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Department of
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Service

**Southwestern
Region**

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Coronado National Forest

Ecological Sustainability Report

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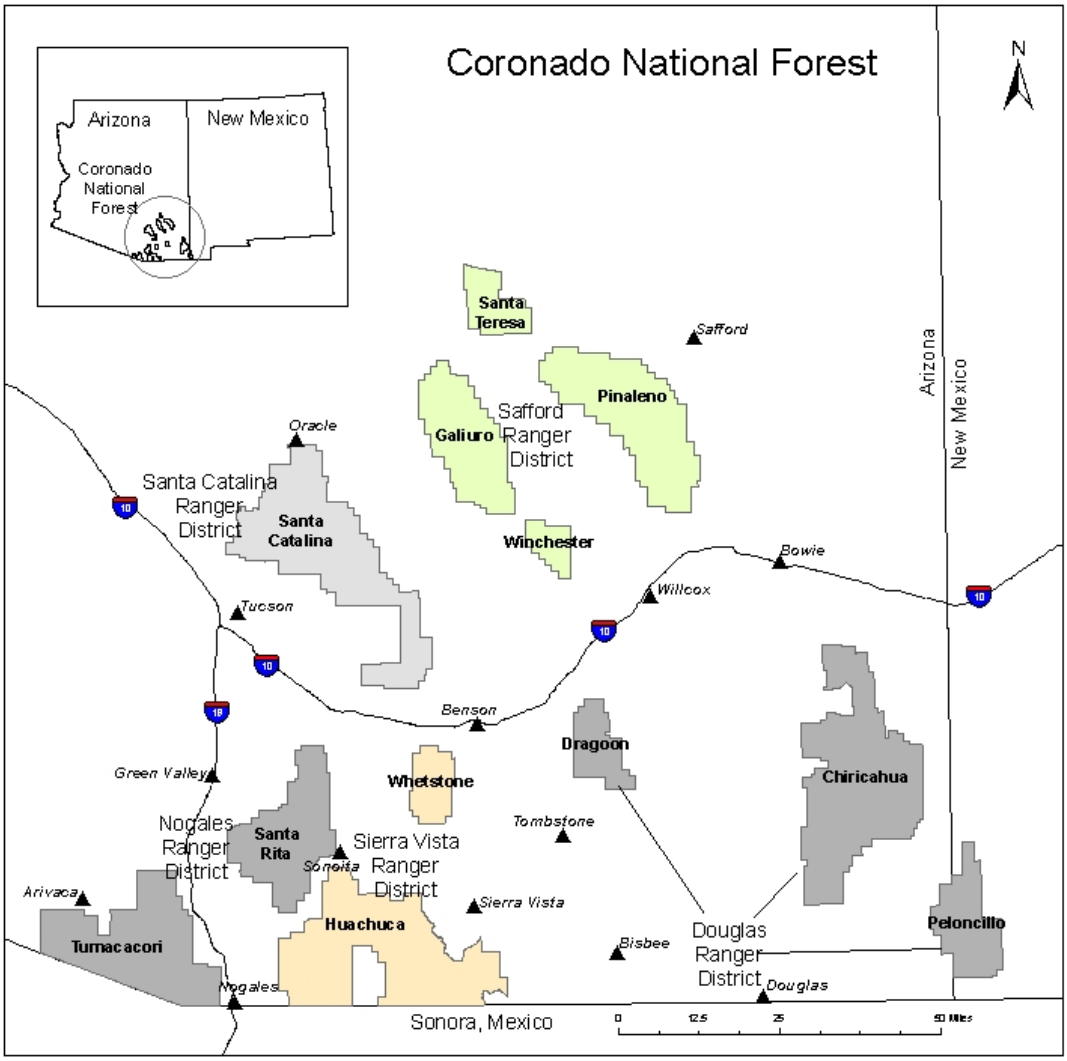
Introduction

The purpose of this report is to profile the ecological environment of the Coronado National Forest (NF) and the surrounding area (figure 1). This information will serve as a baseline to evaluate the existing Land and Resource Management Plan for the Coronado NF, 1986 as amended (hereinafter referred to as the forest plan) to determine if parts of the forest plan need to change. It will do so by facilitating a better understanding of the relationship between National Forest System lands and resources administered by the Coronado NF in the context of the broader ecological environment. This will aid in the identification of specific forest plan elements capable of responding to ecological trends. The report is organized into two main sections, ecosystem diversity and species diversity. The ecosystem diversity discusses conditions and trends in the vegetation communities and physical resources. Wildlife, fish, rare plants, and their habitats are discussed in the species diversity section.

Figure 1. Location of the Coronado National Forest



Ecological Attributes

The Coronado NF has twelve mountain ranges (also termed Ecosystem Management Areas, or EMAs), often referred to as “sky islands”. Sky islands are isolated mountain ranges that rise above the deserts and grasslands throughout southern Arizona, southwestern New Mexico, and northwestern Mexico. With elevations ranging from about 3,000 feet to 10,720 feet, these sky islands tower above the intervening seas of grass and desert. While each of the sky islands has similar, if not common, geologic histories, each is unique in many ways. The ecological attributes of the Coronado NF are described here in the context of the broader landscape, by examining subsections in the national ecological hierarchy, and in the context of the various ecological communities and processes that are represented within the boundaries of the Coronado NF.

Ecoregions, Provinces, Sections, and Subsections

Ecoregions are ecosystems of regional extent. As described by Bailey (1983) ecoregions distinguish areas that share common climatic and vegetation characteristics (Cleland et al.., 1997). Ecoregions are sub-divided into provinces, which are controlled primarily by continental weather patterns such as length of dry season and duration of cold temperatures. Provinces are also characterized by similar soil orders. Sections are a subdivision of provinces, described by broad areas of similar subregional climate, geomorphic process, stratigraphy, geologic origin, topography, and drainage networks. Such areas are often inferred by relating geologic maps to potential natural vegetation “series” groupings such as those mapped by Kuchler (1964).

