Gila chub from other resource program impacts.

Determination of Effects
The species is subject to numerous indirect effects of fire, both prescribed and wild. Increased soil erosion as a result of fire may result in amplified stream channelization and sedimentation, which may alter the species habitat (85-90 percent of the Gila chub's habitat has been degraded or destroyed, and much of it is unrecoverable).

Indirect effects of fire include ash and debris flows, increases in water temperature, and increased nutrient inputs, and sedimentation (Swanston 1991, Bozek and Young 1994, Gresswell 1999). Ash and debris flows can cause mortality months after fires occur when barren soils are eroded during monsoonal rain storms (Bozek and Young 1994, Brown et al. 2001). Fish suffocate when their gills are coated with fire particulate matter, they can be physically injured

by rocks and debris, or they can be displaced downstream below impassable barriers into habitat occupied by non-native fishes. Ash and debris flows or severe flash flooding can also decimate aquatic invertebrate populations that the fish depend on for food (Molles 1985, Rinne 1996, Lytle 2000). In larger streams, refugia are typically available where fish can withstand the short-term adverse conditions; small headwater streams are usually more confined concentrating the force of water and debris (Pearsons et al. 1992, Brown et al. 2001).

Increases in water temperature occur when the riparian canopy is eliminated by fire and the stream is directly exposed to the sun. After fires in Yellowstone National Park, Minshall et al. (1997) reported that maximum water temperatures were significantly greater in headwater streams affected by fire than in reference (unburned) streams and often surpassed tolerance levels of fish. Warm water can lead to increases in disease, lowered reproductive potential, and change in the food supply, as well (Bjornn and Reiser 1991, Minshall 1984, Wiederholm 1984, Roy et al. 2003). Finally, increased soil erosion as a result of fire and associated suppression actions (e.g., the contruction of control lines by hand or dozer) may result in amplified stream channelization and sedimentation, which may alter the species habitat.

In addition, the Gila chub is likely to react adversely to fire retardant, which may be used to control a burn. Fire retardants contain ammonium compounds that are typically toxic to fish (Gaikowsky et al. 1996, Buhl and Hamilton 2000). Possibly more important is sodium ferrocyanide, an ingredient in retardants, which is used as a corrosion inhibitor. This substance has been shown to be highly toxic to fish and amphibians at very dilute concentrations, especially when exposed to sunlight (Burdick and Lipschuetz 1950, Little and Calfee 2000). Little and Calfee (2000) reported that fire retardants with sodium ferrocyanide, under natural light conditions, were highly toxic to amphibians compared to treatments using the same chemical formulations without sodium ferrocyanide or without exposure to sunlight. Sodium ferrocyanide is oxidized in the presence of ultraviolet radiation, releasing higher concentrations of free cyanide (U.S. Fish and Wildlife Service 2004). Because of these factors, our effects determination for the Gila chub is may affect, is likely to adversely affect.

Candidate species

Huachuca springsnail

History & Background
The U.S. Fish and Wildlife Service petitioned the Huachuca springsnail as a candidate species in May 2004. Though candidate species are not subject to consultation, local biologists consider them sensitive species that merit special management consideration.

The Huachuca springsnail generally resides in springs or cienegas at 4,500 to 7,200 feet elevation in southeastern Arizona and adjacent portions of Sonora, Mexico, including nine sites in the upper San Pedro River drainage (Huachuca Mountains, Canelo Hills, San Rafael Valley - Arizona/Sonora), and four in the upper Santa Cruz River drainage (Sonoita Creek drainage, San Rafael Valley, Santa Cruz River drainage - Sonora). Springs and cienegas inhabited by the snail are typically marshy areas characterized by various aquatic and emergent plant species that occur within plains grassland, oak and pine-oak woodlands, and coniferous forest vegetation communities. The species is typically found in the shallower areas of springs or cienegas, often in rocky seeps at the spring source. Many potentially suitable sites in the southern half of the

Huachuca Mountains have not been surveyed for Huachuca springsnail. Other potentially suitable unsurveyed habitats exist within the range of the species. Small, isolated populations are subject to environmental, genetic, and demographic stochasticity.

As a candidate species, the Huachuca springsnail is not subject to consultation under section 7 of the ESA. Thus, a determination of effects and list of conservation measures is not included. Nonetheless, HAFP projects five and six (Table 5-1) will consider the snail, and apply measures to protect the species where feasible.

Yellow-billed cuckoo (western)

History & Background
The yellow-billed cuckoo was originally petitioned as a candidate species in February 1998. Though not Federally listed or subject to consultation, the cuckoo is considered a sensitive species that merits special management consideration. As a note, the petition to the U.S. Fish and Wildlife Service lists the yellow-billed cuckoo as a western United States distinct population segment (DPS) according to the research of Franzreb and Laymon (1993).

Western yellow-billed cuckoo habitat is limited to riparian cottonwood-willow galleries (though non-native saltcedar [*Tamarix ramosissima*] is also used by the cuckoo). Dense understory foliage appears to be an important factor in nest site selection, while cottonwood trees are an important foraging habitat in areas where the species has been studied in California. The species is usually found at elevations less than 6,600 feet. The species, based on historic accounts, was widespread and locally common in California and Arizona. Arizona probably contains the largest remaining cuckoo population among States west of the Rocky Mountains, but cuckoo numbers in 1999 are substantially less than some previous estimates for Arizona as habitat has declined. One hundred sixty-eight yellow-billed cuckoo pairs and 80 single birds were located in Arizona in 1999, based on preliminary results from a State-wide survey which covered 265 miles of river and creek bottoms. Losses of riparian habitats from historic levels have been substantial in Arizona (90 - 95 percent of the species habitat has been degraded or destroyed, and much of it may be unrecoverable) (Noss et al. 1995, Ohmart 1994). Despite this, the cuckoo is still found in many cottonwood-willow riparian zones of Arizona (Corman and Magill 2000).

As a candidate species, the yellow-billed cuckoo is not subject to consultation. Thus, a determination of effects and list of conservation measures is not included. Nonetheless, HAFP projects five and six (Table 5-1) will consider the southwestern willow flycatcher, and apply measures to protect the species where feasible.

Lemmon fleabane

History & Background
The U.S. Fish and Wildlife Service petitioned the Lemmon fleabane as a candidate species in May, 2004. Though candidate species are not subject to consultation, local biologists consider them sensitive species that merit special management consideration. For example, the proposed project five will consider the species, and apply measures to protect the species where feasible.

“This prostrate perennial fleabane occurs in crevices and ledges of west-, south-, and north-facing limestone cliffs and on faces of large boulders in canyon bottoms within the pine-oak woodland association at elevations from 6300 to 7300 feet (U.S. Fish and Wildlife Service

1992). The species is now only known from one site on the Fort Huachuca Military Reservation of southeastern Arizona. Approximately 70 individuals are at this site. The Arizona Game and Fish Department (1999) concurs that only 1 known site currently exists - the 6 other historical occurrence sites were likely mis-identified. The type specimen was probably from Scheelite Canyon, a tributary of Garden Canyon."

"Virtually any habitat change is a serious threat to the species because it only occurs as a single population. Due to its vertical cliff face habitat, many of the more usual impacts (e.g., grazing, development) are unlikely. The single largest threat to the species is from catastrophic wildfire in the canyon where the plant occurs. An intense wildfire in the narrow canyon would almost certainly desiccate plants on the cliff face, possibly directly killing individuals or stressing out plants that could lead to lower reproductive output. The landowner (DOD, Ft. Huachuca) is willing to develop a conservation agreement for this species. Measures have been taken to reduce the threat of wildfire (the entire range of this species is within the Federally listed Mexican Spotted Owl Protected Activity Center) and also the threats from recreational rappelling, which is not allowed on the cliff faces occupied by the plant (U.S. Fish and Wildlife Service 2004-b)."

Chapter 8: Invasive Non-native Species Relevant to Fire Regime

Many invasive non-native species live or grow in the Huachuca planning area. The Natural Resources Conservation Service (NRCS) defines invasives as those species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health. Non-native species, also called exotics, are defined as any species within a particular ecosystem—including its seeds, eggs, spores, or other biological material capable of propagating that species—that is not native to that ecosystem (NRCS 2005). For example, vertebrates such as the crayfish, green sunfish, and bullfrog (all deliberately introduced) have been implicated in the decline of native fishes and frogs statewide. Shrubs such as the saltcedar are also responsible for altering riparian vegetation communities. This chapter addresses fire management implications of Johnson grass (*Sorghum halepense*) and Lehmann lovegrass (*Eragrostis lehmanniana*) judged by the partners as the most problematic species. Other invasive non-native species, like Boer lovegrass (*E. chloromelas*), exist in portions of the Huachuca planning area but are not discussed here. For information on related monitoring activities in the area, refer to Chapter 11.

Johnson grass

Johnson grass is a coarse perennial grass with stalks reaching from one to seven feet in height. It can be spread by water, wind, livestock, wildlife, and contaminated vehicles, crops, or machinery. In the San Pedro Valley, the species is well established along bottomlands, roadsides, drainages, and river banks where other grasses, especially sacaton (*Sorobolus wrightii*), once proliferated. It begins its growth cycle in June or July with the onset of the summer rains or earlier if soil moisture is available. Seed heads mature in late summer and the plant becomes quiescent in mid to late autumn. Through winter it persists as dry, dense stands which are highly susceptible to fire. In riparian areas these can burn with great intensity in any season, especially in summer. Cottonwoods and other native species are usually killed or scarred, while Johnson grass regrows vigorously from subsurface rhizomes and spreads once the tree canopy is removed. Some reaches of the San Pedro River have been subject to one or more hot-season wildfires and are now dominated by Johnson grass along the stream banks. At the TNC Canelo Hills Preserve, Johnson grass and other non-native plants may partially explain the decline in the endangered ladies tresses (*Spiranthes delitescens*) on the unburned plots.

The USGS Weeds in the West project addresses the Johnson grass relationship to fire below (Guertin and Halvorson 2003):

"Spring burning may encourage *Sorghum halepense*, and is not recommended as a control method (Invasive Alien Plant Species of Virginia 1999). *Sorghum halepense* survives fire with its deeply buried rhizomes that can subsequently sprout; and, it can increase following a fire (Odum et al. 1974 *in* Snyder 1992). They report on a mid-March prescribed burn in Georgia in which unburned plots yielded 0.20 g/m^2 of ovendry weight for the season, and burned plots yielded 27.42 g/m^2. In contrast, in a Texas field, a late April fire reduced the amounts of *Sorghum halepense*, allowing the establishment of a native grass (Wood 1989 *in* Newman 1993). Newman (1993) provides several opinions stating a general ineffectiveness of fire as a useful, long term control method.

When costs were significantly lower, the preferred method of *Sorghum halepense* control in the southwest was torching fields by using butane-propane burners (McWhorter 1981 *in* Newman 1993)."

Other measures to control the spread of Johnson grass include:

- After visiting locations prone to Johnson grass, shaking off grass debris from clothes and shoes in a manner that will not lead to future spreading.
- Using guaranteed Johnson grass-free seed for livestock feed and erosion control.
- Cleaning vehicles (radiators and undercarriages especially).


photo by Patty Guertin


photo by Patty Guertin


photo by Patty Guertin


photo by Patty Guertin

Lehmann lovegrass

Lehmann lovegrass (*Eragrostis lehmanniana*) is another well-studied grass known to the Huachuca Mountains area. Guertin and Halvorson (2003) explain that Lehmann lovegrass introduction was the result of an international search for species intended to revegetate degraded land (from grazing and recurring droughts). It was identified as a species able to revegetate without intensive horticultural inputs (Cable 1971 *in* Anable et al. 1992). Until recently it had been used to reseed/revegetate livestock grazing areas, rights-of-way, construction sites, golf courses, and wildfire areas (Anable et al. 1992).

Guertin and Halvorson (2003) also mention that: "Bock et al. (1986 *in* D'Antonio and Vitousek 1992) note the significant decline of 10 common native plant species in Arizona in the presence of *Eragrostis lehmanniana*. *Eragrostis lehmanniana* replaces native grasses over vast areas, radically altering community composition and reducing biodiversity (Bock and Bock 2002, Van Devender et al. 1997). Cable (1971 *in* Uchytil 1992) reports that on the Santa Rita Experimental Range in southern Arizona, it has replaced Arizona cottontop (*Trichachne californica*), threeawn grasses (*Aristida* spp.), and grama grasses (*Bouteloua* spp.) over much of the range. *Eragrostis lehmanniana* has spread beyond initially seeded degraded areas to invade desert grassland sites that have had no animal or human disturbance (McClaran and Anable 1992 *in* Williams and Baruch 2000)."

Lehmann lovegrass is of considerable concern in the planning area because it contributes to increased fire frequency, greater fire intensities, and fire spread. Its prolific seed production, positive response to fire, and wide range of environmental tolerances allow it to out-compete native grasses (Ruyle et al. 1988). Presence of Lehmann lovegrass promotes a positive feedback pattern because Lehmann lovegrass abundance increases the fire frequency which in turn increases Lehmann lovegrass abundance (Anable et al. 1992). Because Lehmann lovegrass produces more fine fuel than native grasses, fires burn with greater intensity which may have detrimental effects on native grasses and other plant species that rely on spatial refugia to escape fire (Bock et al. 1986, Abbott 1997). Native grasses recover after fire but recovery is dependent on drought conditions at the time of the fire and in successive growing seasons. Lehmann lovegrass is opportunistic and can take advantage of drought conditions and expand into other areas at the expense of native grasses (Cable 1965, Robinett 1992).

The goal of increasing native grass cover and decreasing shrub canopy cover may be accomplished with prescribed burning; however fire may not reduce Lehmann lovegrass in favor of native grasses. Current research suggests that fire does not have an effect on limiting the spread of Lehmann lovegrass in favor of native grasses (McPherson 2004). This research, conducted to assess the seasonal impact of fire on Lehmann lovegrass, indicates that no matter which season Lehmann lovegrass was burned or how much rainfall there was in a particular year, the proportion of Lehmann lovegrass to native grasses either remained the same or slightly increased.

Measures to control the spread of Lehmann lovegrass include:

- After visiting locations prone to Lehman lovegrass, shaking off grass debris from clothes and shoes in a manner that will not lead to future spreading.
- Using guaranteed Lehmann-free seed for livestock feed and erosion control.
- Cleaning vehicles (radiators and undercarriages especially).

photo by Patty Guertin

photo by Patty Guertin

photo by Patty Guertin

Chapter 9: Sensitive Cultural Resources

Cultural resources on the Huachuca Area Fire Partners planning area consist of sites, structures, and objects created and used by prehistoric and historic peoples. These phenomena represent the physical remains of past human occupation and activities in the area. A wide variety of cultural site types both above and below the modern ground surface reflect the sequence of area occupants. Studies of regional cultural resources might focus on prehistoric, pre-European, Apache, Spanish Colonial (with mining and ranching), American (with mining and ranching), and "Federal" (government surveyors and public land managers) historic contexts. Historic contexts are defined as patterns, themes, or trends in history by which a specific occurrence, property, or site is understood.

Table 9-1 is a matrix of resources, values at risk, and protection measures for the Huachuca Area Fire Partners planning area. Values are defined as the unique research and interpretive potential of cultural resources that are potentially affected by fire program activities. This matrix considers historical, archeological, architectural, engineering, and cultural values. It is useful as a planning and operations guide to prevent resource loss or degradation. Rock art sites and wooden structures are the resources most at risk from fire operations. Prehistoric sites that are in locations where fire is a risk now have undoubtedly been exposed to numerous low-severity fires in past centuries. However, in many places there is a substantially greater risk of more destructive high-severity fires than at any time in the past. The risk of high-severity fire is a result of nearly a century of land management practices, particularly fire suppression, that have generated high fuel amounts.

The Huachuca Area Fire Partners conducted the analysis in Table 9-1 by defining historic contexts and a list of cultural resource types that included elements and values at risk from fire. In this analysis, there are two historic contexts: Native American and Euro-Historic. Cultural Resources professionals from Fort Huachuca (Charlie Slaymaker), National Park Service (Kevin Harper), Bureau of Land Management (Jane Childress), and the Coronado National Forest (Bill Gillespie) guided the April 21, 2004 exercise. Tables 9-1 and 9-2 include meeting notes with Kevin Harper's additions and a review by Bill Gillespie.

Native American

This period includes Native American cultural resources such as habitation sites, artifacts, and artwork from the pre-Apache period through the end of the 19th century. After the surrender of Geronimo in 1886, Chiricahua Apache and Western Apache increasingly lived on reservations outside the Huachuca Mountain area.

Euro-historic

This period begins with the arrival of Europeans to the area in the 16th century and continues through the early 20th century. Cultural resources include artifacts from mining, ranching, military, and Civilian Conservation Corps activities.

Table 9-1. Cultural resources and fire: Native American historic context

Major site types	Site elements	What values are at risk from fire activities?	Take action to protect?
Habitation sites	surface architecture (pit houses), features (roasting pits and trash heaps), ceramics, chipped stone, ground stone	alignment, enclosure, remnants of structure, research potential of pollen and carbon samples, date contamination, spatial arrangement	involve tribes, remove items by hand, black-line, limit intensity of prescribed burns, thin fuels, avoid disturbance—restrict suppression activities at sites
Artifact scatter/ limited activity sites	ceramics, chipped stone, ground stone food processing features	visibility (post fire), date contamination, spatial arrangement	collect/ not collect, seed to conceal and stabilize soil, thin fuels, restrict suppression activities at sites
Rock shelters/ caves	chipped stone, ground stone, food processing features, perishable features, rock art	date contamination, date of classification, spatial arrangement, feature integrity, interpretive value, preservation	clear away entrance of caves to avoid convection damage, avoid retardant, construct lines, thin fuels, restrict suppression activities
Rock art sites	pictographs, petroglyphs associated artifacts	obsidian artifacts, pigments	thin fuels, construct line, conduct test burns to assess impacts
Other	gathering area, ceremonial areas proto-historic sites, graves	ground disturbance, research potential from pollen, carbon, etc.	avoid disturbance, black-line, remove items by hand

Table 9-2. Cultural resources and fire: Euro-historic context

Major site types	Site elements	What values are at risk from fire activities?	Take action to protect?
Ranching/ livestock	homesteads fences and corrals, dumps-perishables, windmills-wells, fruit trees	remnants of structure, historic signage, feature integrity	protect area with buffer and thinning, restrict ground disturbance, black-line, suppress, use retardant
Mining	wooden structures, trails/roads, wells, metal mining tools	remnants of structure, historic signage, timbers, feature integrity, dating/ information, interpretive value	thin fuels near mine entrances, restrict ground disturbance, black-line, suppress, use retardant
Military	earth works, range towers, wooden towers, historic weapons	remnants of structure, rock alignment, trenches	avoid unexploded ordnance
Spanish colonial	Spanish forts with adobe walls, other structures, perishables, historic weapons	remnants of structure, historic signage, research potential of carbon and pollen samples	thin fuels, black-line, suppress
Transportation, communication (people and water)	trusses, rail lines, and railroad ties, water lines, telegraph lines	remnants of structure	thin fuels, restrict ground disturbance, suppress
Administration (CCC structures, camps, lookouts, A.S., boundary monuments)	fire lookout, dams and ditches, flumes camps, survey markers and boundaries	remnants of structure	black-line, restrict line construction, rehab for erosion
Other	wagon trails (stage road), historic fire breaks, outhouses	remnants of structure, historic signage	thin fuels, restrict ground disturbance, monitor post-burn

Chapter 10: Border Considerations

A regional approach to fire management includes U.S./Mexico border issues and, ideally, the participation of Mexican landowners. Fire management operations and communications should include border considerations because (1) watersheds and the distribution of plants and animals are contiguous and (2) human, fire, and invasive species disturbances often cross freely between the U.S. and Mexico. This chapter begins by describing the Huachuca region south of the border, next discusses the role and impact of various landowners and users in the region, and concludes with a look at cross-border fire management cooperation.

Regional overview

The Huachuca region south of the international border lies within the municipalities of Nogales, Santa Cruz, Cananea, and Naco in the State of Sonora. Similar to the U.S. side, the Mexico portion is defined by sky islands, grasslands, and sparse development. The region runs from the Patagonia Mountains in the west to the San Pedro River basin in the east to about 30 miles south of the border. The Mexican commission on biodiversity, CONABIO, also recognizes the region as a prioritized conservation area (Arriaga et al. 2000).

Given that the restoration of the historical fire regime poses similar opportunities and risks to Mexican land managers, the HAFP support an international effort to cooperatively maximize the benefits of fire while working to mitigate the adverse effects. Landownership includes communal ranches called ejidos, private property, and virtually no public land. As a first step, the HAFP intend to invite the participation of Mexico's National Forestry Commission and other groups. (Appendix G includes a draft of our solicitation letter.) The boundaries of this informal region will be revised depending on the response to our invitation to participate in the HAFP.

Elections in Mexico often result in staffing changes at the organizations involved in this cross-border cooperation. For this reason, U.S. land managers should keep in mind the election schedule for the State of Sonora and Mexico's Federal agencies to anticipate the possible impact. The current Sonora governor is Eduardo Bours Castelo of the PRI (Institutional Revolutionary Party). His term began in 2003 and ends in 2009. The current president of Mexico is Vicente Fox Quesada of the PAN (National Action Party). His term began in 2000 and ends in 2006.

Border Patrol

The HAFP planning area includes three of the eight Border Patrol stations within the Tucson sector. The Nogales station runs from Nogales to the crest of the Patagonia Mountains. The Sonoita station runs from there to the crest of the Huachuca Mountains at Monument Pass and the Naco station extends from there to east of Naco, Arizona. As an indication of the traffic volume in this region, the Border Patrol took into custody 123,966 illegal immigrants and seized 139,076 pounds of marijuana at the Naco and Sonoita stations in the 2004 fiscal year (Table 10-1).

Border Patrol is assigned to all lands within 25 miles of the border to apprehend undocumented immigrants, drug traffickers, and potential terrorists crossing into the U.S. These groups travel from the border into National Forest and other protected public lands where their warming and

Table 10-1. Illegal immigration and marijuana seizures (fiscal year)

	Illegal Immigrants (taken into custody)			Marijuana Seizures (pounds)		
	2002	**2003**	**2004**	**2002**	**2003**	**2004**
Sonoita Station	4,280	5,363	12,565	58,685	88,443	91,227
Naco Station	61,993	95,096	111,401	25,467	43,168	47,849
Tucson Sector	333,648	347,263	491,771	305,390	362,351	446,754
U.S./ Mexico Border	929,809	906,321	1,137,554	1,223,275	1,350,809	1,347,145

cooking fires increase the likelihood of ignitions. Additionally, their concealed movements place them at risk during prescribed burns and suppression activities.

Human-caused wildfires are the largest single threat to many of the most sensitive ecological areas in this planning unit. While illegal immigrants are a significant source of these types of fires, they are not the only source. Large fires like the Merritt fire, the Ash Canyon fire, and the Sunday fire were all caused by local landowners. In reviewing the statistics for the Coronado National Forest, the percentage of human-caused fires versus natural ignitions greatly increases as proximity to the border increases. The Coronado National Forest as a whole has more natural ignitions while the Sierra Vista and Nogales Ranger Districts have a much higher percentage of human-caused fires than natural ignitions.

Warming and cooking fires built by illegal immigrants and smugglers that are not properly extinguished are often particularly difficult to deal with due to the locations of the starts. Most of these individuals are trying to avoid being detected by Border Patrol and other law enforcement organizations. They hide in areas that are not easily accessed by vehicle or trail system. They are often under a dense canopy of vegetation that shields them from visual detection. These fires often smolder around for several hours or days. When the wind, or relative humidity, is just right they spring to life and burn very rapidly through the grasses and other fine fuels.

Due to the recent fire history on the Sierra Vista Ranger District, many of the new starts are in areas that have not burned in several years. Much of the sensitive wildlife habitat, like Mexican spotted owl nest locations, is in these areas. That means that much of the most sensitive remnant stands of pine at the higher elevations are at very high risk for stand-replacing fires. This is also true for many of the dense canyons and riparian habitats.

The U.S. Federal government has responded to these concerns in various manners. For example, the Border Patrol has installed a remote video surveillance system at Coronado National Memorial and the National Park Service (NPS) has installed approximately one mile of barriers to curb illegal vehicular traffic. The NPS completed an Environmental Assessment which addresses numerous border issues such as improvements to the road immediately adjacent to the international boundary. Besides enhancing border patrols, these measures would increase responsiveness to wildfires approaching from Mexico and act as fire breaks (NPS 2003).

Role of Mexican agencies, organizations, and landowners in fire management

Federal and state role in fire management

Publicly owned lands are nearly non-existent in the Huachuca area south of the international border. There are no state-owned lands and the Ajos-Bavispe National Forest Reserve and Wildlife Refuge southeast of Cananea is the only Federal holding in the region. The National Commission of Protected Areas (CONANP) manages the Reserve. Nonetheless, many other groups are involved in land management in the area (Table 10-2). For example, the National Forestry Commission (CONAFOR) holds the primary responsibility for fire management.

Dating back to 1940, Mexico has followed a nation-wide fire exclusion (suppression) policy. Recognizing the complications of this approach in combination with accumulated fuels and prolonged drought, reserve managers now consider alternatives to fire suppression. For example, managers at the Ajos-Bavispe National Forest Reserve & Wildlife Refuge will draft a fire management plan with cooperation from the Chiricahua National Monument staff.

Coordination of fire planning across the border will also require work with the State of Sonora fire committees, called Comités Estatales de Protección Contra Incendios Forestales or State Committees for Protection against Forest Fires. The State of Sonora provides political leadership while CONAFOR equips the Committees with the technical skills and resources (equipment, vehicles, food, etc.) necessary for wildland fire management.

University and nonprofit role in fire management

The University of Sonora, located in Hermosillo, is the closest university to the Huachuca area. Faculty and students are only a one to three-hour drive from the borderlands south of the Patagonia and Huachuca Mountains. Nonetheless, there are currently no known fire-related studies in the area by members of the University of Sonora or any other Mexican university.

A fruitful partnership has developed among The Nature Conservancy, BIDA (see below), and Naturalia A.C. to manage the Los Fresnos preserve located south of the international border southwest of the Coronado National Memorial. The Los Fresnos preserve had been sensitively managed for ranching by an Hermosillo family for generations. In the fall of 2005, TNC, the Mexican nonprofits, and CONAFOR will burn a section of the preserve to demonstrate the additional benefits of reintroducing fire into the landscape. The logistics and lessons from this burn will be described afterwards. This will include an explanation of partner roles, protocols, communication, guidelines for operational issues, and permits.

Biodiversidad y Desarrollo Armónico (BIDA), or Biodiversity and Harmonic Development by its English translation, is the Hermosillo-based nonprofit working with The Nature Conservancy (TNC) on fire planning at the TNC Los Fresnos preserve while Naturalia A.C. manages other aspects of the preserve. This partnership between TNC and Mexican nonprofits is an example of the regional land management approach sought by the HAFP.

Table 10-2. Mexican agencies relevant to fire management in the HAFP planning area

Name		Acronym	Notes
National Commission for the Knowledge and Use of Biodiversity	Comisión Nacional para el Conocimiento y Uso de la Biodiversidad	CONABIO	Independent executive commission that collects and disseminates data on biodiversity
Secretary of Environment & Natural Resources	Secretaría del Medio Ambiente y Recursos Naturales	SEMARNAT	Involved at various levels in fire management
National Commission of Protected Areas	Comisión Nacional de Áreas Naturales Protegidas	CONANP	Part of SEMARNAT, working on a general management plan with a chapter on fire for Ajos-Bavispe Refuge
National Forestry Commission	Comisión Nacional Forestal	CONAFOR	Part of SEMARNAT, decentralized public organization that handles forest fire management in the State of Sonora
Secretary of Agriculture, Livestock, Rural Development, Fish, and Food	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación	SAGARPA	Involved in ranching and rural development near protected areas
Secretary of National Defense	Secretaría de La Defensa Nacional	SEDENA	Involved in fire control and management
Secretary of Governance, Civil Protection System	Secretaría de Gobernación, Sistema Nacional de Protección Civil	SEGOB	Mexico's emergency management agency
National Ecological Institute	Instituto Nacional de Ecología	INE	Responsible for impact statements
National Institute of Statistics, Geography and Information	Instituto Nacional de Estadística, Geografía e Informática	INEGI	Manages mapping
Institute for the Environment & Sustainable Development of the State of Sonora	Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora	IMADES	Part of the Sonoran State Secretary of Urban Infrastructure and Ecology, involved in the study of Sonoran ecosystems

Ejido and private role in fire management

There are approximately seven ejidos, or community-owned properties, in the approximately 40 by 80-kilometer area south of the HAFP planning area. These local ejidos are primarily engaged in ranching and practice fire suppression as the preferred fire management tool. Ejidos are not likely to have the economic resources to participate in burn projects, and their lands may be heavily grazed so that fire is neither a danger nor an immediate tool for recovery. Nonetheless, members of the Ejido Miguel Hidalgo appear to be receptive to alternative management practices. The Sonoran Institute, a Tucson-based conservation organization, is currently working with Ejido Miguel Hidalgo to address issues of livestock overgrazing, soil erosion, and water quality decline. HAFP has not yet invited these ejidos to participate in fire planning but does have their contact information in the event that they would like to do so.

Private landowners constitute the remaining property owners in the area. There are approximately 162 private properties owned by about 60 families. Like the ejidos, these owners are also primarily involved in ranching and practice fire suppression as the preferred fire management tool. In the absence of a HAFP Mexican planning area, the percentage of ejido and private land can not be calculated. Nonetheless, a generalization can be made that the core of the area south of the HAFP planning area is private property while the periphery is owned by ejidos (see Figure 1-1). HAFP has not yet invited these landowners to participate in fire planning but does have their contact information in the event that they would like to do so. Nonetheless, managers at the TNC Los Fresnos preserve, previously a working ranch, intend to invite neighboring landowners to the preserve for demonstrations of sustainable ranching practices. Presentations may include fire management activities with prescribed fire and non-fire treatments.

There are no known Mexican indigenous groups living, or involved, in the area. In the event that an indigenous group were to voice an interest in fire management planning, the HAFP would welcome its participation.

International fire management

The HAFP are not the first to address the need for cooperation on fire management issues along the border. The governments of Mexico and the United States have in place various measures to address fire concerns. HAFP seeks to extend these cooperative responses to fire threats with proactive measures like prescribed fire and non-fire treatments. The Big Bend National Park (Diablos program) and burn plans at the TNC Los Fresnos preserve are examples of this international collaboration on fire management. HAFP seek to emphasize and extend a coordinated approach to fire management with U.S. and Mexican counterparts in the Huachuca area.

Border agreements

An area of 10 miles to each side of the U.S./Mexico border marks the “zone of mutual assistance” as determined by the Department of the Interior and Department of Agriculture of the United States and the Secretary of the Environment and Natural Resources of Mexico (Appendix H). The agreement facilitates coordination on wildfire suppression and encourages further cooperation to develop operating plans for other fire management activities outside of the zone of mutual assistance (U.S.-Mexico Borderlands Wildland Fire Agreement 1999). Some of the Mexican agencies involved are listed in Table 10-2.

An area of 60 feet parallel and north of the international border is often designated (Forest Service lands excluded) as the “Roosevelt Reservation” under the jurisdiction of the International Boundary and Water Commission of the State Department. The Commission is not equipped to address any significant fire monitoring or fire management. This responsibility goes to the nearest landowner.

The U.S. Environmental Protection Agency (EPA) and the Mexican Secretary of Environment and Natural Resources (SEMARNAT) created the Mexico-United States Joint Contingency Plan in 1999 to prepare and respond to environmental emergencies caused by leaks, spills, fires, or explosions of dangerous substances in the strip along the terrestrial border. This plan in combination with the agreement in Appendix H allows for international cooperation to respond to fire emergencies along the border.

Big Bend Diablos: A lesson in international fire management

A program that may serve as a model for the Huachuca area is the Diablos fire training program developed at Big Bend National Park in southwest Texas. The implementation of such a program could provide beneficial fire support to local U.S. agencies and valuable work and education to neighboring Mexican communities.

The Diablos are 40 trained Mexican type II firefighters available for fire and project work in Big Bend, other parks of the region, and national fire incidents. Big Bend National Park used about $15,500 on start-up funding for instructor travel, transportation, 26 sets of personal protective equipment, boots, and food. Funding came from the NPS Southwest Region Fire Management Program, the NPS Intermountain Region International Conservation Programs Office, and FirePro. The program minimized expenses by receiving equipment donations (for example, Lake Mead National Recreation Area and Chiricahua National Monument donated fire crew buses).

Start-up funding and training for the Diablos began in 1990. Twenty-three Mexicans were given basic firefighter training and formed into an emergency firefighter crew. Big Bend employees continued training and supervising them on incidents and project work. In 1997, they gave a National Wildfire Coordinating Group course in Spanish and 44 Mexicans completed it. The 1997 and 1999 agreements between Department of the Interior and SEMARNAT expanded cooperative activities along the border. Big Bend National Park arranged for the Diablos to enter into the U.S. under Immigration and Naturalization Service authorized parole authority. Eventually Big Bend got permission to send the Diablos to fire management activities beyond the zone of mutual assistance. They have been employed during times of non-emergency to work on projects such as fuels management, burned area emergency rehabilitation, and reduction of non-native species. The Diablos are paid as administratively determined employees. Depending on experience, they receive the AD-1, -2, or -3 hourly wage.

Developing a Mexican crew in the Huachuca area would require financial and personnel commitment from one of the agencies in the Department of the Interior or Agriculture. The benefit of this sort of resource includes close-by, trained type II firefighters available for mobilization on fires, support on burns, and work on fuels projects that often overwhelm local U.S. resources. The Mexican crew would also serve as a way to disseminate information to nearby Mexican communities about planned burns and appropriate use of fire in land management. As with the Big Bend example, the agency can establish a connection with a particular community, facilitating direct communications, training, and future recruitment of additional firefighters.

Chapter 11: Monitoring

Monitoring can be a powerful tool for assessing the effectiveness of land management treatments. It can be used to quantify the effects of prescribed burning, wildland fire, or other fuels management prescriptions by evaluating vegetation community response and trends through time as well as other ecological factors including hydrology, soils, and wildlife. Monitoring is an essential element of adaptive management that enables managers to assess their effectiveness and adjust future management plans accordingly.

Prior to application of fire or mechanical treatments, it is advisable to collect baseline, pre-burn vegetation and other resources data on treatment areas. Once baseline conditions have been established, monitoring can be used to identify potential problems in the early stages when solutions are likely to be less expensive and more successful. When monitoring the effects of wildland fire, pre-burn monitoring is not usually an option except when plots already exist so post-burn changes must be compared to nearby similar areas that did not burn.

This chapter summarizes monitoring activities in the Huachuca area. When applicable, various organizations have provided their monitoring history on sensitive species, invasive species, fire, range/grazing, border impacts, weather, and water. The intention of providing this information is to encourage the use of these monitoring studies for improved fire management. The HAFP do not want to see valuable data going to waste or being underutilized!

Members of the HAFP also utilize the interagency three-level fire regime condition class (FRCC) tool for determining the degree of departure from reference condition vegetation, fuels, and disturbance regimes in the Huachuca area. Nonetheless, the HAFP does not consider the FRCC as a monitoring tool. Current condition classes are unlikely to fluctuate in the short term regardless of current management objectives or treatment priorities—changes will likely occur at intervals of centuries rather than years. The monitoring activities listed below provide more immediate and detailed results than the FRCCs.

Current monitoring

San Pedro Riparian National Conservation Area, Bureau of Land Management

Sensitive Species
Vegetation monitoring consists of approximately baseline 40 photo points, 12 line intercept transects in the riparian zone, and approximately 45 pace frequency transects in grassland, mesquite woodland, Chihuahuan desert habitats and abandoned agricultural lands. Assessment of proper function and condition of the riparian area occurs every five years. Fisheries monitoring is performed annually at five sites along river. Bird population trends are monitored, with volunteer assistance, at an established Monitoring Avian Productivity and Survivorship (MAPS) bird banding site near Highway 90. BLM personnel also undertake yearly monitoring of the river for Huachuca water umbel.

Invasive species
BLM is monitoring Johnson grass, Lehmann lovegrass, saltcedar, Russian thistle, and other invasive non-native species in the Conservation Area by using pace frequency transects, line-intercept transects, and photo points.

Fire
The BLM has recently completed an environmental assessment for prescribed fire. BLM will monitor the effects of prescribed fire on mesquite woodlands, cottonwood/willow forests, and sacaton grasslands using line intercept transects and photo points.

Water
BLM and cooperators in the Upper San Pedro partnership are monitoring stream flow at three permanent locations and thirteen newly established sites. Ground water is also being monitored at approximately twenty-five locations throughout the conservation area.

Coronado National Memorial

Sensitive Species
The 2005 Memorial Fire Plan specifies that NPS will monitor PAC and additional areas that contain primary constituent elements of owl habitat for the presence of Mexican spotted owls, especially where prescribed burning will occur.

Invasive species
Theresa Mau-Crimmins (NPS Tucson) has done some work on Lehmann lovegrass.

Fire
None

Range/Grazing
There is ongoing vegetation monitoring and Palmer agave (lesser long-nosed bat food plant) monitoring related to impacts from grazing.

Border Impacts
None

Water
None

Fort Huachuca

Sensitive Species
The Fort monitors on an annual basis: the Mexican spotted owl (since 1990), lesser long-nosed bat, mountain lion (since 1989), pronghorn, Gould's turkey, and southwestern willow flycatcher. Gould's turkey populations are surveyed in cooperation with Arizona Fish and Game Department (AFGD). The pronghorn monitoring takes place with aerial surveys in support of a habitat suitability study also conducted by the AFGD. Ramsey Canyon leopard frog, and Huachuca springsnail are monitored or surveyed periodically.

Fort Huachuca also monitors sensitive plants. The Huachuca water umbel is monitored annually while the lemon lily, Chiricahua dock, and Lemmon fleabane are monitored periodically. Palmer and Parry agave population dynamics have been monitored since 2002. Agaves are the main foraging plant for the endangered lesser long-nosed bat during summer months.

Invasive species
Lehmann lovegrass has been monitored in conjunction with the agave population study since 2002. The project includes a historic baseline (1992-93) for Lehmann lovegrass and its dynamics associated with fire. In addition, onionweed is a recent invasive plant arrival that staff are watching.

Fire
In the last two years, Fort Huachuca has undertaken several prescribed burn projects requested through Environmental and Range Control offices. Currently there are 26 plots on the East Range to monitor the effects of fire on grassland and shrub plant communities. A three to four year study was conducted to monitor the effect of fire on Lehmann lovegrass, agave, and ground nesting birds. Over 200 fuel inventory plots were established at Fort Huachuca so there is potential to re-monitor them after a prescribed fire or wildfire. In addition, the Fort has monitored the effects of controlled burns on watershed rehabilitation and mapped fire perimeters at Fort Huachuca to determine fire history since 1972.

Range/Grazing
Not Applicable

Border Impacts
The impacts are present but not monitored.

Water
The Fort also regularly monitors ground and surface water quantity and quality with support from the U.S. Geological Survey (USGS) and Arizona Department of Water Resources (ADWR).

Southern Arizona Office, National Park Service

Sensitive Species
Larry Laing at the National Park Service (NPS) Southern Arizona Office is working with the USDA Forest Service (through an Interagency Agreement) on a seamless regional map of landscape ecological units, based on vegetation, landform, and soil patterns. This map product will result in a refinement of the ecological units described in Chapter 2. They will cover a roughly 3 million acre area that includes the HAFP planning area. They will provide a valuable context for evaluating landscape-scale patterns and processes and their relationship to, among other things, species distribution and abundance.

Invasive species
None

Fire

The NPS Sonoran Desert Inventory and Monitoring Network would like to do more with fire monitoring and is especially interested in the interaction between fire and other ecological components.

Range/Grazing
None

Border Impacts
The Southern Arizona office is conducting a Cultural Resources Border Impacts Project. Jeff McGovern, the project leader, is working with 11 border parks in Arizona and Texas to help them develop baseline databases of impacted areas and/or potentially impacted areas, and then to formulate long-term monitoring plans for those resources.

Water
None

Ecological Services, U.S. Fish and Wildlife Service

The Ecological Services division of the U.S. Fish and Wildlife Service issues Biological Opinions, but not does not conduct monitor. It ensures agencies do the required monitoring. Biological Opinions generally require some sort of monitoring of the species or habitat, especially when take of a listed species is anticipated. The Biological Opinions it produces are found on their website (www.fws.gov/arizonaes).

USDA Forest Service

The Forest Service collects fire cost trend information, especially along the border. It also has a wildland fire management policy and measures to determine success (issued in June of 2003). For more information, check their website (www.fs.fed.us). The Forest Service plans to adopt a new environmental management system that will aid managers in adaptive management.

Arizona Game and Fish Department

The Arizona Game and Fish Department is expanding efforts to monitor species throughout the state, including within the HAFP planning area. The Department monitors riparian and upland projects, and has recently partnered to acquired conservation easements (which will be monitored) on private properties in southeastern Arizona. The Department manages the Heritage Database Management System (HDMS), which monitors sensitive species occurrences statewide through both internal and external agency data support.

Sensitive Species
The Department is actively pursuing the recovery of native fishes in southern Arizona. The Department receives U.S. Fish and Wildlife Service funding (in accordance with Section 6 of the Endangered Species Act) to monitor wild and introduced Gila topminnow and desert pupfish populations. Sites that are monitored annually include: Bog Hole, Redrock Canyon, Audubon Ranch near Elgin, Cottonwood Spring, Monkey Spring, Coal Mine Canyon, Fresno Canyon, Sonoita Creek, Santa Cruz River (upper and middle), O'Donnell Creek, Sharp Spring, Sheehy Spring, Heron Spring, Cienega Creek. This list of sites (within and just west of the HAFP planning area) is not inclusive and is likely to change.