Most of the Coronado NF is contained in the Chihuahuan Semi-Desert Province (Province 321)/ Chihuahuan Desert Basin and Range Section (Section 321A). A very small fraction of the forest represents the American Semi-desert and Desert Province (Province 322)/Sonoran Desert Section (Section 322B). A description of the two province/section combinations represented on the Coronado NF taken from McNab, et al. (2005) follows:

Province 321: Chihuahuan Semi-desert Province/Section 321A: Chihuahuan Desert-Basin and Range

The province is characterized by a subtropical arid climate of short winters and long, hot summers and includes isolated embedded areas of mountain climates of cooler temperatures, lower relative humidity, and increased orographic precipitation. Most precipitation occurs during mid to late summer, mainly as thunderstorms that cause rapid runoff. Vegetation is almost entirely dwarf-shrubland and sparse coverage, although small areas of woodland do occur on higher mountains.

Landforms of the Chihuahuan Desert-Basin and Range section include alluvial fans, elevated and lowland plains, with hills and low mountains presenting a pattern of alternating basins and ranges. Lithology includes both igneous and sedimentary rocks of varying ages. Vegetation is a mixture of southwestern creosote-mesquite desert shrub, grama-tobosa grasslands, and coniferous and encinal oak woodland communities. Isolated areas of montane, mixed conifer, and limited spruce-fir forests occur on mountain sideslopes and summits. Soils include Torriorthents, Calciorthids, and Haplargids at the lower elevations; and Alfisols and Mollisols at mid to upper elevations.

Province 322: American Semi-Desert and Desert/ Section 322B: Sonoran Desert

The province is characterized by long, hot summers and mild winters; little precipitation, although some occurs as summer thunderstorms. Landscape, parts of which are below sea

level, consists of plains with low mountain ranges. Vegetation is sparse and consists mainly of dwarf-shrubland, with occasional shrubland and woodland at higher elevations.

The Sonoran Desert section is characterized by widely scattered mountain ranges abruptly rising above the desert basin floor. Major landforms include mountains, elevated and lowland plains, alluvial fans, and stream terraces. Elevation ranges from 300 feet to over 9,000 feet. The lowest elevation on the Coronado NF in this section is approximately 3,300 feet. Lithology is mainly non-marine sedimentary and igneous granitic parent materials of the Precambrian Era. Vegetation is desert shrub and grassland composed of palo verde (*Cercidium* spp.), creosote bush (*Larrea tridentata*), saguaro cactus (*Carnegiea gigantea*), mesquite (*Prosopis* spp.), and bursage (*Ambrosia* spp.). Dominant soils include Calciorthids, Haplargids, and Torrifluvents in the lower elevations and Haplustalfs at mid to higher elevations.

Sections are further divided into subsections, shown mapped in figure 2. The subsections represented on the Coronado NF provide further insight into the ecological attributes of the Coronado NF, and the ability of the Coronado NF to contribute to ecological sustainability in the broader scale of the southwestern region of the United States. Some basic statistics about the subsections represented on the Coronado NF are given in table 1.

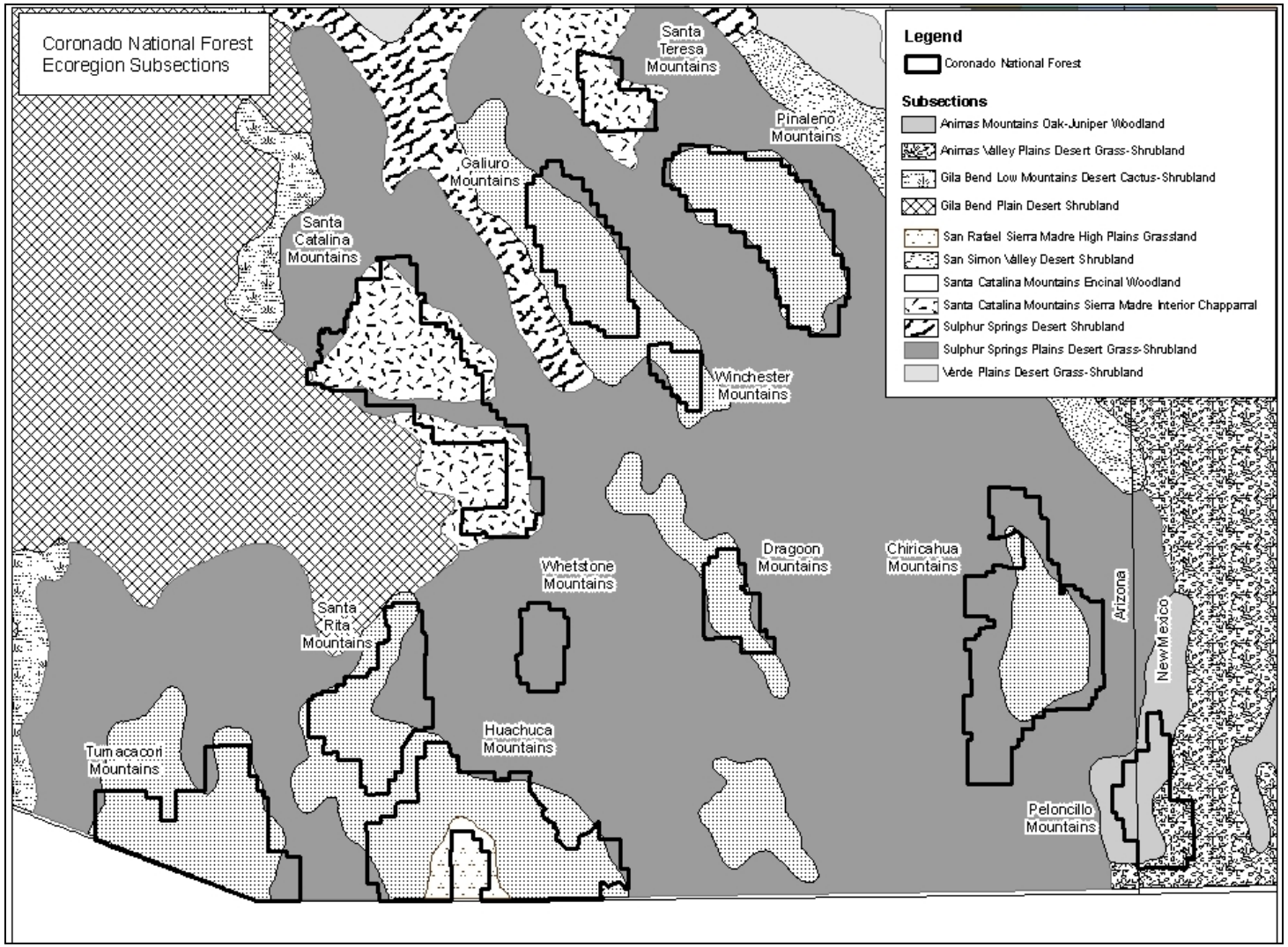


Figure 2. Subsections of the Coronado NF

Table 1. Subsections of the Coronado NF

Subsection	Subsection Name	Coronado NF(mi^2)	Subsection (mi^2)	Percent of Subsection in the United States (%)	Percent of Coronado NF (%)
321AG	Animas Valley Plains Desert Grass-Shrubland	48.7	9,984.0	0.49	1.76
321AH	Animas Mountains Oak-Juniper Woodland	89.0	579.9	15.34	3.22
321AJ	Sulphur Springs Plains Desert Grass-Shrubland	615.9	8,952.8	6.88	22.29
321AK	Santa Catalina Mountains Sierra Madre Interior Chapparral	411.1	759.1	54.16	14.88
321AL	San Rafael Sierra Madre High Plains Grassland	44.3	86.1	51.42	1.60
321AM	Santa Catalina Mountains Encinal Woodland	1,551.8	2,466.8	62.91	56.17
322BF	Gila Bend Plain Desert Shrubland	2.1	21,055.1	0.01	0.08

Contribution to Ecosystem Sustainability

The importance of the lands within the Coronado NF to the sustainability of ecosystems represented by these subsections varies with amount and distribution within and outside of the forest boundaries. On one hand, the Gila Bend Plain Desert Shrubland Subsection comprises eight-hundredths of one percent (0.08 percent) of the Coronado NF, and the 2.1 square miles of that subsection on the Coronado NF only represents one-hundredth of one percent (0.01 percent) of the overall subsection. Because this is such a small area, the ability of the Coronado NF to make a significant contribution to the ecological sustainability of that subsection or section is extremely limited. Conversely, the Santa Catalina Mountains Encinal Woodland type occurs over 56 percent of the Coronado NF, which represents 63 percent of the total square miles in the subsection. The management of these lands within the Coronado NF is highly influential to the sustainability of this subsection.

Table 2 displays how the subsections are distributed across the 12 mountain ranges. This illustrates the unique contribution of each mountain range to the ecological sustainability of the Coronado NF and to the larger ecological land base. Once again, the Coronado NF has a wide range of subsection representation. Over half of the San Rafael Sierra Madre High Plains Grassland Subsection occurs on the Coronado NF (see table 1 above), and table 2 illustrates that all of this subsection occurs within the Huachuca Mountain Range. Therefore, the

Coronado NF makes a major contribution to the ecological sustainability of this subsection, and 100 percent of that contribution is coming from the Huachuca Mountain Range. In contrast, while 63 percent of the Santa Catalina Mountain's Encinal Woodland Subsection occurs on the Coronado NF, this subsection is well distributed across 11 of the 12 mountain ranges.

Table 2. Subsections of the Coronado NF by Mountain Range

Mountain Range	Area (mi^2)	321AG (mi^2)	321AH (mi^2)	321AJ (mi^2)	321AK (mi^2)	321AL (mi^2)	321AM (mi^2)	322BF (mi^2)
Chiricahua	455.56	0	0	263.0	0	0	192.6	0
Dragoon	84.74	0	0	16.2	0	0	68.6	0
Galiuro	210.27	0	0	27.7	0	0	182.5	0
Huachuca	431.77	0	0	22.9	0	44.3	356	0
Peloncillo	137.63	48.7	89.0	0.0	0	0	0	0
Pinaleño	310.79	0	0	32.6	0	0	278.2	0
Santa Catalina	405.75	0	0	64.5	339.2	0	0	2.1
Santa Rita	231.14	0	0	71.2	0	0	160	0
Santa Teresa	77.90	0	0	6.0	71.9	0	0	0
Tumacacori	318.52	0	0	36.5	0	0	275.1	0
Whetstone	70.29	0	0	70.3	0	0	0	0
Winchester	43.86	0	0	5.1	0	0	38.8	0

Ecosystem Diversity

The Coronado NF encompasses 12 major mountain ranges where the Sierra Madre Occidental of Mexico and the Rocky Mountains converge. These mountains, where sub-tropical and temperate origins intersect, are also part of what is known as the Sky Island Archipelago. Here, lands within the Coronado NF rise from the desert floor approximately 7,720 feet to forested mountains where five "life-zones" (environments that are characterized by particular groupings of plants and animals) occur: Lower Sonoran, Upper Sonoran, Transition, Canadian, and Hudsonian (Lowe 1961). As a result, the Coronado NF exhibits an impressive diversity of ecosystems that provide habitat for myriad plant and animal species. This section of the Ecological Sustainability Report discusses current conditions, reference conditions, and trends and projected conditions of the vegetation and the physical environment, including soil, water and air.

Vegetation

Vegetation Communities

Information from the Southwest Regional Gap Analysis Project (SWReGAP) was used to represent the extent of the vegetation communities on the Coronado NF (USGS 2004) in terms of the types of potential vegetation and historic fire patterns. The extent and proportion of each

vegetation community on the Coronado NF is summarized here, as well as the proportion of each vegetation community within the USDA Forest Service's Southwestern Region (Region 3) that occurs on the Coronado NF.

Nine major vegetation communities are identified within the Coronado NF. Table 3 displays the relative percentage of these vegetation communities. Vegetation community descriptions, conditions, and trends are summarized below and further described in appendix A. Appendix A also provides an assessment of risks to sustainability for each vegetation community.