Additional aquatic sensitive species include: Sonora and desert suckers, longfin and speckled dace, Gila chub, and Sonora chub. In addition, spikedace and loach minnow are in the process of being stocked into Redfield and Hot Springs Canyons and may be stocked into suitable habitats on the Coronado National Forest at a later date (but do not currently occupy habitats within the scope of this document).

Monitoring efforts of other sensitive species includes, but is not limited to: Gould's turkey, pronghorn, bat species, Chiricahua/Ramsey Canyon leopard frog, and southwest willow flycatcher.

Invasive species
None

Fire
None

Range/Grazing
None

Border Impacts
The Department organizes Adopt-A-Ranch cleanup efforts with volunteer groups to remove litter left from recreational users and undocumented immigrants on public and private lands in the border region.

Water
The Department is in the process of recording (GPS) perennial and intermittent water sources in the area. The Department maintains several water developments in the fire planning area for wildlife in a cooperative effort with landowners.

Arizona State Parks

Sensitive Species
There are programs underway at Sonoita Creek (just beyond the western HAFP boundary) to monitor birds, grassland birds, fish, salamanders, leopard frogs, and riparian habitats. In the past there has been vegetation monitoring at Sonoita Creek as well.

At San Rafael Ranch State Park, there are vegetation monitoring plots based on Natural Resources Conservation Service (NRCS) and Malpai Borderlands Group protocols. These organizations are currently evaluating the effectiveness of these efforts.

Invasive species
None

Fire
Arizona State Parks generally does not have a policy for fire; fire management defaults to the agency of land ownership. For the properties that the State Parks holds, it is exploring a policy for their response to fire.

Range/Grazing
None

Border Impacts
None

Water
None

Appleton-Whittell Research Ranch, National Audubon Society

Sensitive Species
The Ranch monitors endangered fish species and will implement avian monitoring associated with its designation as an Important Bird Area by the National Audubon Society.

Invasive species
There is some Lehmann lovegrass monitoring (primarily based on roads) and treatment of Lehmann and Boer lovegrasses.

Fire
There is no defined fire monitoring program. Nonetheless, all research projects occurring on the ranch since the Ryan fire include a fire component. The vegetation monitoring, based on NRCS methodology. The Ranch also has pre-/post-fire data.

Range/Grazing
The ranch has excluded grazing since 1968. There are lots of research projects that use the ranch, but not much long-term monitoring—only what staff have been able to design and implement herself. It is often difficult to raise funds for monitoring and to allocate staff time to it. Although the Research Ranch has had a lot of data collected on it, these data are not always available to inform managers because they are proprietary to researchers and data access is not always permitted.

Border Impacts
None

Water
The ranch's goal with in-house monitoring is to get basic data collection protocols established, including precipitation and vegetation. There are 18 simple rain gauges (readings collected quarterly) and 2 MET stations on the ranch. They also measure depth to groundwater on 12 sites. This information is available to share.

Ramsey Canyon Preserve, The Nature Conservancy

Sensitive Species
Ramsey Canyon leopard frog surveying began in 1990 and ended with the species' extirpation in 2001. Hummingbird monitoring, including banding, began 1985.

Spotty monitoring data are available for the lemon lily *(Lilium parryi)*, Lemmon milkweed *(Asclepias lemmonii)*, and Tepic flame flower *(Talinum marginatum)*.

Invasive species
The Ramsey Canyon preserve has been recording and removing *Vinca major* along Ramsey Creek since the late 1970s.

Fire
Monitoring for fire centers on whether prescribed burns or other treatment measures fulfill the fire objectives. TNC experimentally burned five hectares of oak woodland in December 2000. Plots were set up before-the-fact in three treatment areas—thin only, thin and burn, and control. Baseline data collection included herbaceous plant inventory, tree/shrub cover/density, litter/duff depth, estimated fuel load from downed woody material, shrubs, herbaceous vegetation, litter/duff. Plots read after thinning/before fire, six weeks post-fire, one and a half years post-fire; photos taken. The study found that fire was not hot enough to burn surface fuels, that thinned areas opened up but distributing lopped material in place increased downed woody material and litter 100-500%, and that all cut oak stumps resprouted. There have not been post-wildland fire/Burned Area Emergency Recovery (BAER) or other research projects.

Range/Grazing
None

Border Impacts
There is plenty of traffic through the preserve but no formal records of trails and trash are kept. Staff and volunteers pick up trash on the preserve and observe it on the surrounding Coronado National Forest lands.

Weather and Water
There is a stream gauge on Ramsey Creek next to the visitor center (USGS 09470750 Ramsey Canyon near Sierra Vista, Arizona). Operation began in 2000, and data are available online—http://waterdata.usgs.gov/az/nwis/uv?09470750. Preserve personnel also made measurements beginning in 1982. The preserve has maintained a rain gauge since 1982 and made daily readings of maximum and minimum temperature since 1995 (missing 1999 when preserved was closed). Files contain water quality reports for Ramsey Creek at irregular intervals between 1992 and 1998.

General framework and guidelines for future HAFP monitoring

Monitoring will be applied at the landscape and project scale.

Landscape Scale:

- Implementation—
  (1) what planned projects have been implemented, how many acres were successfully treated, and what is their spatial distribution relative to the ecological units and the fire management units.
  (2) what unplanned ignitions have occurred, how many acres were affected, and what is their distribution relative to ecological units and fire management units.

- Effectiveness—
  (1) what progress has been made toward desired conditions across the planning area
  (2) how does this progress relate to the ecologically desired conditions defined for the ecological units and goals related to the fire management units (the wildland/urban interface, for example).

Project Scale:

- Implementation—was the project implemented as planned
- Effectiveness—were the treatment objectives achieved
- Unplanned ignitions—what were effects

Based on monitoring results or information needs identified during monitoring or project planning, the HAFP will recommend future research studies and seek partnerships and funding to facilitate their implementation. The HAFP will also recommend specific units for monitoring and baseline parameters.

Budgets for monitoring are limited or nonexistent so the group will draw on its membership and capacity to develop project-specific monitoring plans and perform the desired monitoring.

Not all projects will be quantitatively monitored at the project scale but the partnership will attempt to collect qualitative monitoring (photopoints, ocular estimates, etc.) on the effectiveness of all projects. Quantitative monitoring will be reserved for projects that occur in ecological units where the effects of different treatments are poorly understood or where there is limited experience in implementing treatments.

Projects that have the potential to affect (positively or negatively) sensitive species are monitoring priorities. Monitoring of listed species will be necessary, especially for those that will be adversely affected by projects. These are important data for maintaining the U.S. Fish and Wildlife Service baseline information for each species (including its habitat).

Since fire effects often manifest themselves outside the burn areas, the HAFP may recommend monitoring parameters of hydrologic function, water quality and quantity, wildlife response, and WUI-related factors.

If recommended monitoring can not be accomplished within the group, the partnership will seek funding and partnerships with the academic community to implement needed monitoring.

The partnership will coordinate with the Sonoran Desert Monitoring Network, another regional resource management consortium, to ensure that where monitoring objectives warrant and time/resources allow, field-tested protocols developed by the Network will be used.

Chapter 12: Outreach

The outreach effort seeks to promote the various advantages of managing fire on a regional scale. As explained in Chapter 1, cooperation among all landowners in the region is a first step to improving fire management. Second, the HAFP promote a healthy ecosystem and economy. Both have unique area-specific needs and face unique area-specific fire threats. For example, the long-term benefits of a proactive fire management program will likely outweigh any benefits of a reactive fire management program. By focusing on preventive fire management, the HAFP expect increased firefighter safety and fewer risks at the wildland-urban interface.

The result of promoting cooperation, safety, healthy landscapes, and strong economies requires that the public understands that:

- Not all fire is "bad."
- Managed fire is necessary.
- Short-term inconvenience and smoke are substitutes for long-term uncontrolled risk and smoke.
- Property owners must take responsibility for creating defensible space around their homes and businesses.
- Cooperation among agencies and the public facilitates the goals of the HAFP fire management plan.

Target audience

The FMP attempts to consider the issues and needs of all interested groups in the Huachuca area. These groups are more likely to support the fire management objectives if the plan addresses their concerns. To facilitate this, outreach includes regularly notifying these interested groups of management actions which may affect them. Below are the major target audiences of the HAFP.

Residents in the wildland-urban interface (WUI)

Interests and concerns

The primary issue for residents in the WUI will likely be the safety of their families, animals, and property. In addition, residents will also be interested in financial issues regarding changes to property value, the cost and availability of insurance, and the cost of implementing actions recommended by the HAFP. The visual impact of fire, its aftermath, and smoke is also a concern of residents.

Key messages

Residents should be aware that their proximity to wilderness means fire is always something to consider. By managing fire projects, the HAFP intends to reduce these fire risks to property. In addition, residents should know that there are also cost-effective protection measures that they can use to reduce risks. In tandem with neighbors, these measures can improve safety considerably. In other words, what neighbors do (or do not do) may impact neighboring property. For this reason, the agencies involved in managing fire need the cooperation and support of local residents.

Effective communications channels:
- Homeowners associations
- Area fire departments
- Displays in areas that residents frequently visit
- Workshops
- Speaker's bureau
- Media (radio announcements, newspaper articles)
- Direct mail (bill stuffers)
- Realty companies

Private ranchers

Interests and concerns
Private ranchers, including permittees and ranch land residents, have interests and concerns regarding fire management. In addition to those listed for WUI residents, ranchers look closely at the availability of ample forage, the effects of fire on water sources, and any need to relocate cattle. The protection of ranch improvements is also a concern.

Key messages
The HAFP will continue to highlight the benefits of fire for ranchers. For example, healthier ecosystems result in more forage ("blazing means more grazing") and prescribed burns protect resources. In addition, the HAFP want ranchers to know that agencies understand their concerns and need their cooperation and support.

Effective communication channels
- Opinion leaders
- UA Cooperative Extension
- Permittee meetings
- Society for Range Management
- Cattle Growers Association
- Hereford National Resources Conservation District
- Sonoita Cowbelles
- Feed stores
- Events (County fairs, rodeos, 4-H)

Non-land management government agencies

Various agencies have an interest in land management but are not significant landowners in the Huachuca area. These agencies include:

- U.S. Fish and Wildlife Service
- Arizona Game and Fish Department
- Department of Homeland Security, Immigration and Naturalization Service
- State Historic Preservation Office of Arizona State Parks
- Chambers of Commerce in the Huachuca planning area
- Convention and Visitors Bureau and State Tourism Office
- Planning & zoning staffs of city and county governments
- Mexican agencies like SEMARNAT and CONAFOR (Appendix G provides a draft of an invitation to Mexican agency officials to participate with the HAFP on fire planning)

- Tribes

Interests and concerns
All agencies are concerned about public safety. Federal agencies are also interested in the ability to streamline communication and compliance. Tourism agencies are concerned about the impact of the negative effects of fire.

Key messages
Federal agencies should know that the HAFP goals support their missions. Also, these agencies may save time and money by working with the Partners. Not only that, but the group is also easy to work with—effective, open, and willing.

Tourism agencies should know that managed fire protects the area's unique ecosystem and supports eco-tourism. Planned fires result in fewer public land closures and increased public safety.

Effective communication channels
- Land Managers Forum presentation
- SE Arizona Managers Meeting presentation
- Fort Huachuca Conservation Committee presentation
- SW Strategies presentation
- Annual meeting with Mexico counterparts
- Invite representatives to meetings and provide them with HAFP minutes
- Sonoran Desert Monitoring Network

Non-governmental organizations (NGO's)

Many NGO's are interested in land management issues in the Huachuca area. Environmental organizations like the Sky Island Alliance, Audubon Society, Sierra Club, and Center for Biological Diversity work in the area. Additionally, the concerns of nearby fire departments, researchers, recreational land users, and the general public should also be addressed.

Interests and concerns
The most common concern may be the maintenance of healthy ecosystems. Policies based on "good" science will likely preserve biodiversity. At the same time, they will want to make sure HAFP actions are cost effective.

Key messages
These constituencies should know that managed fire contributes to the recovery of the ecosystem and reduces the threat of catastrophic fires. HAFP actions are one step beyond where we are now and support adaptive management. Agencies involved in the management of fire need their cooperation and informed consent.

Effective communication channels
- Sky Island and future conference presentations
- SAVE meeting presentation
- Newsletter
- Attend and present at NGO meetings
- Website

Funding Organizations

Organizations that may become funders (for example, agency executives, politicians and their staffs) should also be considered in outreach efforts.

Interests and concerns
These organizations may be interested in the benefit to local communities, the visible success of fire management, long-term cost/benefits, accountability, uniqueness, and the potential of plans rooted in solid science.

Key messages
These organizations should know that agencies are working together for the public good—cooperating to keep costs down and maintain the uniqueness of the area. This collaborative effort allows the group to accomplish more than partners could individually.

Communication channels
Agency executives:
- Briefing papers
- Face-to-face reporting
- Resource Advisory Council presentation
- SW Strategy Presentation
- Develop talking points for their use

Politicians and their staffs:
- Briefing papers with short executive summaries
- Face to face reporting to get ahead of constituent calls

Huachuca Area Fire Partners members

Last but not least, HAFP members have a direct interest in the outcome of planning activities. Although representatives attend meetings, the HAFP should also address key messages to the broader audiences in their organizations.

Interests & concerns
The most common interest may be the survival of the partnership. The HAFP wants to see the partners working collaboratively on fire management.

Key messages
The key message would be to emphasize the importance of collaboration.

Effective communication channels
- HAFP workshops
- Discussion of HAFP at meetings with the broader audience of partner organizations
- Promotional materials and/or events

Chapter 13: Consultation and Coordination

HAFP history

The HAFP began in 1997 to share prescribed burn plans through annual round-table forums. In 1999, The Nature Conservancy received a small Fire Learning Network grant. This grant was originally intended to fund the development of an “interactive fire model.” But TNC staffers Dave Gori and Carol Lambert determined that a collaborative fire management plan was what the Huachuca area really needed.

After the initial pulse of activity, the fire group remained relatively dormant until the large wildland fires in the spring of 2002 affected the Sierra Vista Ranger District of the Coronado National Forest, Fort Huachuca, the Audubon Research Ranch, the Babocomari Ranch, and other lands in the planning area. In the fall of 2002 The Nature Conservancy spearheaded a restart that has continued through the production of this plan.

The summary of HAFP meeting topics from 2002 through 2005 offers a view of the pace of progress on the fire management plans. Full meeting minutes are available upon request.

December 18, 2002: FMP goals, graduate student request, budget, political advocacy, national level USFS support.

March 10, 2003: planning area boundaries, funding opportunities, partner fire management plans, interagency agreements, public outreach, sensitive species, prescribed burns, vegetative classification system.

April 18, 2003: local fire update, planning area boundary, partner fire management plans, sensitive species, vegetative classifications system, GIS fuel load project, planning area fire atlas, upper San Pedro Partnership, funding, FMP process, outreach, review of Biological Opinions, impact analysis, collaborative process, fire planning issues, cultural resources, partner projects.

May 19, 2003: planning area boundary, Biological Opinion reviews, sensitive species, fire history, outreach.

July 10, 2003: bibliography, planning area, fire atlas, Mexico protocol, promotional brochure, outreach, planning process.

August 12, 2003: planning area map, operational resources, outreach, Fort Huachuca interagency support, review of Biological Opinions, fire history, research and monitoring needs, vegetation map, administration, project list, cultural resources, Mexico partnerships.

September 16, 2003: outline review, section leader organization, map revision.

November 12, 2003: fire ecology, border considerations, operations, outreach.

December 5, 2003: outline review, publicity, wildfire alternatives evaluation tool (WALTER) summary, budget.

April 6, 2004: ecological units, condition class assessment, project areas, communication

April 20, 2004: cultural resources and history.

October 18, 2004: ecological units, fire management units, outreach.

December 7, 2004: fire management units, funding ideas, possible projects.

March 3, 2005: outreach, draft FMP, monitoring goals, partnership with Mexican agencies, FMU/project update.

May 19, 2005: draft FMP editing.

July 28, 2005: completed the draft FMP and distributed it for outside review.

November 17, 2005: unveiling of completed fire management plan.

Funding

The majority of HAFP activities have taken place on a voluntary basis. Partner organizations have donated a great deal of time and effort to this plan—behind-the-scenes "homework," field work, and monthly meeting time.

A $40,000 grant from the Fire Learning Network (The Nature Conservancy and USDA Forest Service) funded TNC staff participation for two years.

Two sources at Fort Huachuca each provided $10,000 to the University of Arizona to fund graduate student and staff help with the plan. The Peace Corps Fellows program also contributed funding for the graduate students.

The National Park Service Intermountain Region contributed $10,000 to offset outreach and plan preparation expenses.

Contributors

Many HAFP participants with diverse and extensive backgrounds have contributed to the FMP. Below is a summary of their applicable experience along with their role in the planning process.

Barbara Alberti, *Integrated Resources Program Manager, Coronado National Memorial*. HAFP role: border considerations, outreach.

Jane Childress, *Archeologist, Bureau of Land Management*. HAFP role: cultural resources.

Bill Crolly, *Assistant Fire Management Officer, Sierra Vista Ranger District, Coronado National Forest*. HAFP role: fire operations, fire project delineation.

Shelley Danzer, *Integrated Training Area Management (ITAM) Coordinator, Fort Huachuca*—MS in Watershed Management with a focus on fire as a disturbance from the University of Arizona School of Natural Resources; 4 years Fort Huachuca; 4 years Senior Research Specialist at the University of Arizona. HAFP role: fire history, fire ecology, mapping, non-native species.

Cori Dolan, *Research Specialist, University of Arizona*—BS in Entomology from University of Delaware; graduate student UA School of National Resources; 1 year field work at Coronado National Memorial; 2 years fire management planning and development of national park interpretive materials. HAFP role: partner profiles, sensitive natural resources.

James Feldmann, *Planning Specialist, University of Arizona, School of Natural Resources*—MS in Planning from University of Arizona; 2 years fire management planning assistance; 2 years Peace Corps volunteer. HAFP role: editor-in-chief, border considerations, operational resources survey, sensitive natural resources.

Denisse Fisher, *Research Specialist, University of Arizona*. HAFP role: border considerations.

Mark Fredlake, *Wildlife Biologist, SPRNCA, Bureau of Land Management*—BS in wildlife biology Arizona State University. 25 years with the BLM. HAFP role: operations, sensitive natural resources, general review.

Brooke Gebow, *Southeastern Arizona Preserves Manager, The Nature Conservancy* (as of February, 2005)—MS in Ecology & Evolutionary Biology from University of Arizona; 12 years free-lance science writer; 4 years Tucson Botanical Gardens; 6 years project support for USGS Sonoran Desert Field Station. HAFP role: overall FMP coordinator, environmental issues, fire project descriptions.

Leila Gass, *GIS analyst, Southwest Geographic Science Team, USGS*—MS in Biology with a minor in Geography from Texas State University, San Marcos; nine years GIS and remote sensing. HAFP role: land ownership maps.

Bill Gillespie, *Archeologist, Coronado National Forest*. HAFP role: cultural resources.

Dave Gori, *Ecologist, The Nature Conservancy*—PhD in Ecology and Evolutionary Biology from University of Arizona; 15 years at The Nature Conservancy. HAFP role: ecological mapping units.

Steve Gunzel, *District Ranger, Sierra Vista Ranger District, USDA Forest Service*—BS in Watershed Management from University of Arizona; 19 years district ranger, 5 of which at Sierra Vista. HAFP role: fire ecology, development of fire projects, border considerations, wildland fire management.

Kevin Harper, *Archeologist, Southern Arizona Office, National Park Service*—MA in Anthropology from Northern Arizona University; 3 years National Park Service; 18 years experience in cultural resources management with other Federal, state, and tribal agencies. HAFP role: responsible for cultural resources impact topics.

Tyler Jones, *GIS Analyst, Fort Huachuca*—MS in Geography and natural resource management from the University of Arizona; 1.5 years at Fort Huachuca. HAFP role: land ownership maps, ecological mapping units.

Linda Kennedy, *Assistant Director and Science Coordinator, Appleton-Whittell Research Ranch, National Audubon Society*—BS and MS in Biology from Fort Hays State University; PhD in Botany from Arizona State University; 6 years Audubon Research Ranch. HAFP role: non-native species, general grassland ecology.

Carol Lambert, *Southeast Arizona Program Coordinator, The Nature Conservancy*—MBA from the University of Denver; 6 years TNC Ramsey Canyon preserve manager. HAFP role: organizer, group facilitator, outreach.

Larry Laing, *Natural Resource Program Manager, National Park Service*—BS in Agriculture from The Ohio State University; 3 years with NPS; 22 years with the USDA Forest Service; 8 years with the Soil Conservation Service (Natural Resource Conservation Service). HAFP role: ecological mapping units, fire ecology.

Sabra Schwartz, *Heritage Data Management System (HDMS) Program Supervisor, Arizona Game and Fish Department*. BS in Biology from Northern Arizona University; 14 years with HDMS Program. HAFP role: sensitive natural resources.

Lynn Slagle, *Consultant, Lynn Slagle Marketing & Communications*. HAFP role: assessment of outreach needs.

Charlie Slaymaker, *Archeologist, Fort Huachuca*. HAFP role: cultural resources.

Josh Swanson, *GIS analyst, ITAM Program, Fort Huachuca*. MS in Geography from the University of Columbia, Missouri. HAFP role: fire management and other maps.

Sherry Tune, *Coronado National Forest*. HAFP role: fire management units.

Bill Wilcox, *Fire Management Officer, Sierra Vista Ranger District, Coronado National Forest*—BS in Agriculture and Range Science from University of Arizona; 10 years Fire Management Officer; 20 years range conservationist; 5 years range conservationist staff. HAFP role: fire operations, ecology, border considerations, collaborative projects.

Brian Wooldridge, *Fish and Wildlife Biologist, Arizona Ecological Services, U.S. Fish and Wildlife Service*. BS in Biology from Iowa State University; MS in Biology from University of Texas at El Paso; 1.5 years USFWS; 6 years private consulting. HAFP role: sensitive natural resources.

Joan Vasey, *Fort Huachuca*. HAFP role: outreach.

Other Participants

Erin Boyle	Supervisor's Office, Coronado National Forest
Lee Eseman	San Rafael State Park, Arizona State Parks
Frank Hammond	Environmental and Natural Resources Office, Fort Huachuca
Jim Hessil	Environmental and Natural Resources Office, Fort Huachuca
Ross Humphreys	San Rafael Ranch
Sara Jensen	School of Natural Resources, University of Arizona
Wayne Lackner	Immigration & Naturalization Service, Department of Homeland Security
Brian Lauber	Arizona State Land Department
Gordon Lewis	Palominas Firewise Community
Jayleen Lineback	School of Natural Resources, University of Arizona
Keith Lombardo	Department of Geography, University of Arizona
John Millican	Arizona Game and Fish Department
Barbara Morehouse	Institute for the Study of Planet Earth, University of Arizona
Dan Quintana	Safford District Office, Bureau of Land Management
Joanne Roberts	Arizona State Parks
Doug Ruppel	Babocamori Ranch
Ethan Stapp	School of Natural Resources, University of Arizona
Matt Walton	Landowner Relations Program, Arizona Game and Fish Department
Peter Warren	The Nature Conservancy

Outside Reviewers of the FMP

Tom Dooley	Fire Ecologist, Western U.S., The Nature Conservancy
Peter Ffolliott	Professor, School of Natural Resources, University of Arizona
Lisa Hanson	Environmental Protection Specialist, Intermountain Regional Office, National Park Service
Bob Lineback	Wildland Fire Specialist, Intermountain Regional Office, National Park Service
Dean McAlister	Fire Management Officer, Coronado National Forest
Guy McPherson	Professor, School of Natural Resources, University of Arizona
Mark Pater	Zone Fire Ecologist, Safford District, Bureau of Land Management

Literature Cited

Abbott, L. 1997. The ecological role of fire in semidesert grassland ecosystems of southeastern Arizona. Final Draft, Upper San Pedro Ecosystem Program, The Nature Conservancy, Contract No. USPE050197.

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, H.E. 1982. Aids to determining fuel models for estimating fire behavior. USDA Forest Service, GTR-INT-122. Intermountain Forest and Range Experiment Station, Ogden UT. 22 pp.

Archer, S. 1994. Woody plant encroachment into southwestern grasslands and savannas: rates, patterns and proximate causes. Pp. 13-68 *in* M. Vavra, W. A Laycock, and R. D. Pieper (eds.), Ecological Implication of Livestock Herbivory in the West. Society of Range Management, Denver.

Arizona Game and Fish Department. 1999. Heritage Data Management System: Plants-Status and Occurrences. Phoenix, Arizona.

Arizona Game and Fish Department. 2003. Arizona Game and Fish Department. *Leptonycteris curasoae yerbabuenae*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 8 pp.

Armstrong, W. E. 1980. Impact of prescribed burning on wildlife. In: White, Larry D.,ed. Prescribed range burning in the Edwards Plateau of Texas: Proceedings of a symposium; 1980 October 23; Junction, TX. College Station, TX: Texas Agricultural Extension Service, The Texas A&M University System: 22-26.

Aronson, J.C., C. Floret, E. LeFloch, C. Ovalle, and R. Pontanier. 1993. Restoration and rehabilitation of degraded ecysostems in arid and semi-arid lands. A view from the south. Restoration Ecology 1: 8-17.

Arriaga, L., J.M. Espinoza, C. Aguilar, E. Martínez, L. Gómez and E. Loa (coordinators). 2000. *Regiones terrestres prioritarias de México*. Escala de trabajo 1:1 000 000. Comisión Nacional para el Conocimiento y uso de la Biodiversidad (CONABIO). México.

Bahre, C.J. 1985. Wildfire in southeastern Arizona between 1859 and 1890. Desert Plants 7:190 – 194.

Bahre, C.J. 1991. A Legacy of Change: Historic Human Impact on Vegetation in the Arizona Borderlands. Tucson, AZ, The University of Arizona Press. 231 pp.

Baker, W. L. and D. Ehle. 2003. Uncertainty in fire history and restoration of ponderosa pine forests in the western United States. In: Omi, Philip N.; Joyce, Linda A., technical editors. Fire, Fuel Treatments, and Ecological Restoration: Conference Proceedings.

Proceedings RMRS-P-29. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 319-333

Barton, A.M. 1999. Pines versus oaks: effects of fire on the composition of Madrean forests in Arizona. Forest Ecology and Management 120: 143-156.

Bendix, J. 1994. Among-site variation in riparian vegetation in the Southern California Transverse Ranges. American Midland Naturalist 132: 136-151.

Bock, C.E., J.H. Bock, K.L. Jepson, and J.C. Ortega. 1986. Ecological effects of planting African lovegrasses in Arizona. National Geographic Research 2: 456-463.

Bock, J. H., and C.E. Bock. 1992. Vegetation responses to wildfire in native versus exotic Arizona grassland. Journal of Vegetation Science 3: 439-446.

Bock, J.H., and C.E. Bock. 2002. Exotic species grasslands. *In*: Tellman, B. (ed.). Invasive exotic species in the Sonoran Desert region. The University of Arizona Press and The Arizona-Sonora Desert Museum, Tucson, Arizona. 424 pp.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan (editor). American Fisheries Society Special Publication 19. Bethesda, Maryland. 83-138 pp.

Bozek, M.A. and M.K. Young. 1994. Fish mortality resulting from delayed effects of fire in the Greater Yellowstone Ecosystem. Great Basin Nat. 54: 91-95.

Brown, D. E. (ed.). 1982. Biotic Communities of the American Southwest -United States and Mexico. Desert Plants 4: 1-342.

Brown, D.K., A.A. Echelle, D.L. Propst, J.E. Brooks, and W.L. Fisher. 2001. Catastrophic wildfire and number of populations as factors influencing risk of extinction for Gila trout (Oncorhynchus gilae). Western North American Naturalist 61: 139-148.

Buhl, K.J. and S.J. Hamilton. 2000. Acute toxicity of fire-control chemicals, nitrogenous chemicals, and surfactants to rainbow trout. Trans. Am. Fish Soc. 129: 408-418.

Burdick, G.E. and M. Lipschuetz. 1950. Toxicity of ferro- and ferricyanide solutions to fish and determination of the cause of mortality. Transactions of the American Fisheries Society 78: 192.

Burgess, T.L. 1995. Desert grassland, mixed shrub savanna, shrub steppe, or semidesert scrub? The dilemma of coexisting growth forms. pp 31 – 67 in M.P. McClaran, and T.R. Van Devender (eds.), The Desert Grassland. University of Arizona Press, Tucson, AZ.

Cable, D.R. 1965. Damage to mesquite, Lehmann lovegrass and black grama by a hot June fire. Journal of Range Management 18: 326-329.

Cable, D.R. 1971. Lehmann lovegrass on the Santa Rita Experimental Range, 1937-1968. Journal of Range Management 24:17-24.

Cockrum, E. L., S. M. Russell, and C. H. Lowe. 1976. Survey of the Vertebrate Fauna of Fort Bowie National Historic Site. Cooperative National Park Resources Studies Unit, University of Arizona. Technical Report #2. (Authors of chapters are actually Roth and Cockrum, Russell and Johnson, and Lowe and Johnson). 120 pp.

Cooper, C.F. 1960. Changes in vegetation, structure and growth of southwestern pine forests since white settlement. Ecol. Monogr. 30: 129-164.

Cooper, C.F. 1961. The ecology of fire. Scientific American 204: 150-160.

Corman, T. E. and R. T. Magill. 2000. Western yellow-billed cuckoo in Arizona: 1998 and 1999 survey report. Arizona Game and Fish Department, Nongame and endangered wildlife program, Technical report 150. Phoenix, Arizona.

Coronado National Forest. 2005. Wildland Fire Use Implementation Guide.

Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa forest structure: Changes since Euro-American settlement. Journal of Forestry 92: 39-47.

Cox, J.R. 1988. Seasonal burning and mowing impacts on Sporobolus wrightii grasslands. Journal of Range Management 41(1): 12-15.

Cox, J.R., G.B. Ruyle, and B.A. Roundy. 1990. Lehmann lovegrass in southeastern Arizona: Biomass production and disappearance. Journal of Range Management 43(4): 367-372.

Cushing, C.E., Jr., and P.A. Olson. 1963. Effects of weed burning on stream conditions. Transactions of the American Fisheries Society 92: 303-305.

D'Antonio, C.M., and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.

Danzer, S.R. 1998. Impact of fire and land-use history on stand dynamics in the Huachuca Mountains of southeastern Arizona. Tucson, Arizona, The University of Arizona. Masters Thesis.109 pp.

Daubenmire, R. 1968. Ecology of fire in grasslands. Advances in Ecological Restoration 5: 209-266.

Dieterich, J.H. 1983. Fire history of southwestern mixed conifer: a case study. Forest Ecology and Management 6: 13-31.

Dwire, K.A. and J.B. Kauffman 2003. Fire and riparian ecosystems in landscapes of the western USA. Forest Ecology and Management 178: 61-74.

Endangered Species Act of 1973, U.S. Code 16 (2000), SS1531 et. seq.

Federal Register. 2002. Part III, Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Listing the Gila Chub as Endangered With Critical Habitat; Proposed Rule. Volume 67, Number 154. Friday, August 9, 2002.

Federal Register. 2004. Part III, Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for the Mexican Spotted Owl; Final Rule. Volume 69, Number 168. Tuesday, August 31, 2004.

Felger, R.S., M.B. Johnson, M.F. Wilson. 2001. The trees of Sonora, Mexico. Oxford University Press, New York.

Franzreb, K. F., and S. A. Laymon. 1993. A reassessment of the taxonomic status of the Yellow-billed Cuckoo. Western Birds 24:17-18.

Gaikowsky, M.P., S.J. Hamilton, K.J. Buhl, S.F. McDonald, and C. Summers. 1996. Acute toxicity of firefighting chemical formulations to four life stages of fathead minnow. Ecotoxicity and Environmental Safety. 34:2131-2137.

General Ecosystem Survey. 1991. USDA Forest Service, Southwestern Region.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-550.

Greswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

Griffiths, D. A. 1910. Range improvement in Arizona. U. S. Department of Agriculture Bureau of Plant Industry Bulletin 177.

Grissino-Mayer, H.D. 1993. An updatd list of species used in tree-ring research. Tree-Ring Bulletin 53:17-43.

Guertin, P. and W.L. Halvorson. 2003. Status of Fifty Introduced Plants in Southern Arizona Parks. USGS Sonoran Desert Research Station, School of Natural Resources, University of Arizona, Tucson.

Hastings, J.R., and R.M. Turner. 1965. The Changing Mile: An Ecological Study of Vegetation Change with Time in the Lower Mile of an Arid and Semiarid Region. Tucson, AZ. University of Arizona Press.

Hubbard Report. 2001. Developing an interagency landscape-scale fire planning analysis and budget tool. Report to the National Fire Plan Coordinators, USDA Forest Service and US Department of Interior. 41 pp.

Humphrey, R.R. 1958. The Desert Grassland: A history of vegetational change and an analysis of causes. Botanical Review 24:193-252.

Humphrey, R.R. 1962. Range Ecology. Ronald Press, New York.

Invasive Alien Plants Species of Virginia. 1999. Johnson grass (*Sorghum halepense* (L.) Persoon). Department of Conservation and Recreation and the Virginia Native Plant Society. Website: http://www.dcr.state.va.us/dnh/invlist.htm then click on species name.

Johnson, R.R. and D.A. Jones, eds. 1977. Importance, preservation and management of riparian habitat. GTR-RM-43. Fort Collins, CO. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 217 pp.

Johnson, R.R., C.D. Ziebel, D.R. Patton, P.F. Ffolliott, and R.H. Hamre, tech. cords. 1985. Riparian ecosystems and their management: reconciling conflicting uses. GTR-RM-120. Fort Collins, CO. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 523 pp.

Jofre, M.B. and W.H. Karasov. 1999. Direct effects of ammonia on three species of North American anuran amphibians. Environmental Toxicology and Chemistry. 18:1806-1812.

Kaib, J.M., C.H. Baisan, H.D. Grissino-Mayer, and T.W. Swetnam. 1996. Fire history in the gallery pine-oak forests and adjacent grasslands of the Chiricahua Mountains of Arizona. In: Ffolliott and others, tech. coords. Proceedings of the Symposium on Effects of Fire on Madrean Province Ecosystems, March 11-4, 1996, Tucson, AZ. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO: Gen. Tech. Rpt. RM-GTR-289. 253-264 pp.

Kaib, J.M. 1998. Fire history in riparian canyon pine-oak forests and the intervening desert grasslands of the southwest borderlands: A dendroecological, historical, and cultural inquiry. Tucson, AZ. The University of Arizona, Masters Thesis. 234 pp.

Kerby. J.L. and L.B. Kats. 1998. Modified interactions between salamander life stages caused by wildfire-induced sedimentation. Ecology, 79(2), 740-745 pp.

Laing, L.E., D. Gori, and J.T. Jones. 2005. The development of landscape-scale ecological units and their application to the greater Huachuca Mountains fire planning process. In: Biodiversity and Management of the Madrean Archipelago II and 5th Conference on Research and Resource Management in the Southwestern Deserts. May 11 – 15, 2004, Tucson, AZ.

Leopold, A. 1924. Grass, Brush, and Timber Fire in Southern Arizona. Journal of Forestry 22(6):1-10.

Little, E.E. and R.D. Calfee. 2000. The effects of UVB radiation on the toxicity of fire-fighting chemicals. U.S. Geological Survey, Columbia Environmental Research Center, Columbia Missouri. Final Report, 71 pp.

Lytle, D.A. 2000. Biotic and abiotic effects of flash flooding in a montane desert stream. Archive fur Hydrobiologia. 150:85-100.

Martin, S.C. 1983. Responses of semi-desert grasses and shrubs to fall burning. Journal of Range Management 36:604-610.

McClaran, M.P., and M.E. Anable. 1992. Spread of introduced Lehmann lovegrass along a grazing intensity gradient. Journal of Applied Ecology 29:92-98.

McClaran, M.P., and P.C. Sundt. 1992. Population dynamics of rare orchid *Spiranthes delitescens.* Southwestern Naturalist 37:299-333.

McPherson, G.R. 1992. Ecology of oak woodlands in Arizona. In: P.F. Ffolliott, G.J. Gottfried, D.A. Bennett, C. Hernandez, V. Manuel, A. Ortega-Rubio, and R.H. Hamre, tech. cords. Ecology and management of oak and associated woodlands: perspectives in the southwestern United States and northern Mexico. 1992, April 27 – 30. Sierra Vista, AZ, GTR-RM-218. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 24-33 pp.

McPherson, G.R. 1995. The role of fire in desert grasslands. In: M. P. McClaran, and T. R Van Devender (eds.), The Desert Grassland. University of Arizona Press, Tucson. 130 – 151 pp.

McPherson, G.R. 1997. Ecology and Management of North American Savannas. University of Arizona Press, Tucson, AZ.

McPherson, G.R., and J.F. Weltzin. 1997. Disturbance and climate change in U.S./Mexico borderland communities: a state-of-the-knowledge review. USDA Forest Service General Technical Report RM-GTR-50. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 24 pp.

McPherson, G.R. 2004. Linking science and management to mitigate impacts of non-native plants. Weed Technology 18:1185-1188.

McWhorter, C.G. 1981. Johnson grass as a weed. USDA Farmers Bulletin 1537:3-19.

Miller, J.D., and S. Yool 2002. Modeling fire in semi-desert grassland/oak woodland: the spatial implications. Ecological Modeling 153 (3): 229-245.

Miller, J.D., S.R. Danzer, J.M. Watts, S. Stone, and S.R. Yool. 2003. Cluster analysis of structural stage classes to map wildland fuels in a Madrean ecosystem. Journal of Environmental Management, 68: 239-252.

Minshall, G.W. 1984. Aquatic insect-substratum relationships. The Ecology of Aquatic Insects. V.H. Resh and D.M. Rosenberg (editors). Praeger Publishers, New York. 358-400 pp.

Minshall, G.W., J.T. Brock, and J.D. Varley. 1989. Wildfires and Yellowstone's stream ecosystems. BioScience 39:707-715.

Minshall, G.W., C.T. Robinson, and D.E. Lawrence. 1997. Postfire responses of lotic ecosystems in Yellowstone National Park. U.S.A. Canadian Journal of Fisheries and Aquatic Sciences. 54:2509-2525.

Moir, W.H. 1982. A fire history of the high Chisos, Big Bend National Park, Texas. Southwestern Naturalist. 27(1): 87-98.

Molles, M.C. Jr. 1985. Recovery of a stream invertebrate community from a flash flood in Tesque Creek, New Mexico. The Southwestern Naturalist. 30:279-287.

Morino, K.A. 1996. Reconstruction and Interpretation of Historical Patterns of Fire Occurrence in the Organ Mountains, New Mexico. Masters Thesis, The University of Arizona, Tucson. 140 pp.

Morino, K. 1999. Fire regime assessment for Coronado National Memorial, Arizona. Final Report, Cooperative Agreement #CA8000-2-9001.

National Park Service. U.S. Department of the Interior. 2000. *Bird Sightings at Coronado National Memorial.* Accessed on the Internet in July 2002 at <www.nps.gov/coro/birdcolr.htm>.

National Park Service. U.S. Department of the Interior. 2003. Proposed Vehicle Barrier Environmental Assessment. Organ Pipe National Monument and Coronado National Memorial. 144 pp.

National Resource Conservation Service, USDA. 2005. Electronic Directives System: General Manual. Title 190: Part 414.3 Definitions.

Newman, D. 1993. The Nature Conservancy Element Stewardship Abstract for *Sorghum halepense*. The Nature Conservancy. 1815 North Lynn St., Arlington, Virginia. Website: http://tncweeds.ucdavis.edu/esadocs/documnts/sorghal.html

Noss, R., M. Scott, and E.T. LaRoe. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. Biological Report 28, National Biological Service, Washington, DC, 58 pp.

Odum, E.P., S.E. Pomeroy, J.C. Dickson III, and K. Hutcheson. 1974. The effects of late winter litter burn on the composition, productivity and diversity of a 4-year old fallow-field in Georgia. *In*: Proceedings, annual Tall Timbers Fire Ecology Conference, March 22-23, 1973, Tallahassee, Florida, No. 113, Tallahassee, Florida. Tall Timbers Research Station. 399-419 pp.

Ohmart, R. D. 1994. The effects of human-induced changes on the avifauna of western riparian habitats. *Studies in Avian Biology* **15:** 273-285.

Pearsons, T.N., H.W. Li, and G.A. Lamberti. 1992. Influence of habitat complexity on resistence to flooding and resilience of stream fish assemblages. Transactions of the American Fisheries Society. 121:427-436.

Petryszyn, Y. 2005. Personal communication. “Concerning Leptonycteris curasoae (Lesser long-nosed bat)--almost all populations have been increasing. This includes sites in Organ Pipe Cactus Nat. Monument, Cabeza Prieta Wildlife Refuge, the Pinacates, Huachucas, Coronado National Monument, Patagonia Mountains, etc. Other sites continue to contain numbers at the same level that were originally documented. Also several new sites have been discovered recently that contain L. long-nosed bats by the 1,000's. Overall this species is doing quite well.”

Reeves, G.H., L.E. Benda, K.M. Burnett, P.A. Bisson, and J.R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. In: Nielsen, J. (Ed.), Evolution and the Aquatic Ecosystem, Proceedings of the 17th Symposium of the American Fisheries Society, Bethesda, MD. 334-349 pp.

Richardson, M.L., S.D. Clemmons, and J.C. Walker. 1979. Soil Survey of Santa Cruz and Parts of Cochise and Pima Counties, Arizona. USDA Soil Conservation Service and Forest Service.

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.

Robinett, D. 1992. Lehmann lovegrass and drought in Southern Arizona. Rangelands 14(2): 100-103.

Roy, A.H., A.D. Rosemond, D.S. Leigh, M.J. Paul, and J.B. Wallace. 2003. Habitat-specific responses of stream insects to land cover disturbance: biological consequences and monitoring implications. Journal of the North American Bethological Society. 22:292-307.