Table 3. Major Vegetation Communities of theCoronado NF

Vegetation Community	Percent of Coronado NF
Desert communities	9%
Semi-desert grassland	26%
Interior chaparral	9%
Madrean encinal woodland	42%
Madrean pine/oak woodland	8%
Ponderosa pine	3%
Mixed conifer forest	2%
Spruce/fir	<1%
Riparian communities	<1%

Desert communities include both the Sonoran and Chihuahuan deserts. The semi-desert grassland category includes some other, less common grassland community types. The term "encinal" refers to oak communities. One other very small vegetation community, montane meadow, is not included in this section, but will be considered in the wildlife, fish, and rare plant habitat section.

Desert communities, interior chaparral, Madrean encinal woodlands, Madrean pine-oak woodlands, and semi-desert grasslands make up approximately 93 percent of the total area of the Coronado NF. Of this, Madrean encinal woodlands account for approximately 42 percent, and grasslands represent around 26 percent. In contrast, the combined area of riparian communities, ponderosa pine, mixed conifer forest, and spruce/fir make up around 7 percent of the total area of the Coronado NF[1].

Riparian communities range across all elevation gradients, from deserts to subalpine forests, thereby spanning a variety of characteristic vegetation communities. Therefore riparian communities are composed of various plant species, dependent upon the elevation and upland vegetation community type. Vander Lee et al. (2006) considered there to be three primary riparian associations on the Coronado NF: cottonwood willow riparian forest (in deserts and grasslands), mixed broadleaf deciduous riparian forest (in oak and pine woodlands), and

[1] These results are largely based on data from SWReGAP, which has not been accuracy tested. Furthermore, SWReGAP data is based on satellite imagery that may not be appropriate at small spatial scales. For example, it is well known that spruce-fir forest exists on the Coronado NF; however, this vegetation community was not detected in the SWReGAP data. This is likely due to the small area that spruce-fir forest occupies on the Forest.

montane willow riparian forest (in conifer forests). In the "Riparian Systems" section, different riparian communities are discussed in greater detail, to show how the various riparian communities differ with regards to the Fire Regime Condition Class (FRCC) and other parameters. In the "Species Diversity" section, riparian areas are functionally considered to be physical, rather than biotic, attributes, in order to discuss habitat associations.

The Coronado NF comprises approximately 8 percent of the total area of National Forest System lands in Arizona and New Mexico (Region 3), yet manages large percentages of certain vegetation communities across the Region 3 national forests. The largest proportion of all Madrean encinal woodlands (approximately 26 percent) in Region 3 national forests is found on the Coronado NF. In addition, the Coronado manages 27 percent of the cottonwood willow riparian forests, 25 percent of the semi-desert grasslands, approximately 17 percent each of the desert communities and Madrean pine-oak woodland, 12 percent of the montane willow riparian forests, and 11 percent of the interior chaparral found overall on National Forest System lands in Arizona and New Mexico (Vander Lee et al. 2006).

Compared with non-Forest Service land-ownership entities in the States of Arizona and New Mexico, the Coronado NF manages large percentages of certain vegetation communities. In the case of the Madrean encinal woodlands, the Coronado NF manages the second largest portion (11 percent) relative to other major land managers throughout the States of Arizona and New Mexico. This represents the largest amount of Madrean encinal woodlands in the region under a single management entity. The largest portion (19 percent) in Arizona and New Mexico is managed by various private landowners, while State lands manage the third largest portion of this vegetation community (9 percent). Conversely, the Coronado NF manages only a tiny fraction of desert plant communities compared to surrounding landownership entities (Vander Lee et al. 2006).

Vegetation Conditions and Trends

In this section, current vegetation conditions are compared to a historic range of variation (HRV) of conditions, as determined by a review of published scientific literature (Schussman and Smith 2006). The HRV characterizes a range of reference conditions, reflecting natural disturbance regimes. The reference conditions are, for the most part, based on conditions that existed between the years 1000 to 1880, that is, before major human-caused disturbances were affected on the landscape[2]. The current conditions in many of the Coronado NF vegetation communities vary, sometimes substantially, from reference conditions. The following descriptions of vegetation condition are arranged according to the general elevational gradient along which they occur, from lowest to highest. Riparian areas, which occur at all elevations, are described last. This section provides a summary of current vegetation conditions, trends and risks to sustainability. More detailed descriptions of each plant community including; plant species composition, associated wildlife,context within the broader planning area, disturbances, current and reference conditions, projected future trends and an assessment of risks to sustainability, are found in Appendix A.

Desert Communities

The Coronado NF manages only a tiny fraction of desert plant communities, compared to the surrounding land-ownership entities. Desert plant communities within the HRV are typically sparse, with few grasses in the understory. They evolved without fire as an ecological process,

[2] It should be noted that many of the large-scale human disturbances known to impact vegetation and ecological processes, such as extensive livestock overgrazing, river damming and canal construction, railroad logging and fire regime alteration, were widespread in the area prior to the establishment of the National Forest in 1908. The notable exception was active fire suppression, which was implemented in National Forests as a standard management practice in the early part of the century.

and most of the plants that characterize the community, including the iconic saguaro cactus, cannot survive fire. On the Coronado NF and on other land-ownerships, this plant community is currently at risk from non-native, invasive grasses which provide fuel for wildfires. The biggest threat is buffelgrass (*Pennisetum ciliare*), The risk to Sonoran desert from non-native, invasive grasses goes beyond wildfire. Buffelgrass grows densely and crowds out native plants of similar size. Competition for water can weaken and kill larger desert plants. Dense roots and ground shading prevent germination of seeds. It appears that buffelgrass can kill most native plants by these means alone (Arizona-Sonora Desert Museum 2008). Populations of invasive, non-native grasses are increasing in desert communities in spite of concerted efforts to restrict them. Most sources of, and vectors for invasive species are beyond the control of the Coronado NF (see Threat Matrix, Appendix A). This combination of factors indicate that the risk[3] to the sustainability of desert communities is high.