Ruyle, G.B., B.A. Roundy, and J.R. Cox. 1988. Effects of burning on germinability of Lehmann lovegrass. Journal of Range Management 41(5): 404-406.

Schlesinger, W.H., J.F. Reynolds, G.L. Cunningham, L.F. Huenneke, W.M. Jarrell, R.A. Virginia, and W.G. Witford. 1990. Biological feedbacks in global desertification. Science 247: 1043-1048.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J.Hann, and D.L. Bunnell. 2002. Historical fire regime patterns in the southwestern United States since AD 1700. In: Allen, C.D., ed. Proceedings of the Second La Mesa Fire Symposium 29-30 March 1994, Los Alamos, New Mexico. General Technical Report RM-GTR-286. USDA Forest Service, Rocky Mountain Research Station: 11-32.

Snyder, S.A. 1992. *Sorghum halepense*. In: USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. 2003. Fire Effects Information System. Website: http://www.fs.fed.us/database/feis/plants/graminoid/sorhal/all.html

Spencer, C.N. and F.R. Hauer. 1991. Phosphorus and nitrogen dynamics in streams during a wildfire. Journal of the North American Benthological Society. 10:24-30.

Stromberg, J., and E. Ortiz-Zuazaga. 1998. Fire effects on riparian communities of the San Pedro Basin and associated species of concern. Final Report, The Nature Conservancy, Contract No. 1030528825. Arizona State University, Tempe, AZ. 42 pp.

Swanston, D.N. 1991. Natural processes. Page 139-179 in Influences of forest and rangeland management on salmonid fishes and their habitats. W.R. Meehan (editor) American Fisheries Society, Special Publication 19. Bethesda, Maryland.

Swetnam, T.W., C.H. Baisan, A.C. Caprio, and P.M. Brown. 1989. Fire history of Rhyolite Canyon Chiricahua National Park. USDI National Park Service, Cooperative National Park Resources Studies Unit Technical Report No. 32. University of Arizona, Tucson, AZ.

Swetnam, T.W. and C.H. Baisan. 1996. Fire histories of montane forests in the Madrean Borderlands. In: Ffolliott and others, tech. coords. Proceedings of the Symposium on Effects of Fire on Madrean Province Ecosystems, March 11-4, 1996, Tucson, AZ. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO: Gen. Tech. Rpt. RM-GTR-289. 15-36 pp.

Swetnam, T.W., C.D. Allen, and J.L. Betancourt. 1999. Applied historical ecology: using the past to manage for the future. Ecological Applications. 9:1189-1206.

Sidner, R. 2005. Fifteen years of monitoring the endangered lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*) and other bat species on the Fort Huachuca Military Installation, Cochise County, Arizona. June – November 2004. EEC Project Report to the Commander U.S. Army Garrison Fort Huachuca, Arizona. 104 pp.

Tratz, W. M. and R.J. Vogl. 1977. Postfire vegetational recovery, productivity, and herbivore utilization of a chaparral-desert ecotone. In: Mooney, Harold A.; Conrad, C. Eugene, technical coordinators. Proceedings of the symposium on the environmental consequences of fire & fuel management in Mediterranean ecosystems; 1977 August 1-5; Palo Alto, CA. GTR WO-3. Washington, DC: USDA Forest Service: 426-430 pp.

Uchytil, R.J. 1992. *Eragrostis lehmanniana*. In: Fischer, W.C., Compiler. The Fire Effects Information System [Data base]. USDA Forest Service, Intermountain Research Station, Intermountain Fire Sciences Laboratory, Missoula, MT. Magnetic tape reels; 9 track; 1600 bpi, ASCII with Common LISP present. Website: http://www.fs.fed.us/database/feis/plants/graminoid/eraleh/

USDA Forest Service. 1991. General ecosystem survey. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region, 4th printing, variable pagination.

USDA Forest Service. 2005. Forest Service Manual 5108. *Interagency Standards for Fire and Fire Aviation Operations 2005* (or updates).

USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

U.S.-Mexico Borderlands Wildland Fire Agreement. 1999. Wildfire protection agreement between the Department of the Interior and the Department of Agriculture of the United States of America and the Secretariat of Environment, Natural Resources, and Fisheries of the United Mexican States for the common border. June 6, 1999. http://www.cerc.usgs.gov/fcc/wildfire_protection_agreement.htm

USDA/USDI. 2005. Wildland Fire Use Implementation Procedures Reference Guide. 71 pp.

USDI, Bureau of Land Management. 1994, revised 1998. Riparian Area Management: Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas. Technical Reference 1737-11. Denver, CO.

U.S. Fish and Wildlife Service. 1992. Handbook of Arizona's Endangered Threatened, and Candidate Plants. Arizona Ecological Services Field Office, Phoenix, Arizona.

U.S. Fish and Wildlife Service. 1995. Recovery plan for the Mexican spotted owl: Vol. I. Albuquerque, New Mexico. 172 pp.

U.S. Fish and Wildlife Service. 2002-a. Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*) recovery plan. U.S. Fish and Wildlife Service, Phoenix, Arizona. iv + 67 p.

U.S. Fish and Wildlife Service. 2002-b. Southwestern willow flycatcher final recovery plan. Albuquerque, New Mexico. i-ix + 210 p., Appendices A-O.

U.S. Fish and Wildlife Service. 2004-a. Final biological opinion on the effects to Gila trout and Chiricahua leopard frog from the Meown wildfire suppression activities, wilderness ranger district, Grant County, New Mexico. New Mexico Ecological Services Field Office. 33 pp.

U.S. Fish and Wildlife Service. 2004-b. Species assessment and listing priority assignment form. Lemmon fleabane (*Erigeron lemmonii*). Arizona Ecological Services Field Office. 6 pp.

U.S. Geological Survey. 2000. The effects of UVB radiation on the toxicity of fire-fighting chemicals. U.S. Geological Survey, Columbia Environmental Research Center. Columbia, Missouri. 43 pp.

Van Devender, T.R., R.S. Felger, and A. Burquez M. 1997. Exotic plants in the Sonoran Desert region, Arizona and Sonora. 1997 Symposium Proceedings, California Exotic Pest Plant Council. Website: http://www.caleppc.org/symposia/97symposium/VanDevender.PDF

Westoby, M.B., Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. Journal of Range Management 42: 266-274.

Wiederholm, T. 1984. Responses of aquatic insects to environmental pollution. The Ecology of Aquatic Insects. V.H. Resh and D.M. Rosenberg (editors). Praeger Publishers, New York. 508-557 pp.

Wildlands Project. 2005. Sky Islands Conservation Programs website. Accessed: May 24, 2005. http://www.twp.org/cms/page1111.cfm

Willey, D.W. 1998. Effects of fire on Mexican spotted owls (*strix occidentalis lucida*) at Saguaro National Park. USGS Forest and Range Ecosystem Science Center. Colorado Plateau Field Station. Heritage Project No. I96029. 32 pp.

Williams, D.G., and Z. Baruch. 2000. African grass invasion in the Americas: ecosystem consequences and the role of ecophysiology. Biological Invasions 2(2):123 – 140.

Wood, T. 1989. Preserve Manager, Mile Hi/Ramsey Canyon Preserve, Arizona. Telephone conversation with D. Newman (1993) on November 14, 1989.

Wooten, E.O. 1916. Carrying capacity of grazing ranges in southern Arizona. USDA Bulletin No. 367. Washington, D.C.: GPO.

Wright, H.A. 1980. The role and use of fire in the semidesert grass-shrub type. USDA Forest Service GTR-INT-85. Ogden, UT: Intermountain Forest and Range Experiment Station.

Wright, H.A. and A.W. Bailey. 1982. Fire Ecology: United States and Southern Canada. John Wiley and Sons, Inc. 501 pp.

Wright, H.A. 1986. Effect of fire on arid and semi-arid ecosystems – North American continent. In: Rangelands! A resource under siege. Proceedings, 2nd international rangeland congress. Cambridge University Press: 575-576 pp.

Appendices

Appendix A: Partner profiles

Arizona State Land Department

Agency Mission (relative to fire):
To manage State Trust lands and resources to enhance value and optimize economic return for the Trust beneficiaries, consistent with sound stewardship, conservation, and business management principles supporting socioeconomic goals for citizens here today and generations to come. To manage and provide support for resource conservation programs for the well-being of the public and the State's natural environment.

The Forestry Division provides for the prevention and suppression of wildfires on state and private lands, located outside incorporated municipalities, through the use of cooperative agreements with local fire departments, other state and Federal agencies and persons organized to prevent and suppress wildfires.

Description of area managed (e.g., location, area managed, uses):
There are 6,400 acres of state land in the Huachuca Area Fire Partners planning area. These parcels of land lie mostly north and west of Fort Huachuca, northeast and northwest corners of the Audubon Research Ranch, and directly north of San Rafael Ranch. State lands are used primarily for grazing, but some commercial leases and right-of-ways exist.

Fire management goal and objectives:
"Future Goals" from Division Highlights (Annual Report Fiscal Year 2002-2003)

- Assist private landowners in the WUI to reduce the risk of loss from wildfire. Educate and encourage rural residents to protect their property from wildfire. Help prepare local fire departments and develop local zoning and fire codes.
- Mitigate potential losses due to wildland fired in the WUI. Implement fuel hazard programs on State and private lands in the WUI. Reduce the accumulation of natural vegetation and fuels around homes and subdivisions in the interface in a cooperative effort with our Federal partners.
- Provide eight to ten excess Federal wildland fire trucks to cooperating fire departments each year.
- Train firefighters from cooperating local rural fire departments in wildland fire suppression strategies and tactics through cooperative programs with the State Fire Marshal's Office, other State and Federal agencies, and in-house courses.
- Encourage and assist with developing an interagency dispatching system that will make more efficient use of fire suppression resources.
- Provide assistance to the Department of Emergency and Military Affairs and other State and Federal agencies to prevent and suppress wildfires and manage other non-fire emergencies.

- Provide prompt cost repayment of expenses incurred for the suppression of wildfires on State-protected lands to cooperating agencies and persons.

Overview of current fire management plan:
Currently, there is no fire management plan for the Forestry Division of the State Lands Department.

Contact: Brian Lauber
brianlauber@az.statefire.org
(520) 628-6015

Arizona State Parks
San Rafael Ranch State Park

Agency Mission (relative to fire):
Partnerships Division – Committees Mission Statement: Managing and conserving Arizona's natural, cultural and recreational resources for the benefit of the people both in our parks and through our partners. There is no mission statement that pertains to fire directly.

Description of area managed (e.g., location, area managed, uses):
San Rafael Ranch State Park contains 3,550 acres of short grass prairie in Patagonia, Arizona. The southern boundary of the park is the U.S.-Mexico border between the Patagonia and Huachuca Mountains. The park was purchased for unique landscape and riparian habitat of the Santa Cruz River and historic structures. It is not open to the public while the structures are being restored. Baseline studies for flora and fauna in the park have been initiated.

Fire management goal and objectives:
The ultimate goal of all fire activity in the park is suppression.

Overview of current fire management plan:
There is no written FMP for the park. However, all staff are trained to handle initial attack until the fire is handed over the State Lands Department or a neighboring fire department. If the fire is naturally ignited and does not threaten the historic structures, it will not be aggressively suppressed.

Contact: Lee Eseman
leseman@pr.state.az.us
(520) 394-2447

Babocomari Ranch

Agency Mission (relative to fire):
To allow fire to return to its natural role in the ecosystem and return the vegetative communities to a more natural grassland state.

Description of area managed (e.g., location, area managed, uses):

The ranch lies on 30,000 acres of deeded land that runs along the Babocomari drainage. The area runs south of Sonoita to Highway 90 in a narrow band that is only 2 1/2 miles wide. The ranch is used primarily for grazing 1200 to 1800 yearling cattle per year.

Fire management goal and objectives:
The overall goal of fire activities on the ranch is to return fire to its natural interval on the landscape and reduce fuel loads and woody encroachment.

Overview of current fire management plan:
There is no written fire management plan for the Babocomari Ranch. However, the focus of fire management activities has two parts:

- Long-term plan has been to burn each sacaton bottom approximately every 5 years
- In the last 4 years, burning in the uplands every 8 to 10 years to stem woody encroachment, has begun. This is followed with an application of herbicide.

Fire activities on the ranch are primarily completed by local fire departments who use the opportunity for training. The USFS, BLM, State Land Department, and other neighboring fire departments are used as deemed necessary or as they are available.

Contact: Doug Ruppel (Manager)
ruppel@dakotacom.net
520-455-5507

Bureau of Land Management
San Pedro Riparian National Conservation Area and other BLM lands

Agency Mission (relative to fire):
The mission of the Arizona BLM Fire and Aviation management program is to provide a better understanding of wildland fire management as well as the aviation management program. The number one priority is public and firefighter safety.

Description of area managed (e.g., location, area managed, uses):
There is approximately 54,800 acres of BLM land within the Huachuca Area Fire Partners planning area. Of that, approximately 50,400 acres are in the San Pedro Riparian NCA. The San Pedro Riparian NCA is located in Cochise County, Arizona, between the international border (United States and Mexico) and St. David, Arizona. It is used for dispersed recreation opportunities including birdwatching, wildlife viewing, photography, hiking, camping, seasonal hunting, horseback riding, nature study, and environmental education

Fire management goal and objectives:
The goal of suppression is to keep wildland fires from spreading onto adjacent lands. The prescribed fire management objectives for each vegetative community include:

- Riparian: Maintain canopy cover and structural diversity of cottonwood and willow galleries; reduce the number of flood debris piles concentrated directly against cottonwood trees; reduce the fuel loading in and adjacent to the riparian areas; promote regeneration of

cottonwood and willow trees; reduce the number, intensity and size of wildfires in the cottonwood and willow galleries; create mosaic burn patterns.

- Grasslands: Increase cover and density of native perennial grasses; reduce annual weed cover and density; reduce canopy cover of shrub species; reduce fuel loads; improve wildlife habitat; reduce exotic species; create mosaic burn patterns.
- Cienegas: Maintain or increase reed and sedge cover; reduce exotic, invasive weed cover and density; create open areas for wildlife access to water; improve wildlife habitat; maintain canopy cover of trees around the margins of the cienegas; create mosaic burn patterns.
- Uplands: Increase density of perennial native grass species; reduce exotic, invasive weed cover; reduce frequency of shrub species; improve wildlife habitat; maintain scattered canopy of desert tree species; create mosaic burn patterns.

Overview of current fire management plan:
The current FMP for the San Pedro Riparian NCA was written in 2004. BLM will suppress natural or human-caused wildland fires by first addressing the safety concerns of firefighters and the public and then addressing resource concerns, considering both ecological and administrative issues. Private lands and structures located adjacent to the San Pedro Riparian NCA require protection from wildfire. The priority AMR is to prevent wildfires from spreading to private land. Prescribed fore will be used for resource benefit based on vegetative community type that is intended to benefit its particular fuel type. Non-fire treatments will be used to reduce hazardous fuel loads, invasive or woody species cover, increase herbaceous cover, improve ingress/egress routes, improve water infiltration, and reduce soil erosion.

Contact: Mark Fredlake
Mark_Fredlake@blm.gov
(520) 439-6405

David Peters
David_Peters@blm.gov
(520) 258-7207

National Audubon Society
Appleton-Whittell Research Ranch

Agency Mission in regard to fire and/or in general:
Audubon's mission is to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity. There is no mission statement that pertains to fire directly.

Description of area managed (e.g., location, area managed, uses):
8,000 acres located 6 miles from Elgin, Arizona. The land is used as a sanctuary for native plants and animals and research on semi-arid grasslands and related ecosystems.

Fire management goal and objectives:

Main goal is to return the area to a natural fire return interval using naturally occurring fires in addition to prescribed burning.

Prescribed fire goals on ARR include:

- Maintain fire adapted natural communities by assuring an historic frequency of prescribed fires that mimics the historic natural wildfires, which occurred prior to Anglo settlement.
- Reduce the potential for accidental or arson wildfires during the driest time of year when the fire might burn hotter than desired and would be hardest to contain.
- Prevent loss of buildings, vehicles, and infrastructure.
- Prevent fire spreading into cottonwood and willow riparian areas.
- Create a patchy post-fire mosaic within burn units as well as between burn units. A vegetative mosaic can be maintained by varying intensity, frequency, and season of burn within each fire. This should minimize wildlife losses to fire, and should stimulate the native grasses and forbs, on which our wildlife depends.
- Reduce the fuel load in risky areas (bordering houses or riparian areas).
- Inflict minimum disruption to the land surface during the fire management operation. Vehicles should remain on designated roads wherever possible to minimize unnecessary habitat damage.

Overview of current fire management plan:
There is no current fire management plan for the Research Ranch, however, in 1999, the director of the Research Ranch and representatives from the BLM documented burn units and a schedule of prescribed fire. That burn plan emphasizes returning fire to its natural return interval of 7 to 15 years using prescribed fires and naturally ignited fires (lightning). The intent is to burn 1,000 acres annually, however, because the Ryan Fire of 2002 burned 7,200 acres of the ranch, prescribed burns have been put on hold.

Contact: Bill Branan
grassland@theriver.com
(520) 455-5522

Linda Kennedy
lkennedy@audubon.org
(520) 455-5522

National Park Service
Coronado National Memorial

Agency Mission (relative to fire):
"...to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." (National Park Service Organic Act, 16 U.S.C.1.)

[NPS] wildland fire management activities are essential to the protection of human life, personal property and irreplaceable natural and cultural resources, and to the accomplishment of the NPS mission. (NPS Director's Orders #18 — Wildland Fire Management)

Description of area managed (e.g., location, area managed, uses):
The memorial includes 4,750 acres in Hereford, Arizona whose southern boundary is the U.S.-Mexico border. Used for recreational, educational, and research opportunities.

Fire management goal and objectives:
The goal of the fire management program is to effectively manage wildland fire and provide for the protection of life, property, and cultural resources, while ensuring the perpetuation of memorial ecosystems and natural resources. Objectives include:

- Provide public, employee, and firefighter safety.
- Control all wildland fires using the appropriate management response (AMR) considering the protection of natural and cultural resources and reasonable costs.
- Maintain fire management agreements with adjacent land management agencies, Greater Huachuca Fire Management Group (discussed below), and local fire departments.
- Implement a program to use prescribed burning and hazard fuels reduction to restore natural fuel loadings.
- Utilize research and monitoring to improve our understanding of the role of fire in the memorial's vegetative communities

Overview of current fire management plan:
A new FMP for the memorial was completed in 2005. A wildland fire suppression strategy will be utilized in all areas of the memorial. However, some wildland fires (human and lightning caused) will be suppressed using less aggressive suppression strategies (appropriate management response) when suitable. Natural barriers will be used in suppression and will help reduce costs and exposure of firefighters to risk. Therefore, minimizing acreage burned might not be a primary consideration depending on the location.

Prescribed fire projects for reduction of hazardous fuel conditions will be used in areas that threaten values-to-be-protected, sensitive species, and specific ecosystems. The long-range objective of this program is to reduce wildland fire hazards to levels that enable wildland fires to be managed in as natural a state as possible. Each prescribed fire will have an appropriate monitoring plan.

A mechanical fuel reduction program will be implemented to modify vegetation for fuel and resource management objectives. Thinning and mowing will be utilized on the trees and grasses in and immediately surrounding the headquarters and other developed areas on an annual basis as needed. Pile burning may be used to dispose of fuels removed during mechanical treatments. These activities will be addressed by project-specific analysis and compliance.

Contact: Kym Hall
Kym_Hall@nps.gov
(520) 366-5515 x21

Palominas Firewise Community

Agency Mission (relative to fire):
To develop area-specific solutions to reduce fire risks in the wildland-urban interface.

Description of area managed (e.g., location, area managed, uses):
Seven properties in the wildland-urban interface located between the Hereford Road and U.S./Mexico border in the southern portion of Cochise County, Arizona. This area includes 'areas of Concern' near the San Pedro Riparian Conservation Area as identified by the Bureau of Land Management.

Fire management goal and objectives:
The Board has made a commitment to

- Protect private property from wildfire and related damages. Values to protect include human life, livestock, homes and other structures, vegetation, financial values and insurance rates.
- Preserve the aesthetics and wildlife within the riparian area.
- Partner with the BLM and other public and private entities in managing fire risk in and around the SPRNCA.

Overview of current fire management plan:
The Palominas Firewise Community is involved in various projects. Examples include: building a firebreak at the Highway 92 bridge, installing fire education signs in the community and San Pedro Riparian National Conservation Area, submitting a grant request for a chipper and brush mower, and applying for FirewiseUSA status.

Contact: Gordon Lewis
glewis@theriver.com
(520) 366-5560

U.S. Army
Fort Huachuca

Agency Mission (relative to fire):
The primary mission of the resource management program on the Fort is to protect naturally evolving biotic communities and landscapes in order to support military training that takes place on the land. The Sikes Act requires the Secretary of the Army to manage natural resources of each military reservation for sustained, multiple use.

Description of area managed (e.g., location, area managed, uses):
Fort Huachuca, located in Sierra Vista, encompasses approximately 81,000 acres including the housing areas. Its primary use is as a military training facility.

Fire management goal and objectives:

- Protect life as the highest priority. Provide for the safety of army personnel, dependents, employees, visitors, and fire staff. Maintain a qualified and properly trained fire staff. Reduce fuels that threaten high-use areas.

- Protect post and personal property. Reduce fuels that threaten high-value areas. Coordinate structural and wildland fire operations.
- Manage fire to minimize conflict with military training. Schedule planned fire operations around training exercises. Conduct suppression activities to minimize adverse effects on training areas.
- Manage fire to benefit natural resources. Allow fire to be a dynamic ecosystem process. Use fire to improve habitat of Federally listed and other sensitive species. Minimize adverse effects of fire and suppression activities on natural resources.
- Manage fire to benefit cultural resources. Minimize adverse effects of fire and suppression activities on archaeological sites, historic structures, ethnographic resources, and cultural landscapes. Use prescribed fire to reduce fuels around sensitive resources and maintain landscapes. Take advantage of surveying opportunities during and after fire operations.
- Coordinate fire operations with other post divisions and neighboring land owners. Bring together structural and wildland fire planning operations. Maintain communication and educate the neighbors about the fire program. maintain formal agreements and conduct joint fire management activities with neighbors.

Overview of current fire management plan:
The current fire plan was written in 1997. Work is being done on a new FMP that should be completed in 2005. Four strategies play important roles in wildland fire management at Fort Huachuca. Wildland fire suppression is applied via appropriate management response around high-use, developed, and training areas and certain sensitive resources needing protection. Prescribed fire is used to reduce fuels in high-risk areas and accomplish ecological goals. Wildland fire use allows natural ignitions to burn when they meet predetermined prescriptions related to safety and ecological goals. Non-fire applications-most notably thinning and herbicides-are treatments that are used instead of prescribed burning in areas where fire is inherently unsafe or undesirable given current fuels conditions.

Contact: Frank Hammond
frank.hammond@us.army.mil
(520) 533-5701

Jim Hessil
james.hessil@us.army.mil
(520) 533-7084

San Rafael Ranch

Agency Mission (relative to fire):
This land is privately owned and does not have a mission statement relating to fire.

Description of area managed (e.g., location, area managed, uses):
The ranch includes 18,500 acres that have been mainly used for farming and grazing over the last 180 years.

Fire management goal and objectives:

Ross Humphreys, the manager and owner of the ranch, has no fire management goals for San Rafael Ranch.

Overview of current fire management plan:
There is no written fire management plan for the ranch.

Contact: Ross Humphreys (Owner)
rossh@rionuevo.com
(520) 623-9558

The Nature Conservancy
Ramsey Canyon and Canelo Hills preserves

Agency Mission (relative to fire):
The mission of The Nature Conservancy is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

Description of area managed (e.g., location, area managed, uses):
The 380-acre Ramsey Canyon Preserve is open to the public all year round and is used for hiking, wildlife viewing, birdwatching, and educational outreach. Staff and volunteers also participate in many stewardship projects such as vegetation restoration and mechanical thinning. Canelo Hills Preserve is not open to the public, but some stewardship projects such as native fish population monitoring and trail maintenance takes place.

Fire management goal and objectives:
The 1998 Ramsey Canyon FMP states that the main goal of fire management is to reduce fuel loads to protect high value resource areas and return the area to a natural disturbance regime. Objectives include:

- Work cooperatively with the USFS, Fry Fire Department, and neighbors to improve safety.
- Reduce the need for high impact fire suppression measures that may negatively affect the ecological resources.
- Increase the level of preparedness.
- Carry out mitigation activities to protect the riparian area and facilities.
- Determine desired condition for each plant community.
- Meet air, water, and other environmental standards when carrying out any management activity.

Overview of current fire management plan:
There is no current written plan for the Canelo Hills Preserve. The 1998 Ramsey Canyon Preserve FMP states that the fire management strategy for the pr eserve is to work cooperatively with the USFS, the Fry Fire Department, and adjacent private landowners to develop and implement a coordinated fire management program for the entire Ramsey Canyon watershed by interrupting the fuel continuity between the wildland-urban interface and the wildland through the use of fuelbreaks. The purpose is to provide a location to stop a fire from spreading into the

wildland-urban interface and threatening lives and property. Projects will focus on reducing risks within the riparian area and increasing the public's awareness about fire's role in the ecosystem.

Contact: Brooke Gebow (Manager)
bgebow@tnc.org
520-803-7953

USDA Forest Service
Coronado National Forest, Sierra Vista Ranger District

Agency Mission (relative to fire):
- Reduce the costs, resource damage, and threats to public and firefighter safety from future wildland fires.
- Manage naturally occurring fires to restore and sustain ecological processes in fire-dependent ecosystems.
- Create and maintain fuel conditions to lower risk of extreme fire behavior and high-intensity wildland fires.

Description of area managed (e.g., location, area managed, uses):
The entire Coronado National Forest consists of 1,746,000 acres, with approximately 254,000 acres in the Huachuca Area Fire Partners planning area. There is an additional 23,000 acres containing private inholdings. The land in this district is used for grazing and recreation primarily, but also for fire program activities, endangered species monitoring, and some mining.

Fire management goal and objectives:
- Achieve a program that makes firefighter and public safety the highest priority in *every* fire management activity.
- Wherever appropriate, use Wildland fire and prescribed fire as a tool to meet resource management objectives.
- Consider landscape-scale application of prescribed fire in all appropriate management areas.
- Consider mechanical fuels treatments where wildland fire use or prescribed fire may cause unacceptable damage to other resources or pose an unacceptable risk to private property.
- Enhance hazardous fuel reduction programs with emphasis on wildland-urban interface areas and high resource value areas.
- Hazardous fuels reduction activities within wildland-urban interface areas should have priority when there are differing resource objectives.
- Where opportunities exist, implement cooperative fuels treatment ventures with private, state, and other Federal land management agencies.
- Nurture, sponsor, and develop an overarching fire management plan for southeastern Arizona.
- Retain and recruit experienced and knowledgeable staff to accomplish fire management goals.
- Achieve and maintain a quality suppression and fire use workforce to address changing fire management priorities and fire management complexities.

- Revise the Fire Management Plan annually to incorporate proven efficiencies.
- Reduce the costs, resource damage, and threats to public and firefighter safety from future wildfires.
- Manage naturally occurring fires to restore and sustain ecological processes in fire-dependent ecosystems, consistent with other land management goals.
- Create and maintain fuel conditions that are at lower risk of high intensity, catastrophic wildfires.

Overview of current fire management plan:
The current FMP for Coronado National Forest was written in 2004. Appropriate suppression response Forest-wide could range from aggressive initial attack to a defensive posture, such as a confinement strategy. The confinement strategy may be implemented as the initial action during Stage 1—the Initial Fire Assessment—as long as it is *not* used to meet resource objectives. Confinement can also be a strategic selection derived from the Wildland Fire Situation Analysis (WFSA) process, especially when the fire is expected to exceed the initial attack or planned management capability.

The appropriate management response for each wildland fire will include a full spectrum of options to accomplish resource objectives within fire-adapted ecosystems. Fire management will emphasize allowing lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness.

The Coronado will use prescribed fire to support ecological and socio-economic sustainability, and to protect, maintain, and enhance resources. The treatment objective can be hazard reduction or any other resource benefit requiring fuel manipulation. The timing, location, and decision to burn are within the agency's control. National Fire Plan priorities for fuel treatment are within wildland-urban interface, municipal watersheds, and critical species habitat.

Forest Service managers may ignite a prescribed fire in wilderness to reduce unnatural buildups of fuels only if necessary to meet predetermined wilderness fire management objectives (FSM 2324.21) only if all of the following conditions are met:

- The use of prescribed fire or other fuel treatment measures outside of wilderness is not sufficient to achieve fire management objectives within wilderness.
- An interdisciplinary team of resource specialists has evaluated and recommended the proposed use of prescribed fire.
- The interested public has been involved appropriately in the decision.
- Lightning-caused fires cannot be allowed to burn because they will pose serious threats to life or property within wilderness, or to life, property, or natural resources outside of wilderness.

The primary purpose of prescribed fire in wilderness will not be to benefit wildlife, maintain vegetative types, improve forage production, or enhance other resource values. Although these additional effects may result from a decision to use prescribed fire, fire will be used in wilderness only to meet wilderness fire management objectives. Management-ignited fire will not be use to achieve wilderness fire management objectives where lightning-caused fires can achieve them.

Non-fire applications—or fuel treatment methods other than prescribed fire—will be used and consist of mechanical thinning, fuel wood gathering, chipping, and lopping and scattering to achieve specific resource management objectives.

Contact: Bill Crolly
wcrolly@fs.fed.us
(520) 378-0311

Bill Wilcox
wwilcox@fs.fed.us
(520) 378-0311

Appendix B: Summary of ecological mapping units

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
1. *Low gradient alluvial valleys with broad riparian zones*	Riparian; sacaton with some young willow and cottonwood along Santa Cruz; galley cottonwood/willow forest along San Pedro River	Riparian: wet grass (sacaton dominated), sedges and other hydrophytic vegetation more extensive on some reaches; scattered cottonwood and willow	Very deep, finer textured, high organic matter, high water tables – wet soils more extensive historically on many reaches	Beaver, floods, fire	I (0-35 years, < 75% dominant overstory replaced)	Depending on reach, class 1 (within "historical range) or 2 (moderate departure due to invasive species & soil/channel degradation)	Similar to historical vegetation dominated by herbaceous wetland species (cienegas) interspersed with reaches supporting gallery cottonwood-willow forest; to obtain these conditions, watershed is managed to restore and maintain historic vegetation which will improve watershed condition and function; beaver will also play a pivotal role in riparian restoration.
2. *Chihuahuan desert scrub and grassland mosaic on elevated and dissected plains*	Desert scrub/grass	Grass	Very deep, subsurface clay, gravel and cobbles	Fire, herbivory	II (0-35 years, >75% upper layer replaced)	Class 3 (high departure due to extensive soil loss and shrub increase at expense of grasses; also non-natives in some areas)	Desert scrub & grassland mosaic with increased grass/ herbaceous cover in desert scrub and more extensive grassland patches with shrub canopy cover at < 5%. Non-native grasses are reduced or maintained at current levels.

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
3. *Grassland on elevated plains*	Grass	Grass	Very deep, moderate amounts of gravel and cobble, clay accumulation is more pronounced in absence of lime	Fire, herbivory	II (0-35 years, >75% upper layer replaced)	Class 1 in San Rafael Valley; class 2 or 3 in the Sonoita area and east side of Huachuca Mountains depends on extent of invasive species and shrub/tree encroachment	Native grass communities are maintained; non-native grasses are reduced or maintained at current levels
4. *Moderate gradient alluvial valleys with narrow riparian zones*	Riparian forest or scattered trees/oak savanna	Riparian forest/oak savanna – more extensive wet zone on low gradient reaches	Very deep, generally loams and sandy loams with varying amounts of gravel and cobble	Floods, fire, beaver (on lower gradient reaches)	I (0-35 years, <75% dominant overstory replaced)	Depending on reach, class 1 or 2 (due to soil/channel degradation and non-native species)	Riparian forest bordered by oak savanna side-slopes w/ more extensive perennial flow and near-surface groundwater; to obtain these conditions, watershed is managed to restore and maintain historic vegetation which will improve watershed condition and function; beaver will also play a pivotal role in riparian restoration in low gradient reaches.

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
5. *Madrean oak savanna on elevated plains and hills*	Madrean oak woodland/Madrean oak savanna	Madrean oak savanna	Very deep, high gravel and cobble contents, clayey subsoils on mesas and ridge tops	Fire, herbivory	I (0-35 years, <75% dominant overstory vegetation replaced)	Mostly class 3 (high departure due to greater tree and shrub densities and increasing prevalence of fire-intolerant species); class 1 or moving toward class 1 in areas of large fires (Merit and Ryan Fires)	Madrean oak savanna with a canopy cover of 5-12%, composed mostly of oaks, interspersed with areas of higher tree canopy cover (12-30%) in draws.

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
6. *Madrean oak savanna and open woodland on granitic hills*	Madrean oak woodlands	Madrean oak savanna/Madrean oak open woodland (associated with rock outcrops)	Deep, gravelly or very gravelly sandy loams and sandy clay loams dominate, ridges tend to have clayey subsoils; bedrock control with deeper soil pockets	Fire, herbivory	I (0-35 years, <75% dominant overstory vegetation replaced)	Class 3 in areas east of Patagonia Mountains (high departure due to greater tree and shrub densities) and west of Patagonia Mountains due to added influence of uncharacteristic states of non-native grass species	Madrean oak savanna with a canopy cover of 5-12%, composed mostly of oaks, interspersed with areas of higher tree canopy cover (12-30%) in rock outcrop areas.
7. *Madrean oak open woodland and savanna on volcanic hills and low mountains*	Madrean oak woodlands	Madrean oak open woodland/ Madrean oak savanna	Shallow, high cobble and gravel contents, sandy loam texture dominates, weakly developed	Fire, herbivory	I (0-35 years, <75% dominant overstory vegetation replaced)	Class 3 (high departure due to greater tree and shrub densities and increasing prevalence of fire-intolerant species)	Madrean oak open woodland dominated by oak species (10-30% canopy cover) and oak savanna on drier aspects with continuous fine fuels (<10% canopy cover).

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
8. *Madrean oak open woodland on volcanic mountains*	Madrean oak woodland	Madrean oak open woodland	Shallow, high cobble and gravel contents, sandy loam texture dominates, weakly developed, extensive rock outcrops	Fire	I (0-35 years, <75% dominant overstory vegetation replaced); II (0-35 years, > 75% dominant vegetation replaced)	Mostly class 3 (high departure due to greater tree and shrub densities and increasing prevalence of fire-intolerant species)	Madrean oak open woodland dominated by oak species (12-30% canopy cover).
9. *Madrean chaparral and oak savanna on limestone hills and low mountains*	Madrean chaparral/ oak savanna	Madrean chaparral/ oak savanna	Shallow and very shallow, very cobbly loams, weakly developed, rock outcrops	Fire, herbivory	II [0-35 years, >75% dominant overstory (shrub) vegetation replaced]	Class 2 (moderate departure due to greater tree and shrub densities and increasing prevalence of fire-intolerant species) – trend is moderated by extremely limey soils and extensive bare ground	Mosaic of chaparral patches with varying canopy cover (5-25%), reflecting different post-fire successional stages and composed primarily of fire-tolerant and resprouting species. Areas with deeper soils and higher fine fuel loads support oak savanna (5-12% canopy cover).

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
10. ***Madrean oak-pine woodland on limestone mountains***	Madrean oak-pine woodland	Madrean pine-oak woodland	Shallow and very shallow, very cobbly loams, weakly developed, rock outcrops	Fire	I (0-35 years, <75% dominant overstory vegetation replacement)	Class 3 (high departure due to greater tree and shrub densities, increasing prevalence of fire intolerant species, and replacement of understory vegetation by litter and woody debris)	Madrean oak-pine woodland (canopy cover 12-40%) with grass/herbaceous understory; overstory composed primarily of fire tolerant species including resprouting species.
11. ***Madrean pine-oak woodland on granitic hills and low mountains***	Madrean oak-pine woodland	Madrean pine-oak woodland	Moderately deep and deep, gravelly sandy loams	Fire	I (0-35 years, <75% dominant overstory vegetation replaced)	Class 3 (high departure due to greater tree and shrub densities, increasing prevalence of fire intolerant species, and replacement of understory vegetation by litter and woody debris)	Madrean pine-oak woodland (canopy cover 12-40%) with grass/herbaceous understory; overstory composed primarily of fire tolerant species including resprouting species.

Map Unit	Current Vegetation	"Historical" Vegetation	Soils	Dist-urbance Processes	"Historical" fire regime	Fire regime condition class	Desired Future Condition
12. ***Madrean pine and mixed conifer forest on high elevation limestone mountains***	Madrean pine and mixed conifer forest	Madrean pine and mixed conifer forest	Shallow and very shallow, very cobbly loams, weakly developed, rock outcrops	Fire	I (0-35 years, <75% dominant overstory vegetation replaced)	Class 3 (high departure due to greater tree and shrub densities, increasing prevalence of fire intolerant species, and replacement of understory vegetation by litter and woody debris)	Madrean pine and mixed conifer forest (canopy cover 10-40%) with grass/herbaceous understory; overstory composed primarily of fire tolerant species including resprouting species.
13. ***Sensitive streams (line segments)***	Riparian tree species, oaks and conifers	Riparian tree species, oaks and conifers	Variable, but with substantial rock content and, in some reaches, exposed bedrock	Fire, flooding	Largely dictated by dominant fire processes of landscape units (5,10,11 and/or 12) within which they occur	Largely dictated by the existing conditions of landscape units (5,10,11 and/or 12) within which they occur	Largely dictated by desired conditions of landscape units (5,10,11 and/or 12) within the watersheds within which they occur; at any point in time maintain sufficient critical habitat and areas of refuge for T&E species

Appendix C: Incident complexity analysis worksheet- southwest region

This complexity analysis should be used as a guide for Agency Administrators and/or fire managers to identify and mitigate certain complexity or safety issues by selecting a different strategy, tactic, or higher qualification of incident management personnel to safely and effectively manage the incident.

The complexity analysis should be reviewed periodically to determine the level of management required. Discussion with Incident Commanders, Fire Managers, and Agency Administrators is critical to completion of worksheet.

Safety	YES	NO
Exposure of personnel to unusually hazardous conditions	____	___
Accidents have occurred	____	___
Multiple aircraft are involved or anticipated	____	___
Potential for public evacuations	____	___
Terrain adversely affects tactical capability / limits safety zones	____	___
Fire fighter performance affected by cumulative fatigue	____	___
External / Political Factors		
Potential for numerous damage claims	____	___
More than one jurisdiction involved	____	___
Fire policy is controversial	____	___
Sensitive public/media relationships	____	___
Lack of cohesive organizational structure	____	___
Resource Issues		
Structures	____	___
Cultural values	____	___
Recreational developments	____	___
Urban interface	____	___
Critical watershed	____	___
T & E Species	____	___
Fire Behavior		
Current or predicted fire behavior dictates indirect strategy	____	___
Fuels are extremely dry (90th percentile)	____	___
Red Flag Warnings present or predicted	____	___
Extreme fire behavior exhibited	____	___
Current or predicted winds above 20 MPH	____	___
Severe fire weather predicted for next two burning periods	____	___

Personnel / Equipment

100 or more personnel assigned to incident	____	___
Variety of special support personnel or equipment	____	___
Resources unfamiliar with local conditions and accepted tactics	____	___
Heavy commitment of local resources to logistical support	____	___
Local Initial forces nearly depleted	____	___
Two operational periods worked with limited success	____	___
Communication challenges are present	____	___
Total number of elements checked:	____	___

Complexity Analysis Criteria:
A "yes" in each of the five major elements above could indicate a complexity level sufficient to warrant consideration of utilizing a Type 2 level Incident Management Team. Multiple checks in each element may indicate consideration for a Type I level Incident Management Team.

If some elements are not involved then **use the following ranges as a guide:**

1-3 Current resources/management should be able to handle the incident. The local organization fills positions as needed. Continue to monitor objectives and accomplishments; consider a Type 3 organization.

4-6 Indicates complexity level suggesting a Type 3 organization.

7-10 Scrutinize overall complexity and safety concerns, consider past fire history and current and expected situation, and review WFSA. This complexity suggests the need for a Type 2 Team.

10+ May warrant consideration of a Type 1 Team.