Semi-Desert Grasslands

Semi-desert grasslands within the HRV are typically open with low shrub canopy cover.The semi-desert grasslands of southeastern Arizona have been shown to be trending from open grasslands with low shrub canopy cover towards higher shrub canopy cover. Factors such as precipitation patterns, grazing history, soil, and fire all interact to influence non-uniform changes in grassland composition and structure across the region (Gori and Enquist 2003). On private lands surrounding the Coronado NF, ex-urban development has led to loss and fragmentation of grasslands and the disruption of processes, primarily fire, that played a role in maintaining them. Semi desert grasslands make up 26 percent of the Coronado NF. Around 27 percent of these lands are currently in an open, native condition, similar to the reference condition. Another 42 percent have been invaded by shrubs, but have the potential to be restored to an open, native condition through appropriate management actions. An additional 21 percent are open, non-native grassland (primarily dominated by Lehmann lovegrass), and just over 10 percent of former grasslands are considered by experts to no longer have the potential for restoration to grassland (Schussman and Gori 2004). In summary, fifty-two percent of semi-desert grasslands are shrub invaded, of these, 42 percent are considered restorable. Projected trends are toward increased shrub cover unless restoration treatment efforts are increased. Given this trend, and because of identified threats beyond agency control (see Threat Matrix, Appendix A) the risk[3] to sustainability of semi-desert grasslands is moderate to high.

Interior Chapparal

The interior chaparral vegetation community (9 percent of the Coronado NF) differs from historic condition in that higher percentages have a more open canopy and higher percentages have been recently burned. There are indications that, within the Coronado NF, fires are occurring more frequently in this vegetation community than they did historically. This trend toward recently burned and open canopy structure is expected to continue. That said, the overall structure of chaparral as shrub land has been stable over the historical record, although changes at the species level may be occurring with more frequent fire (Schussman and Smith 2006). An assessement of Fire Regime Condition Class[4] (FRCC) indicates that around half of the interior chaparral vegetation community has a high probability of uncharacteristic fire, and the other half has only an elevated probability of uncharacteristic fire. Projected trends are toward more fires, and more open canopy cover. However, the interior chaparral is a fire adapted ecosystem, and the basic structure as a shub dominated type is not expected to

[3] Risk assessments for each vegetation community are found in Appendix A.

[4] Fire Regime Condition Class (FRCC) is a measure of the departure of current vegetation composition and structure from the historical reference condition (USDA Forest Service 2007).

change. There are no identified threats beyond agency control. Given these factors, the risk[3] to sustainability of the interior chaparral is low.

Madrean Encinal Woodland

The Madrean encinal (oak) woodland makes up 42 percent of the total acreage of the Coronado NF. The reference condition is characterized by open stands of oaks with denser stands on north facing slopes and in drainages. An understory of perennial grasses provides fuel for surface fires. Current conditions are not substantially different from reference conditions, although the trend over the last 150 years has been toward higher canopy cover and higher abundances of mesquite and juniper trees (Schussman and Smith 2006). Projected trends indicate that current management practices, if continued, will lead to a structure similar to reference conditions; thus, a more open canopy, and higher percentage of younger trees than currently exists. In summary, the Madrean encinal woodland is the most extensive vegetation community on the Coronado NF. Projected trends are toward reference conditions. There are identified threats beyond agency control (see Threat Matrix, Appendix A), but they are primarily limited to areas along the Forest boundary. Given these factors, the risk[3] to sustainability of the Madrean encinal woodland is low.

Madrean Pine-Oak Woodland

The Madrean pine-oak woodland (8 percent of the Coronado NF) exhibits a large departure from the HRV, with increased closed canopy structure and higher fuel loads compared to reference conditions. This vegetation community was recently added to a list of global conservation “hotspots” by Conservation International (2005), and remains intact within less than 20 percent of the area of its historical range, which lies mostly in Mexico. Studies indicate that prior to 1880 these communities were characterized by widely spaced pines and oaks, with pines dominating the overstory and an understory dominated by perennial grasses. These conditions were maintained by low-intensity, frequent fire. Changes that have occurred, thought to be the result of fire suppression, are an increase in the dominance of oak and other sprouting species. Also, the bunch grass understory has decreased with increased litter and canopy cover, both consequences of fire suppression (Schussman and Smith 2006). As measured by FRCC[4], there is a high proportion of the Madrean pine oak woodlands type (99 percent) with an elevated or high probability of uncharacteristic fire. This probability, coupled with the the high percentage deviating from reference conditions, projected trends away from reference conditions, and identified threats beyond agency control (see Threat Matrix, Appendix A), all indicate a high risk[3] to the sustainability of the Coronado NF Madrean pine oak woodland.

Ponderosa Pine

Ponderosa pine forests on the Coronado NF are characterized by a shrub understory and occur primarily as an association with silverleaf oak, netleaf oak, mountain muhly or screwleaf muhly. They cover approximately three percent of the land area. Historically, these forests experienced a high frequency, low intensity surface fire regime. High severity fire may have occurred in small areas as individual or groups of trees occasionally torched. This fire regime resulted in a larger proportion of older, larger trees and a smaller proportion of smaller, younger trees compared to current conditions. Also, tree canopy cover was much less historically than it is now (Schussman and Smith 2006). Disruption of the natural fire regime with the onset of active fire suppression in the early part of last century has resulted in an accumulation of fuels through litter-fall and development of fuel “ladders” of live and dead trees. The current level of fuel accumulation can result in widespread, destructive crown fires.

The trend toward increasing closed canopy structure is expected to continue, with the notable exception of areas where large fires occur. Since 1994, approximately 42 percent (around

26,600 acres) of the ponderosa pine vegetation type on the Forest has burned in wildfires. An estimated 16 percent (around 10,000 acres) of that was involved in stand replacing fires. Much of this is in designated Wilderness Areas or steep, inaccessible terrain. On non-Wilderness lands, approximately 322 acres have been identified as currently being deforested. Tree planting is targeted on 147 acres, of which 77 acres have been re-planted to date. The management strategy for much of this type has been to monitor natural regeneration, and some areas have been observed to have natural regeneration occurring at the level expected for these harsh sites. Reforestation needs, accomplishments and capabilities will be assessed and refined on an on-going basis.