Decision / Decision Rationale:

Prepared by: _____ Date: _____ Time: _____

Reviewed by: _____ Date: _____ Time: _____

Reviewed by: _____ Date: _____ Time: _____

-- Note: Slight modifications were made to match Department of Interior "Red Book" --

Appendix D: Proposed fire-related projects of partner agencies

Year	Fort Huachuca Project	Acres	Ecological Mapping Unit	Project Description
2005	Site Papa	100	Grassland on elevated plains (#3)	Emergency burn required for proposed military training complex
2005	Range 13	900	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Support live-fire training, improve grassland habitat and watershed values
2005	Lima/Kilo	1,000	Grassland on elevated plains (#3)	Support increased military training, reduce woody vegetation and improve grassland habitat and watershed values
2005	Whiskey	1,000	Grassland on elevated plains (#3)	Support increased military training and improve grassland habitat and watershed values
2005	Planning Area 1	300	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values
2005	Planning Area 6 (South)	700	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values
2005	Helispot Maint.	2	varies	Reduce woody vegetation on ? helispots for future use
2005	Firebreak Maint.	n/a	n/a	
2006	Kilo Burn	900	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2006	X-Ray Burn - West	500	Grassland on elevated plains (#3)	Support military training, reduce woody vegetation and improve grassland habitat and watershed values
2006	Victor Burn - West	300	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2006	East Range - Planning Area 6 (North)	1,300	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values; Burnable acreage approx. 500.
2006	Old Range 12 Burn	750	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Support live-fire training, improve grassland habitat and watershed values
2006	Area Golf Burn	1,000	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2006	Area Yankee -	150	Grassland on elevated	Reduce woody vegetation and improve grassland habitat and

Year	Fort Huachuca Project	Acres	Ecological Mapping Unit	Project Description
	Southwest		plains (#3)	watershed values
2007	Area India - South	400	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2007	Area T2 - Southeast	600	Grassland on elevated plains (#3)	Support live-fire training, improve grassland habitat and watershed values
2007	Area T1 - East	800	Grassland on elevated plains (#3)	Support live-fire training, improve grassland habitat and watershed values
2007	Area T3 - West	800	Madrean oak-pine woodland (#10)	Support live-fire training, improve grassland habitat and watershed values
2007	Area Uniform - Northcentral	300	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2007	East Range – Planning Area 8 (South)	800	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values. Burnable acreage approx. 300 acres.
2007	East Range – Planning Area 5 (South)	600	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values. Burnable acreage approx. 300 acres.
2008	Area Hotel - South	2,100	Grassland on elevated plains (#3)	Support increased military training, reduce woody vegetation and improve grassland habitat and watershed values
2008	Area T2 - Northcentral	750	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Support live-fire training, improve grassland habitat and watershed values
2008	East Range – Planning Area 8 (North)	800	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values. Burnable acreage approx. 250 acres.
2008	Area Uniform - Northwest	500	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Support military training, improve grassland habitat and watershed values
2009	East Range – Planning Area 5 (North)	1,800	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values. Burnable acreage approx. 600 acres.
2009	Area T2 - Northeast	375	Grassland on elevated plains (#3)	Support live-fire training, improve grassland habitat and watershed values

Year	Fort Huachuca Project	Acres	Ecological Mapping Unit	Project Description
2009	Area P - Southeast	300	Madrean oak-pine woodland (#10)	Support military training, improve grassland habitat and watershed values
2009	Area T1 - Southwest	1,200	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Support military training, improve grassland habitat and watershed values
2009	X-Ray - East	735	Grassland on elevated plains (#3)	Support military training, reduce woody vegetation and improve grassland habitat and watershed values
2009	Victor One Burn	550	Grassland on elevated plains (#3)	Reduce woody vegetation around developed areas and improve grassland habitat and watershed values; avoid research area
2010	Area Hotel - North	2,100	Grassland on elevated plains (#3)	Support increased military training, reduce woody vegetation and improve grassland habitat and watershed values
2010	Area Yankee - West	700	Grassland on elevated plains (#3)	Support increased military training, reduce woody vegetation and improve grassland habitat and watershed values
2010	Area Uniform - Southcentral	400	Madrean oak-pine woodland (#10)	Support military training, reduce fuels and improve habitat and watershed values
2010	Area R - East	300	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Improve habitat and watershed values
2010	East Range – Planning Area 3	1,000	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values. Burnable acreage approx. 300 acres.
2011	Area T1 - Northwest	800	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Reduce fuels, improve habitat and watershed values
2011	Area T2 - Southwest	650	Madrean oak-pine woodland (#10)	Reduce fuels, improve habitat and watershed values
2011	Area Uniform - East	300	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2011	Area T2 - Southeast	600	Grassland on elevated plains (#3)	Support live-fire training with short burn interval, improve grassland habitat and watershed values
2011	Area R/N - North	450	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Reduce fuels, improve habitat and watershed values
2011	East Range –	1,600	Chihuahuan desert scrub	Reduce shrub encroachment and improve watershed values.

Year	Fort Huachuca Project	Acres	Ecological Mapping Unit	Project Description
	Planning Area 2		and grassland (#2)	Burnable acreage approx. 400 acres.
2012	Area Yankee - East	550	Grassland on elevated plains (#3)	Support increased military training, reduce woody vegetation and improve grassland habitat and watershed values
2012	Area India – North	1,800	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2012	Whiskey – West Burn	741	Grassland on elevated plains (#3)	Support increased military training and improve grassland habitat and watershed values
2012	Mike - Northwest	487	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2012	Area Uniform - Central	500	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Reduce woody vegetation and improve habitat and watershed values
2013	Area N – North central	200	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Reduce fuels, improve habitat and watershed values
2013	Range 13	900	Grassland on elevated plains (#3) and Madrean oak-pine woodland (#10)	Support live-fire training, improve grassland habitat and watershed values; Short burn interval will need to be approved by USFWS
2013	East Range – Planning Area 4	5,000	Chihuahuan desert scrub and grassland (#2)	Reduce shrub encroachment and improve watershed values. Burnable acreage approx. acres.
2014	Victor Burn - East	400	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2014	Juliet	1,111	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values
2015	Whiskey – East Burn	741	Grassland on elevated plains (#3)	Support increased military training and improve grassland habitat and watershed values
2015	Mike - Southeast	600	Grassland on elevated plains (#3)	Reduce woody vegetation and improve grassland habitat and watershed values

Year	USFS Project	Acres	Description
2004	Miller Burn II	190	Pile Burn
2004	Miller Burn IV	103	Pile Burn
2004	Hunter Burn	215	Planning
2004	Hunter Burn 1	145	Thin & Pile
2004	Merritt	3,100	Planning
2004	Miller Burn I	65	Broadcast
2005	Miller Burn III	60	Broadcast
2005	Lyle	2,000	Planning
2005	Ash	100	Planning
2005	Hunter Burn 1	145	Pile Burn
2005	Lone Maintenance	5,412	Plan / Broadcast
2005	Hunter II	70	Thin / Pile
2006	Carr Maintenance	225	Plan / Broadcast
2006	Miller Burn II	240	Broadcast
2006	Ash	100	Thin / Pile
2006	Hunter II	70	Pile Burn
2006	Border I	3,000	Plan
2006	Merritt	100	Thin / Pile
2007	Miller Burn IV	103	Broadcast
2007	Lyle	100	Thin / Pile
2007	Ash	100	Pile Burn
2007	Merritt	100	Pile Burn
2007	Border I	3,000	Broadcast
2007	Stump	250	Planning
2007	Oversite	1035	Planning
2008	Lyle	100	Pile Burn
2008	Merritt	3,100	Broadcast
2008	Stump	125	Thin / Pile

Year	USFS Project	Acres	Description
2008	Oversite	100	Thin / Pile
2008	Border II	3,000	Planning
2008	Morgan	225	Planning
2008	Hunter I	145	Broadcast
2009	Lyle	2,000	Broadcast
2009	Stump	125	Thin / Pile
2009	Stump	125	Pile Burn
2009	Oversite	100	Pile Burn
2009	Border II	100	Thin / Pile
2009	Ramsey	110	Planning
2009	Hunter II	70	Broadcast
2009	Alamo	1,000	Planning
2010	Lyle	2,000	Broadcast
2010	Stump	125	Pile Burn
2010	Morgan	225	Thin / Pile
2010	Border II	100	Pile Burn
2010	Hunter II	70	Broadcast
2010	Alamo	1,000	Planning
2011	Ramsey	110	Thin / Pile
2011	Border II	3,000	Broadcast
2011	Morgan	225	Pile Burn
2011	Ash	100	Broadcast
2011	Alamo	100	Thin / Pile
2011	Miller III Plan & Maint.	60	Broadcast
2012	Oversite	3,000	Broadcast
2012	Ramsey	110	Pile Burn
2012	Miller II Plan & Maint.	240	Broadcast
2012	Border III	3,000	Planning

Year	USFS Project	Acres	Description
2012	Alamo	100	Pile Burn
2012	Miller III Plan & Maint.	60	Broadcast
2012	Brown Canyon	200	Planning
2013	Miller II Plan & Maint.	240	Broadcast
2013	Border III	100	Thin Pile
2013	Alamo	1,000	Broadcast
2013	Miller IIII Plan & Maint.	103	Broadcast
2013	Brown Canyon	200	Thin Pile

Year	BLM Project	Acres	Description
2005-2007	Rafael	54	Prescribed Burn
2005-2007	Landburn	570	Prescribed Burn
2005-2007	Flood	109	Prescribed Burn
2005-2007	Lehner	149	Prescribed Burn
2005-2007	Waters	145	Prescribed Burn
2005-2007	Stagg Ranch	72	Prescribed Burn
2005-2007	Hereford 2	144	Prescribed Burn
2005-2007	Paloma	162	Prescribed Burn
2005-2007	Sand	130	Prescribed Burn
2005-2007	Stone	140	Prescribed Burn
2005-2007	Lion	12	Prescribed Burn
2005-2007	Rabbit	97	Prescribed Burn
2005-2007	Deer	68	Prescribed Burn
2005-2007	Hearse	117	Prescribed Burn
2005-2007	Oxbow	415	Prescribed Burn
2005-2007	Moson	78	Prescribed Burn
2005-2007	Escapule	53	Prescribed Burn

Appendix E: Environmental issues associated with managing fire

Possible Impact Area	Issues, Concerns, Opportunities
Water	
Quantity	▪ Runoff increases post-fire with lack of intercepting and water-consuming vegetation; long term: fire will improve watershed condition (increase herbaceous vegetation, decrease woody vegetation), reducing run-off, increasing infiltration, resulting in increased water quantity
Quality	▪ Runoff from fire-denuded slopes will contain increased particulate load; long term: fire will increase herbaceous vegetation cover, reducing soil erosion and improving water quantity
Flooding	▪ Potential for flooding after intense storms increases after high-intensity or large fires ▪ Risk of debris in floodflows increases after fires ▪ Long term: fire will improve watershed condition (i.e., increase herbaceous vegetation, decrease woody vegetation), reducing run-off and flooding.
Wetlands	▪ Fire may cause short-term loss of vegetative cover ▪ Fire can open up thickets that may ultimately dry up wet places ▪ Fire will result in increased vigor of fire-adapted plant species which may improve wetland function ▪ Fire-renewed habitat may re-attract wildlife species formerly occupying wetland areas
Geological Resources	
Soils	▪ Fire may temporarily decrease infiltration and increase erosion ▪ Fire may temporarily increase soil moisture and release nutrients to soil ▪ High-intensity fire on steep upper slopes can lead to type conversion following significant loss of soils ▪ Potential for mudflows increases when intense storms hit fire-denuded slopes ▪ Handlines will expose soil to non-native establishment and increase erosion on slopes ▪ Prescribed burning and wildland fire use bring needed fire to the landscape while avoiding extreme effects on soils
Caves	▪ Fires may expose entrances to previously hidden caves
Air Quality	
Smoke	▪ Smoke can be a health hazard, barrier to visibility, or regulatory problem during fires ▪ Smoke alarms nearby residents ▪ Presence of smoke is temporary ▪ Prescribed burning and wildland fire use are permitted only under optimal

Possible Impact Area	Issues, Concerns, Opportunities
	smoke dispersal conditions
	▪ Public education can get out the message that tolerating smoke from prescribed burning and wildland fire use reduces likelihood of large, smoke-generating wildfires
	▪ Smoke may be a germination agent for some plant species
Cultural Resources	
Archeological Sites	▪ Prehistoric sites have experienced multiple fires
	▪ High-intensity fire might damage sites and artifacts that have previously tolerated low-intensity fire
	▪ Fires facilitate discovery of new sites
	▪ Prescribed burning, wildland fire use, and non-fire treatments can reduce risk of high-intensity fires
	▪ Suppression actions generally put sites more at risk than allowing fire to burn over them
Structures	▪ Fire might damage or destroy significant fire-susceptible structures
	▪ Timbers associated with historic mines are susceptible to high-intensity fires
	▪ Fuels treatments around structures minimize risks from fire
Cultural Landscapes	▪ Fire can be used for maintaining the historic scene at Fort Huachuca
Tribal Concerns	▪ Tribal consultation on the overall plan and individual actions address tribal concerns
Visitor Experience	
Safety	▪ Visitors frequent canyons, where one-way-in/one-way-out can be hairy during fire events
	▪ Backcountry visitors need to be tracked and informed to keep them safe during fire events
	▪ Fire use, prescribed fire, and thinning reduce hazard fuels
Traffic	▪ Fire may force road closures
	▪ Vehicles to support prescribed burning or suppression efforts add to traffic in canyons
Soundscapes	▪ Equipment (chainsaws, helicopters, vehicles) will make noise during burns and suppression
	▪ Border Patrol/Customs activities already make a fair amount of noise on a regular basis
Views	▪ Sight of fire may frighten visitors and aftermath may offend
	▪ Education about the benefits of fire should help change these perceptions
	▪ Smoke from fire events will temporarily cloud views of night skies
	▪ Fires and thinning can open areas and enhance scenic views

Possible Impact Area	Issues, Concerns, Opportunities
Recreation opportunities	▪ Trails, vista points, and campgrounds might be temporarily closed during fire operations ▪ Shoulder season prescribed burning may affect areas open to hunters ▪ Burning improves habitat of many game species ▪ Maintaining habitat mosiacs with fire will aid reestablishment of wild turkey ▪ High-intensity fire above Parker Canyon Lake could lead to erosion and sedimentation problems ▪ Prescribed fire and wildland fire use above the lake can reduce potential effects ▪ International visitors who come to see specific birds could get annoyed if fire activities block access to sites ▪ Alternative recreation destinations abound in southeastern Arizona when fire activities limit access ▪ Newly burned areas may attract species of interest to obsessed birders
Interpretation	▪ Fire operations and sites provide major interpretive opportunities
Wilderness	▪ wildland fire use maintains wilderness natural processes and values ▪ fire operations may bring people to closed areas ▪ fire use requires clearing backcountry users out of areas with limited access ▪ when suppression is unavoidable in wilderness, minimum impact and minimum tool analyses determine course of action ▪ wilderness restrictions on mechanized equipment and overflight can be lifted on CNF by the FS?/RF? during fire-related emergencies ▪ wilderness-WUI juxtaposition complicates fire management
Unique Systems and Sites	
Ecoregions	▪ Madrean ecoregion species (those with south-of-the-border affinities that are present in very few places in the U.S.) could potentially suffer in the short-term from fire activities but likely would benefit in the long-term
Natural Systems	▪ Fire may change the character of uncommon systems: springs, riparian and stream habitats, grassland and oak savanna RNA's on the CNF, Red Rock Creek, cienegas in Canelo Hills, cave ecosystems
Unique Vegetation Stands	▪ Fire may reduce or eliminate unique stands of vegetation that lack readily available colonizing sources, particularly stands of Apache pine, stands of Chihuahua pine, and mixed conifers on Miller Peak ▪ Prescribed fire, wildland fire use, and non-fire fuels treatments may protect unique stands of vegetation from catastrophic wildfire.
Vegetation	
Composition	▪ Fire-intolerant species suffer

Possible Impact Area	Issues, Concerns, Opportunities
	▪ Fire-tolerant species benefit from decreased competition
	▪ Diversity increases post-fire with flush of forb growth
Structure	▪ Intense fires can eliminate entire stands of vegetation
	▪ Presence of fire will cause fire-adapted species to increase
	▪ Fire-intolerant species will decrease over time
Non-Indigenous Species	▪ Fire may facilitate invasion by undesirable lovegrasses and other fire-loving species into degraded habitats (coming attractions: buffel grass and fountain grass) (Interesting note: G. McPherson is finding that summer fires maintain relative abundances of natives and Lehmann's while spring (early season) burns encourage the spread of Lehmann's).
	▪ Fire may prove to be a useful tool for control of non-indigenous species
Wildlife	
Key Species	▪ Fire might kill, injure, or temporarily displace key species that are part of the region's attraction (hummingbirds, black bears, coatimundis, montane rattlesnakes)
	▪ Fire may benefit habitats of key species by thinning vegetation, causing flushes of new growth, exposing prey
Fire Timing	▪ Fire at non-natural times of year may disrupt animal cycles
	▪ Fire during bird breeding season will cause nesting failures and mortality
	▪ Species adapted to cyclical fire will recover if sufficient populations exist for colonizing
Species of Special Concern	
Plants	▪ Rare, protected, or listed plants might suffer injury, death, or destruction of habitat by fire
	▪ Fire-adapted species can benefit from fire-reduced competition in vegetation stands
	▪ Fire-adapted species may actually require fire at some point in their reproductive cycle
	▪ Post-fire nutrient releases may benefit plants
	▪ Prescribed burning, wildland fire use, and non-fire fuels treatments reduce risks of high-intensity events in habitats of sensitive species
Animals	▪ Rare, protected, or listed animals might suffer injury, death, or destruction of habitat by fire
	▪ On the other hand, animals are pretty good at getting out of the way of fires
	▪ Species may benefit from fire-induced habitat renewal
	▪ Fire creates edge habitat preferred by some species
	▪ Prescribed burning, wildland fire use, and non-fire fuels treatments reduce risks of high-intensity events in habitats of sensitive species

Possible Impact Area	Issues, Concerns, Opportunities
	▪ MSO will require protection from direct and indirect effects of fires
Land Use	
Property Damage	▪ Structures and landscaping on participants' and neighboring properties are at risk from fire
	▪ Fuels treatments around developments can reduce threat
Neighbors and Inholdings	▪ Fire may cross cooperative project boundary to neighboring properties
	▪ Smoke and helicopter noise temporarily disturb neighbors during fire operations
	▪ Fuels treatments along boundaries can reduce likelihood of fires crossing out of the cooperative plan area
	▪ Neighboring ranches may welcome fire
CNF Permittees	▪ Grazing permittees, users of facilities, and guide businesses require generous advance notification of fire program activities (mining claims are inactive)
	▪ Permittees will be excluded from areas for preset amounts of time post-burn
	▪ Fire will renew grasses in grazing allotments
	▪ Prescribed burning, wildland fire use, and fuels treatments reduce risk of high-intensity fires that affect permitees
Socioeconomic Concerns	
Local Economy	▪ Local tourism could decline after a large, well-publicized fire in the region
	▪ Ample alternative destinations exist in the area
	▪ Property values may be affected by loss of mature trees
	▪ Fuels treatments help maintain values in the long term
	▪ Fire operations buy goods and services locally
Minority/ Low Income Populations	▪ Contracts for prescribed fire and suppression crews benefit minority and low-income populations
Proximity to International Border	▪ Safety of undocumented aliens (UDAs) traveling through the area is a great concern for fire activities
	▪ Security of fire personnel is an issue as well
	▪ UDAs have greatly increased ignitions and wildfires emphasizing the need for proactive and opportunistic fuels treatments.
Other Agency Policies	
Proximity to International Border	▪ Fire management requires coordination with Immigration and Naturalization Service, Customs, Homeland Security because of our location near the border

Possible Impact Area	Issues, Concerns, Opportunities
Resource Conservation	
Sustainability	▪ Fires and fighting fires consume some non-renewable resources ▪ Long-term sustainability of ecosystems is enhanced by bringing them into their natural fire regimes

Appendix F: Sensitive species within HAFP project boundaries

1. Los Fresnos Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Agosia chrysogaster	Longfin dace	SC		S	
Allium rhizomatum	Redflower onion		S	S	SR
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Astragalus hypoxylus	Huachuca milk-vetch	SC	S	S	SR
Erigeron arisolius			S		
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Samolus vagans	Chiricahua mountain brookweed		S		
Sigmodon ochrognathus	Yellow-nosed cotton rat	SC			
Stenorrhynchos michuacanum	Michoacan ladies'-tresses				SR
Sympetrum signiferum	Mexican meadowfly		S		
Tragia laciniata	Sonoran noseburn		S		
No Critical Habitats in project area.					

2. Coronado West Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Choeronycteris mexicana	Mexican long-tongued bat	SC		S	WSC
Eleutherodactylus augusti cactorum	Western barking frog		S		WSC
Hedeoma dentatum	Mock-pennyroyal		S		
Leptonycteris curasoae yerbabuenae	Lesser long-nosed bat	LE	S		WSC
Myotis velifer	Cave myotis	SC		S	
Pectis imberbis	Beardless chinch weed	SC	S		
Penstemon superbus	Superb beardtongue		S		
Sigmodon ochrognathus	Yellow-nosed cotton rat	SC			
Tephrosia thurberi	Thurber hoary pea		S		
Critical Habitat for the Mexican spotted owl in project area.					

3. Coronado North Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Choeronycteris mexicana	Mexican long-tongued bat	SC		S	WSC
Penstemon superbus	Superb beardtongue		S		
Sigmodon ochrognathus	Yellow-nosed Cotton Rat	SC			
Sistrurus catenatus edwardsii	Desert massasauga		S		WSC
Strix occidentalis lucida	Mexican spotted owl	LT	S		WSC
Tephrosia thurberi	Thurber hoary pea		S		
Critical Habitat for the Mexican spotted owl in project area.					

4. Canelo Hills Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Accipiter gentilis	Northern goshawk	SC	S		WSC
Agosia chrysogaster	Longfin dace	SC		S	
Allium rhizomatum	Redflower onion		S	S	SR
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Browallia eludens	Elusive new browallia species	SC	S		
Coursetia glabella		SC	S		
Crotalus willardi willardi	Arizona ridge-nosed rattlesnake		S		WSC
Erigeron arisolius			S		
Hedeoma dentatum	Mock-pennyroyal		S		
Laennecia eriophylla	Woolly fleabane		S		
Mammillaria wrightii var. wilcoxii	Wilcox fishhook cactus				SR
Metastelma mexicanum	Wiggins milkweed vine	SC	S		
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Sympetrum signiferum	Mexican meadowfly		S		
Thamnophis eques megalops	Northern Mexican gartersnake	SC	S		WSC
Tragia laciniata	Sonoran noseburn		S		
No Critical Habitats in project area.					