The high proportion of the ponderosa pine type (99 percent)) with an elevated or high probability of uncharacteristic fire, the high percentage deviating from reference conditions, projected trends away from reference conditions, and identified threats beyond agency control (see Threat Matrix, Appendix A), all indicate a high risk[3] to the sustainability of the Coronado NF ponderosa pine vegetation type.

Mixed Conifer Forest

The situation is similar in mixed conifer forests, which make up two percent of the Coronado NF. Compared with reference conditions, there is a current over-abundance of closed, mid-seral aged stands. Historically, these forests were less dense, with a larger proportion of older, bigger, trees and fewer small, young trees. There were also fewer fire sensitive species, such as white fir (Schussman and Smith 2006). As with the Ponderosa pine forests, these changes are thought to be the result of the onset of active fire suppression in the early 1900's. In the current condition, the mixed conifer vegetation community is at risk from uncharacteristically large insect outbreaks and destruction by unnaturally large and intense wildfires.

The projected trend for this vegetation community indicates there will be an increase in closed canopy structure in the future, again with the notable exception of areas where large fires occur. Since 1994, approximately 45 percent (around 52,000 acres) of the mixed conifer vegetation type on the forest has burned in wildfires. An estimated 18 percent (around 21,000 acres) of the mixed conifer vegetation type on the forest was involved in stand replacing fires. Much of this is in designated Wilderness Areas or steep, inaccessible terrain. On non-Wilderness lands, approximately 660 acres have been identified as currently being deforested. Tree planting was targeted on 312 acres, of which 262 acres have been re-planted to date. The management strategy for much of this type has been to monitor natural regeneration, and some areas have been observed to have natural regeneration occurring at the level expected for these harsh sites. Reforestation needs, accomplishments and capabilities will be assessed and refined on an on-going basis.

The high proportion of the mixed conifer forest (92 percent)) with an elevated or high probability of uncharacteristic fire, the high percentage deviating from reference conditions, projected trends away from reference conditions, and identified threats beyond agency control (see Threat Matrix, Appendix A), all indicate a high risk to the sustainability of the Coronado NF mixed conifer vegetation type.

Spruce-Fir Forest

The spruce-fir forest makes up much less than one percent of the total acreage of the Coronado NF, but is disproportionately important because of its unique characteristics and lack of representation elsewhere on the Coronado NF. The spruce-fir forest on top of the Pinaleño Mountains is undergoing a massive die-off of mature trees, primarily due to drought, high density of trees and competition, and insect outbreaks (Schussman and Smith 2006). The current insect outbreak involves a variety of species including the exotic spruce aphid (Lynch

2006). Destructive wildfire and/or warming climate could lead to a loss of this vegetation community altogether. Since 1998, over 90 percent (around 1,800 acres) of the spruce-fir vegetation type on the forest has suffered mature tree mortality due to insect attack and wildfire. Many of the areas where mortality has occurred are currently regenerating to aspen forest cover. On non-Wilderness lands, approximately 130 acres have been identified as currently being deforested (insufficient spruce or aspen regeneration). Spruce planting was targeted on 130 acres, all of which have been re-planted to date. The management strategy for much of this type has been to monitor natural regeneration, and some areas have been observed to have natural regeneration of spruce occurring. Reforestation needs, accomplishments and capabilities will be assessed and refined on an on-going basis. The long-term potential for spruce regeneration is unknown, however, due to the presence of an exotic defoliating insect (spruce aphid), which may prevent seedlings from growing to maturity.

The very small amount of the spruce-fir vegetation within the Coronado NF, along with identified threats beyond agency control and limited management options to reduce those threats, indicate a high risk to the sustainability of the Coronado NF spruce-fir vegetation type (see Threat Matrix, Appendix A).

Riparian Areas

Riparian areas are of primary importance because of the rarity of water in the region. The small areal extent of the sky island riparian areas, coupled with the generally shallow saturated zone beneath them, make them vulnerable to changes in climate and management. Historic overgrazing and poorly located roads are management concerns that have been, or are being, addressed. Changes in climate, including drought and summer floods, have resulted in a loss of mature and sapling trees, and therefore a lower canopy closure. In addition, riparian tree species are not successfully reproducing. During drought conditions, riparian areas are more susceptible to damage from wildfire than under normal conditions. Because of the narrow, linear structure of riparian areas, they take on the risk to sustainability of the surrounding vegetation communities. In addition, there are a number of identified threats to riparian areas that are beyond agency control (see Threat Matrix, Appendix A). Given these considerations, the risk[3] to sustainability of riparian areas ranges from low to high.

Soils

Soil Types

Soil descriptions for lands within the Coronado NF boundary are derived from terrestrial ecological units described in the Forest's General Ecosystem Survey (GES) of the Coronado NF, 1991. This survey is the result of the systematic analysis, mapping, classification, and interpretation of terrestrial ecosystems and provides descriptive information of terrestrial ecological units at the landscape level within the boundaries of the Coronado NF. Appendix B displays the GES units found within the Coronado NF boundary, along with a description of units, and the percentage of each unit within the Coronado NF. Because the GES does not extend beyond the boundaries of the Coronado NF, it does not provide a context for the Coronado NF niche in southeastern Arizona.

Soil Conditions and Trends

Soil condition is influenced by climate, geomorphic processes, and anthropogenic disturbances. Lands in southern Arizona, including the Coronado NF, have experienced significant cycles of historic natural and human caused impacts (Bahre 1991, Turner et al. 2003). Drought, fire, livestock grazing, woodcutting, and human settlement have had varying degrees of historical

impact to the soil resource. According to historical records (Bahre 1991) it is assumed that prior to 1870 the biological environment of southeast Arizona was relatively stable. Exceptions to this situation were those areas with inherently unstable geologic parent materials that are naturally erosive.

Generally, flat landforms such as elevated and valley plains experienced greater historic management impacts than steeper slopes (USDA, 1991). Vegetation types typically represented on these landforms are desert communities, semi-arid grasslands, and Madrean encinal woodlands. Recovery of affected soils is a long-term process, and the rate of recovery varies with precipitation patterns across space and time. Current management activities that affect soil conditions are livestock grazing, transportation systems, managed recreation, unmanaged recreation (especially off-highway vehicle use), prospecting for minerals, water withdrawals, and border related activities (including undocumented immigration, smuggling and consequent law enforcement actions).

Soil condition assessment techniques have varied over the years, evolving with increased understanding of soil functionality. Current assessment criteria are found in FSH 2509.18. According to this protocol, soils are classified as either “satisfactory”, “impaired”, or “unsatisfactory.” Satisfactory soil conditions signify that soils are functioning and current soil loss is less than the soil loss tolerance threshold[5], and includes those soil types that are inherently unstable due to extremely steep slopes or unconsolidated parent materials and natural variability in soil productivity. Unsatisfactory soil conditions signify that current erosion rates are higher than the soil loss tolerance threshold, resulting in a loss of soil surface horizons and potentially lower soil productivity.

Overall soil conditions were assessed on the Coronado between 1977 and 1986 (Coronado National Forest, 1986) using a protocol described in Hydrology Note 14 (USDA 1981), and again between 1998 and 2008 (Coronado National Forest, 1998-2008) using a protocol described in FSH 2509.28. Although the assessment protocols differed, the criteria of adequate vegetative ground cover were found in both protocols. Both assessments show that soils classified as “impaired” or “unsatisfactory” were at least in part lacking vegetative ground cover, whereas vegetative ground cover was adequate on soils in “satisfactory” condition. A comparison of these two assessments is shown in table 5.

[5] Soil loss tolerance threshold is defined as the rate of soil loss that can occur while sustaining inherent site productivity. Threshold values vary by kind of soil (depth, soil climate) and roughly equate to the point where long-term soil regeneration and soil productivity is sustained.

Table 4. Soils in Satisfactory Condition by Mountain Range

Mountain Range	% Satisfactory Pre- 1986	% Satisfactory Post 1998
Chiricahua	66%	96%
Dragoon	73%	94%
Galiuro	81%	92%
Huachuca	75%	82%
Peloncillo	74%	97%
Pinaleño	75%	80%
Santa Catalina	55%	99% (26% of the range assessed)
Santa Rita	71%	93%
Santa Teresa	31%	79%
Tumacacori	84%	81%
Whetstones	67%	100%
Winchester	100%	97%

Table 4 shows that in areas that have been assessed, much of the low-elevation and mid-elevation areas have shown an improvement over the past 20 years. “Satisfactory” conditions are mostly found on resilient, stable elevated plains, hills, and mountains and are represented in most vegetation communities. This indicates that onsite soil loss is within threshold limits and soil compaction is not reducing the hydrologic function of the soil to absorb and infiltrate rainfall, minimizing soil loss, and therefore maintaining long-term soil productivity.

Conversely, the greatest areas of “impaired” and “unsatisfactory” soil conditions continue on highly disturbed elevated plains in the desert communities, encinal woodlands, pine-oak woodlands, and minor areas of the grasslands. In “impaired” or “unsatisfactory” areas, soil erosion may be occurring beyond its threshold and soil compaction may be evident, limiting effective precipitation infiltration to support effective groundcover. Therefore, in these areas there is a risk of not maintaining long-term soil productivity. Maintaining “satisfactory” soil condition is important in maintaining long-term soil productivity that is, in turn, essential in sustaining ecosystem diversity.

Projections of soil condition given disturbances and current management activities indicate that there will likely be shorter-term erosion cycles in the future, as large fires and subsequent flooding appear to be increasing. Improved range management practices are allowing for revegetation and maintenance of overall soil productivity, except where gully systems are enlarging or newly developed during erosion events.

Water Quality and Water Quantity

Sub-basins and Watersheds

The Coronado NF uses the organization system for hydrologic data developed by the United States Geologic Survey (USGS) (USDI 1994). The USGS organizes areas into a hydrologic system that divides and subdivides the United States into successively smaller units. These levels of subdivision are called “hydrologic units”. The hydrologic units outlined in the National Atlas are both natural and manmade. The identifying numerical codes called “hydrologic unit codes” are associated with these units. The hydrologic unit codes describe the relation of the hydrologic units to each other to represent the way smaller watersheds drain areas that together form larger units. All of the Coronado NF is located in Region 15 (Lower Colorado River Region). Three subregions are represented: 1504 (Upper Gila Subregion), 1505 (Middle Gila Subregion), and 1508 (Sonora Subregion). Subregions are divided into basins, basins are divided into sub-basins, and sub-basins are divided into watersheds. The term “watershed” in this discussion refers to this subdivision unit.

The Coronado NF is contained within nine sub-basins and 51 watersheds. Subwatersheds have not been developed to date. The sub-basins and watersheds are listed in appendix C.

Water Quality Conditions and Trends

Water quality is affected by direct additions of pollution from a point source, or from landscape accumulations of pollutants (non-point source). The States of Arizona and New Mexico have conducted water quality assessments and reported on them as required by the Clean Water Act[6]. Assessments are not applicable to the watershed or sub-basin level because all data are presented at the stream reach level, which often represents a very small portion of a watershed or sub-basin. Streams and lakes are the only waterbodies tested; springs, stockponds and cienegas are not assessed.

In the State of Arizona, water quality testing is performed by the Arizona Department of Environmental Quality (ADEQ, 2004)). Approximately 5 percent, or 134.24 miles, of the watercourses within the Coronado NF have been assessed for water quality. Also, six Coronado NF lakes have been tested. Off National Forest System lands but within watersheds that originate on the Coronado NF, water quality has been assessed by the ADEQ on 537.65 miles of streams and in eight lakes. The percentage of all watercourses assessed is not known. Specific parameters that are assessed are listed in table 6 and specific ADEQ Categories are defined in the table 7.