5. High Country WFU Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Accipiter gentilis	Northern goshawk	SC	S		WSC
Agathymus aryxna	Arizona giant skipper		S		
Agathymus evansi	Huachuca giant-skipper		S		
Agosia chrysogaster	Longfin dace	SC		S	
Allium plummerae	Plummer onion				SR
Allium rhizomatum	Redflower onion		S	S	SR
Amazilia violiceps	Violet-crowned hummingbird				WSC
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Asclepias lemmonii	Lemmon milkweed		S		
Carex chihuahuensis	Chihuahuan sedge		S		
Carex ultra	Arizona giant sedge		S	S	
Choeronycteris mexicana	Mexican long-tongued bat	SC		S	WSC
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	C	S		WSC
Corynorhinus townsendii pallescens	Pale Townsend's big-eared bat	SC			
Coursetia glabella		SC	S		
Crotalus willardi willardi	Arizona ridge-nosed rattlesnake		S		WSC
Eleutherodactylus augusti cactorum	Western barking frog		S		WSC
Empidonax fulvifrons pygmaeus	Northern buff-breasted flycatcher	SC			WSC
Erigeron arisolius			S		
Erigeron lemmonii	Lemmon fleabane	C			HS
Erynnis scudderi	Scudder's dusky wing		S		
Euphorbia macropus	Woodland spurge	SC			SR
Falco peregrinus anatum	American peregrine falcon	SC	S		WSC
Hedeoma costatum	Chiricahua mock pennyroyal		S		

5. High Country WFU Project					
Hedeoma dentatum	Mock-pennyroyal		S		
Hexalectris spicata	Crested coral root				SR
Hexalectris warnockii	Texas purple spike	SC	S	S	HS
Hieracium pringlei	Pringle hawkweed	SC	S		
Hieracium rusbyi	Rusby hawkweed		S		
Ipomoea thurberi	Thurber's morning-glory		S		
Laennecia eriophylla	Woolly fleabane		S		
Lasiurus blossevillii	Western red bat				WSC
Leptonycteris curasoae yerbabuenae	Lesser long-nosed bat	LE	S		WSC
Lilaeopsis schaffneriana var. recurva	Huachuca water umbel	LE			HS
Lilium parryi	Lemmon lily	SC	S		SR
Lupinus huachucanus	Huachuca Mountain lupine		S		
Malaxis corymbosa	Madrean adders mouth				SR
Malaxis porphyrea	Purple adder's mouth				SR
Mammillaria wrightii var. wilcoxii	Wilcox fishhook cactus				SR
Myotis thysanodes	Fringed myotis	SC		S	
Myotis velifer	Cave myotis	SC		S	
Neophasia terlooii	Chiricahua pine white		S		
Psilactis gentryi	Mexican bare-ray-aster		S		
Pyrgulopsis thompsoni	Huachuca springsnail	C	S	S	
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Rana subaquavocalis	Ramsey Canyon leopard frog	SC	S		
Rumex orthoneurus	Blumer's dock	SC	S		HS
Samolus vagans	Chiricahua Mountain brookweed		S		
Schiedeella arizonica	Fallen ladies'-tresses				SR
Senecio carlomasonii	Seemann groundsel		S		
Senecio huachucanus	Huachuca groundsel		S		HS
Sigmodon ochrognathus	Yellow-nosed cotton rat	SC			
Sorex arizonae	Arizona shrew	SC	S		WSC
Stenorrhynchos michuacanum	Michoacan ladies'-tresses				SR
Strix occidentalis lucida	Mexican spotted owl	LT	S		WSC
Talinum marginatum	Tepic flame flower	SC	S		SR
Tephrosia thurberi	Thurber hoary pea		S		
Thamnophis eques megalops	Northern Mexican gartersnake	SC	S		WSC
Trogon elegans	Elegant trogon				WSC
Viola umbraticola	Shade violet		S		
Zigadenus virescens	Green death camas				SR
Critical Habitats for the Mexican spotted owl and Huachuca water umbel in project area.					

6. West Gate to Hwy. 83 Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Accipiter gentilis	Northern goshawk	SC	S		WSC
Agathymus neumoegeni	Neumogen's giant skipper		S		
Agosia chrysogaster	Longfin dace	SC		S	
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Asclepias lemmonii	Lemmon milkweed		S		
Astragalus hypoxylus	Huachuca milk-vetch	SC	S	S	SR
Browallia eludens	Elusive new browallia Species	SC	S		
Carex chihuahuensis	Chihuahuan sedge		S		
Catostomus insignis	Sonora sucker	SC		S	
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	C	S		WSC
Coursetia glabella		SC	S		
Crotalus willardi willardi	Arizona ridge-nosed rattlesnake		S		WSC
Empidonax fulvifrons pygmaeus	Northern buff-breasted flycatcher	SC			WSC
Erigeron arisolius			S		
Euphorbia macropus	Woodland spurge	SC			SR
Gila intermedia	Gila chub	PE	S		WSC
Hedeoma dentatum	Mock-pennyroyal		S		
Ipomoea thurberi	Thurber's morning-glory		S		
Lasiurus blossevillii	Western red bat				WSC
Leptonycteris curasoae yerbabuenae	Lesser long-nosed bat	LE	S		WSC
Lilaeopsis schaffneriana var. recurva	Huachuca water umbel	LE			HS
Lobelia fenestralis	Leafy lobelia				SR
Lupinus huachucanus	Huachuca Mountain lupine		S		
Mammillaria wrightii var. wilcoxii	Wilcox fishhook cactus				SR
Metastelma mexicanum	Wiggins milkweed vine	SC	S		
Muhlenbergia dubioides	Box Canyon muhly		S		
Myotis velifer	Cave myotis	SC		S	
Neophasia terlooii	Chiricahua pine white		S		
Pectis imberbis	Beardless chinch weed	SC	S		
Pectis imberbis	Beardless chinch weed	SC	S		
Psilactis gentryi	Mexican bare-ray-aster		S		
Pyrgulopsis thompsoni	Huachuca springsnail	C	S	S	
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Samolus vagans	Chiricahua Mountain brookweed		S		
Sigmodon ochrognathus	Yellow-nosed cotton rat	SC			
Spiranthes delitescens	Madrean ladies'-tresses	LE			HS
Stenorrhynchos michuacanum	Michoacan ladies'-tresses				SR
Strix occidentalis lucida	Mexican spotted owl	LT	S		WSC
Sympetrum signiferum	Mexican meadowfly		S		
Thamnophis eques megalops	Northern Mexican gartersnake	SC	S		WSC
Tragia laciniata	Sonoran noseburn		S		
Trogon elegans	Elegant trogon				WSC
Critical Habitats for the Mexican spotted owl and Huachuca water umbel in project area. Proposed Critical Habitat for the Gila chub in project area.					

7. East Slope Treatments Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Accipiter gentilis	Northern goshawk	SC	S		WSC
Agathymus aryxna	Arizona giant skipper		S		
Agathymus evansi	Huachuca giant-skipper		S		
Allium plummerae	Plummer onion				SR
Amazilia violiceps	Violet-crowned hummingbird				WSC
Arabis tricornuta	Chiricahua rock cress		S		
Asclepias lemmonii	Lemmon milkweed		S		
Carex chihuahuensis	Chihuahuan sedge		S		
Choeronycteris mexicana	Mexican long-tongued bat	SC		S	WSC
Crotalus willardi willardi	Arizona ridge-nosed rattlesnake		S		WSC
Eleutherodactylus augusti cactorum	Western barking frog		S		WSC
Empidonax fulvifrons pygmaeus	Northern buff-breasted flycatcher	SC			WSC
Erigeron arisolius			S		
Erynnis scudderi	Scudder's dusky wing		S		
Euptilotis neoxenus	Eared quetzal		S		
Falco peregrinus anatum	American peregrine falcon	SC	S		WSC
Hedeoma dentatum	Mock-pennyroyal		S		
Heterotheca rutteri	Huachuca golden aster	SC	S	S	
Hieracium pringlei	Pringle hawkweed	SC	S		
Ipomoea plummerae var. cuneifolia	Huachuca Morning Glory		S		
Lasiurus blossevillii	Western red bat				WSC
Leptonycteris curasoae yerbabuenae	Lesser long-nosed bat	LE	S		WSC
Lilium parryi	Lemmon lily	SC	S		SR
Lupinus huachucanus	Huachuca Mountain lupine		S		
Malaxis corymbosa	Madrean adders mouth				SR
Mammillaria wrightii var. wilcoxii	Wilcox fishhook cactus				SR
Myotis velifer	Cave myotis	SC		S	
Platanthera limosa	Thurber's bog orchid				SR
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Rana subaquavocalis	Ramsey Canyon leopard frog	SC	S		
Samolus vagans	Chiricahua Mountain brookweed		S		
Senecio carlomasonii	Seemann groundsel		S		
Senecio huachucanus	Huachuca groundsel		S		HS
Sigmodon ochrognathus	Yellow-nosed cotton rat	SC			
Sorex arizonae	Arizona shrew	SC	S		WSC
Strix occidentalis lucida	Mexican spotted owl	LT	S		WSC
Talinum marginatum	Tepic flame flower	SC	S		SR
Tephrosia thurberi	Thurber hoary pea		S		
Thamnophis eques megalops	Northern Mexican gartersnake	SC	S		WSC
Trogon elegans	Elegant trogon				WSC
Viola umbraticola	Shade violet		S		
Zigadenus virescens	Green death camas				SR
Critical Habitat for the Mexican spotted owl in project area.					

8. San Rafael West Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Accipiter gentilis	Northern goshawk	SC	S		WSC
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Heterotheca rutteri	Huachuca golden aster	SC	S	S	
Oxybelis aeneus	Brown vinesnake				WSC
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Sigmodon ochrognathus	Yellow-nosed cotton rat	SC			
Stenorrhynchos michuacanum	Michoacan ladies'-tresses				SR
Thamnophis eques megalops	Northern Mexican gartersnake	SC	S		WSC
Critical Habitat for the Mexican spotted owl in project area.					

8. San Rafael East Project					
Scientific Name	**Common Name**	**ESA**	**USFS**	**BLM**	**STATE**
Ambystoma tigrinum stebbinsi	Sonora tiger salamander	LE			WSC
Browallia eludens	Elusive new browallia Species	SC	S		
Erigeron arisolius			S		
Metastelma mexicanum	Wiggins milkweed vine	SC	S		
Rana chiricahuensis	Chiricahua leopard frog	LT	S		WSC
Tragia laciniata	Sonoran noseburn		S		
No Critical Habitats in project area.					

ESA – Endangered Species Act (LE: listed endangered, LT: listed threatened, PE: proposed endangered, PT: proposed threatened, C: candidate, SC: species of concern)

USFS – US Forest Service (S: sensitive)

BLM – Bureau of Land Management (S: sensitive)

STATE – State of Arizona (HS: highly safeguarded, SR: salvage restricted, ER: export restricted, SA: salvage assessed, HR: harvest restricted, WSC: wildlife of special concern in Arizona)

Arizona Game and Fish Department, Heritage Data Management System, July 15, 2005.

Appendix G: Solicitation to Mexican groups to join the HAFP

Addressed to Mexican landowner, management agency, etc.:

Por medio de la presente nos gustaría extenderle una invitación para que formara parte del Consorcio de Incendios de Huachuca (Huachuca Area Fire Partners, HAFP). Esta organización se fundó en 1996 y surgió como resultado de la cooperación entre agencias gubernamentales de los Estados Unidos (USDA Forest Service, Bureau of Land Management y National Park Service), organizaciones no gubernamentales (The Nature Conservancy, Audubon Society y BIDA) y ranchos privados (Rancho Babocomari y Rancho San Rafael) para comenzar a lidiar efectivamente con los incendios que ocurren en las altiplanicies y valles de las montañas Patagonia y Huachuca en la región sureste de Arizona (ver mapas). Con este esfuerzo esperamos estar mejor preparados para permitir que el fuego pueda reasumir su papel ecológico natural y así reducir combustibles peligrosos al cooperar en actividades como el uso de incendios naturales, quemas prescritas, supresión y la reducción de combustibles alrededor de áreas sensibles. Desafortunadamente, como usted bien sabe, los ecosistemas y los regímenes de incendios no se detienen ante las fronteras políticas. Por esta razón, deseamos incluir a los terratenientes mexicanos que se encuentran en zonas colindantes a nuestra área de trabajo, como lo es su organización, en nuestras actividades de planeación.

Para poder cumplir con estas actividades, el HAFP ha estado trabajando desde el 2002 en un plan de manejo de incendios que sea de utilidad para todos sus socios. El plan incluye unidades de mapeo ecológicas, historia y ecología del fuego en la región, asuntos ambientales regionales y normas de protección de especies en peligro de extinción y recursos culturales. El plan también presenta un programa de 10 años para el tratamiento de combustibles y proyectos que sean de beneficio ecológico, un inventario regional de recursos operacionales (equipo y personal) y un programa de acercamiento a las comunidades que se encuentran en y alrededor del área de planeación. En el futuro, el HAFP continuará trabajando para ejecutar diferentes proyectos y para actualizar regularmente el plan de manejo.

Al participar con el HAFP, las organizaciones mexicanas y otros terratenientes tendrán acceso a estudios extensivos del área, una mejoría en la comunicación entre latifundistas y mejores oportunidades para el manejo de incendios. A cambio, el HAFP quisiera contar con la participación voluntaria de los empleados de (**name**) para asistir a juntas de esta asociación, compartir información y planes para el manejo de incendios y su colaboración en otras actividades (por ejemplo, mapeo y programas de quema).

Junto con esta carta se anexa un folleto del HAFP y dos mapas del área de planeación. El folleto provee una descripción del HAFP y una lista de las agencias estadounidenses participantes. Los mapas indican cuales son los límites actuales de la región de HAFP y señalan las unidades de mapeo ecológico. Esto es solo un ejemplo de nuestro trabajo, pero esperamos que le de una idea clara de cuales son la actividades realizadas por este grupo.

Esperamos poder hablar con usted más adelante para compartir información más detallada y ver la posibilidad de su cooperación con el HAFP. Por ejemplo, quisiéramos invitarlo a nuestra próxima reunión que ocurrirá el 3 de marzo (el tiempo y el lugar serán decididos lo antes posible). La próxima semana (**name**) le hará una llamada para darle continuación a esta carta.

Appendix H: Mexico and U.S. fire agreement

Wildfire Protection Agreement Between the Department of the Interior and the Department of Agriculture of the United States of America and the Secretariet of Environment, Natural Resources, and Fisheries of the United Mexican States for the Common Border

The Department of the Interior and the Department of Agriculture of the United States of America, on the one hand, and the Secretariat of Environment, Natural Resources, and Fisheries of United Mexican States, on the other hand (hereinafter referred to as the "Parties");

Considering that many of the land areas along the approximately 3,200 kilometer (2,000 mile) United States-Mexico border are located such that wildfires in one country may become a threat to the resources of the other country; and

Recognizing that it is desirable and in the public interest to provide for coordinated action between both countries to facilitate effective use of wildfire protection resources to suppress wildfires on both sides of the border;

Hereby agree to follow:

ARTICLE I Purpose

The purpose of this Agreement is to enable wildfire protection resources originating in the territory of one country to cross the United States-Mexico border in order to suppress wildfires on the other side of the border within the zone of mutual assistance in appropriate circumstances.

The purpose of this Agreement is further to give authority for parties to cooperate on other fire management activities outside the zone of mutual assistance.

ARTICLE II Definitions

For the purposes of this agreement:
1. “Wildfire” means a fire that occurs in a "wildland" area, such as a range or forest, in which development is essentially non-existent except for roads, railroads, power lines, and similar transportation facilities, and structures, which if these exist, are widely scattered and are used primarily for recreation or agricultural purposes.
2. “Wildfire protection resources” means personnel, supplies, equipment, aircraft, vehicles, vessels, radios and specialized machinery or other resources, whether owned or contacted, that are intended for wildfire suppression or the transport of wildfire suppression equipment or personnel.
3. “Zone of mutual assistance" means the area of up to 16 kilometers (10 miles) on each side of the United States-Mexico border.
4. “Receiving Party” means the Party receiving wildfire protection resources.
5. “Sending Party” means the party furnishing wildfire protection resources.

ARTICLE III Obligations

1. Each Party shall immediately consider the request of the other Party, whether a Receiving Party or a Sending party, for cross-border movement of wildfire protection resources within the zone of mutual assistance, and, to the fullest extent practicable, promptly approve such request.
2. The Parties shall ensure that annual operating plans are generated in accordance with Article VII.
3. Each Party may obtain, as appropriate, the participation of its state, regional, local, private or

tribal fire organizations in the implementation of this Agreement, subject to its national laws and regulations.

ARTICLE IV Reimbursement

Each party shall assume all of its costs and expenses of furnishing wildland fire protection resources, including costs for lost or damaged wildfire protection resources, according to the performance of this Agreement, unless otherwise agreed by the Parties.

ARTICLE V Cross-Waiver of Claims

1. Each Party hereby waives its claims against the other Party for compensation for loss, damage, personal injury, or death occurring as a consequence of the performance of this Agreement.
2. Each Party shall, by contract or otherwise, extend the cross-waiver of liability set forth in paragraph 1 above to any contractors or subcontractors or agents or any state, regional, local, private or tribal fire organizations it may designate or assign to perform activities under this Agreement.
3. The cross-waiver of liability set forth in paragraph 1 above shall not apply to:
(a) Claims between a Party and its agencies, employees, contractors, subcontractors or agents;
(b) claims arising from willful misconduct; and
(c) claims arising from criminal conduct.

ARTICLE VI Entry of Personnel and Equipment

The Parties are committed to work together, with the involved agencies of their respective governments, to process appropriate legal documentation, within the applicable laws and regulations of both countries, and to otherwise facilitate entry to and exit from its territory of all personnel engaged in wildfire protection pursuant to this Agreement. Also, each Party shall undertake all reasonable steps and use its best efforts, within applicable laws and regulations of both countries, to facilitate the admission of all supplies, equipment, aircraft, vehicles, specialized machinery, or other equipment whether owned or contracted, that are used or intended for use in wildfire suppression or transport of wildfire suppression equipment or personnel pursuant to this Agreement without entry fees and without payment of any duties or taxes imposed by reason of importation.

ARTICLE VII Annual Operating Plans

1. Annual operating plans shall be concluded and executed between the Parties.
2. Each annual operating plan shall:
(a) Identify designated points of contact responsible for fire suppression within the applicable subregion within the zone of mutual assistance.
(b) Set forth specific criteria for approving requests for wildfire protection resources;
(c) Develop plans for mobilization of wildfire protection resources on each side of the United States-Mexico border;
(d) Establish procedures for efficient and timely communication of relevant information between designated points of contact;
(e) Provide for complete and timely reporting and record-keeping of all wildfire suppression incidents occurring in the subregion within the zone of mutual assistance;
(f) Identify the necessary procedures and legal documentation, which are to be completed, with agencies of the governments, for the expeditious cross-border movement of wildfire protection resources;
(g) Specify the conditions and procedures for the reimbursement, as deemed appropriate, of the Sending Party for the furnishing of wildfire protection resources;
(h) Include, terms consistent with Article V, a cross-waiver for compensation for loss, damage,

personal injury, or death occurring in consequence of the performance of this Agreement.
3. The Parties may recommend the development of operating plans for other fire management activities outside the zone of mutual assistance, subject to the approval of their respective governments.
4. The Parties shall maintain on file, copies of all annual operating plans.

ARTICLE VIII Status of Personnel

1. Any service performed in furtherance of this Agreement by an employee of a Party shall constitute service performed on behalf of that Party.
2. The performance of a service under this Agreement by any employee, contractor, subcontractor or agent of one Party shall in no case render such person an employee, contractor, subcontractor or agent of the other Party.

ARTICLE IX Legal Considerations and Relationship to other Agreements

1. Activities under this Agreement shall be subject to the applicable laws, regulations, and policies of each Party and subject to the availability of appropriated funds.
2. This Agreement is without prejudice to rights and obligations of the Parties under existing bilateral and multilateral agreements.

ARTICLE X Dispute Settlement

Any differences that arise in the interpretation or application of the provisions of this Agreement or any Annual Operating Plan negotiated pursuant hereto, shall be resolved by the Parties by means of negotiations and consultations.

ARTICLE XI Final Provisions

1. This Agreement shall enter into force upon signature by the Parties and shall remain in force for five years.
2. This Agreement may only be amended by mutual written consent of the Parties, and such agreement shall specify the date upon which such amendments shall take effect.
3. This Agreement may be terminated at any time by either Party upon six months written notice to the other Party.
4. The termination of this Agreement shall not affect the implementation of any fire suppression effort being carried out under this Agreement at the time when it was in force.

Signed, in Mexico City, this fourth day of June, 1999, in two originals, in the English and Spanish languages, both texts being equally authoritative.

For the United States Department of the Interior:
Bruce Babbitt, Secretary

For the United States Department of Agriculture:
Anne Kennedy, Deputy Under Secretary

For the Secretariat of Environment, Natural Resources, and Fisheries of the United Mexican States:
Julia Carabias Lillo, Secretary