[6] Clean Water Act, 33 U.S.C. Chapter 26 (1972)

Table 5. Water Quality Parameters

Constituents tested	Specific tests
Metals and Metalloids	Arsenic, boron, cadmium, copper, lead, mercury, selenium, silver, zinc
Sediment related pathogens	*Escherichia coli*
Pesticides	Chlordane, DDT, Toxaphene
Nutrients	Nitrogen, nitrate
Other parameters	Low pH, low dissolved oxygen, chlorine

Table 6. ADEQ Water Quality Categories

Category	Definition
1: Attaining All Uses	All designated uses assessed as "attaining"
2: Attaining Some Uses	At least one designated use assessed as "attaining" and all other uses assessed as "inconclusive"
3: Inconclusive	All designated uses are "inconclusive" (by default, any surface water not assessed due to lack of credible data are actually included in this category)
4: Not Attaining	At least one designated use is "not attaining", but a Total Maximum Daily Load (TMDL) analysis is not needed. In our cases, a TMDL analysis is not needed because one has already been completed and is sufficient and being implemented.
5: Impaired	At least one designated use was assessed as "impaired" and a TMDL analysis is needed.

The designated uses for all waterbodies are one or more of the following: aquatic and wildlife (warm), aquatic and wildlife (cold), fish consumption, body contact, domestic water, irrigation, and livestock watering.

According to the 2004 ADEQ draft report, "Status of Water Quality in Arizona: The Integrated 305(b) Assessment and 303(d) Listings Report" (ADEQ 2004), some reaches within and downstream of the Coronado NF have been determined to be impaired and not meeting State standards for uses specified for that water body. A total of one stream (10.6 miles in length) and two lakes within the Coronado NF are classified as "impaired". In addition, five streams (26.41 miles) and two lakes are classified as "not attaining" because they have Total Maximum Daily Load[7] (TMDL) plans in process. Off National Forest System lands, several other streams are listed.

[7] A TMDL plan is a written, quantitative plan and analysis to determine the maximum loading on a pollutant basis that a surface water can assimilate and still attain and maintain a specific water quality standard during all conditions. The TMDL allocates the loading capacity of the surface water to point sources and nonpoint sources identified in the watershed, accounting for natural background levels and seasonal variation, with an allocation set aside as a margin of safety.

The impaired stream within the Coronado NF is Cave Creek in the San Simon Sub-basin. It is classified as impaired due to selenium levels that could be natural background. The impaired lake is Rose Canyon Lake in the Rillito Sub-basin. It is classified as impaired due to its eutrophic condition following two major wildfires in the watershed that caused a large amount of burned organic matter to erode into it. The five streams with TMDL plans in process are Alum Gulch, Humbolt Canyon, Harshaw Creek, Three R Canyon, and Cox Gulch. All five streams are in the Upper Santa Cruz Sub-basin, and all are exposed to heavy metals, resulting from past mining activities within their watersheds. Arivaca Lake in the Brawley Wash subbasin and Peña Blanca Lake in the Upper Santa Cruz Sub-basin have TMDL approved plans for improving mercury content in the lake sediments. The source of mercury is thought to be atmospheric and from natural levels within the soil of the watershed.

Downstream from the Coronado NF there are 153.56 miles of impaired streams and 26.41 miles of streams listed as not attaining. The presence of heavy metals or *Escherichia coli* bacteria is generally the cause of impaired ratings for streams. The presence of mercury or eutrophic conditions is the cause for impaired ratings in lakes.

In New Mexico, no waters within or immediately downstream from the Coronado NF in the State of New Mexico have been identified as not meeting standards.

Reference condition levels of heavy metals and mercury are not known. It is recognized that natural levels of heavy metals and mercury are present in the watersheds of the State of Arizona. Perennial lakes are not natural in southeastern Arizona, and there is no known reference condition for water quality in lakes. In the absence of data indicating what natural levels are expected to be, Clean Water Act standards for heavy metals and other constituents are presumed to be the reference conditions.

Current water quality is almost certainly degraded compared with reference conditions. The majority of pollutants are from activities that did not exist in the reference timeframe; specifically, mining, grazing, hydrologic modification (channelization), pesticide use, recreation, roads, and crop production. Within the Coronado NF, the trend for all water quality constituents is either static or up (improving). The Coronado NF will continue to manage national forest activities using best management practices to minimize impacts to water quality as described in the current Forest Plan.

Water Quantity Conditions and Trends

In the watersheds that have perennial water, the Coronado NF contains a large share of miles of perennial stream compared to land area of National Forest within the watersheds (Lefevre and Halverson, 2007). The Coronado NF manages approximately 21 percent of the land area of its component sub-basins and has about 36 percent of the miles of perennial streams. Exceptions are the Upper San Pedro River Sub-basin, the Animas Valley Sub-basin, and the Whitewater Draw Sub-basin, where there is no, or much less, perennial water.

The amount of perennial surface water on the Coronado NF and in the watersheds beyond its boundaries is perceived to have declined from reference conditions, however, there are no streamflow gauging stations to verify a decline. The cause of the decline on the Coronado NF is thought to be the prolonged drought that affected the region from 1995-2005. Beyond the boundaries of the Coronado NF, in addition to drought, extraction of groundwater for land uses such as agriculture and development is lowering water tables and decreasing perennial surface water.

Riparian Systems

Riparian systems have vegetative as well as physical characteristics. This discussion combines both, emphasizing the physical. An additional riparian vegetation community discussion is found in the "Vegetation Condition and Trends" section.

Riparian Vegetation

There are several classifications of riparian vegetation. The State of Arizona Game and Fish Department developed a riparian area map (AGFD, 1994) that includes all subbasins within the Coronado NF. In addition, the forest has identified riparian areas (USDA, 1986) and conducted riparian area data collection and monitoring on National Forest System Lands since 1984 (USDA, 1984). The Nature Conservancy (Vaner Lee, et. al., 2006) included riparian area descriptions for the Coronado NF. A formal crosswalk between these three vegetation identification systems has not been developed. The following informal crosswalk can be used:

Table 7: Informal crosswalk for riparian area classification

AGFD	Coronado NF	The Nature Conservancy
Conifer Oak	Coniferous Riparian	Montane Willow Riparian Forest
Cottonwood Willow	Deciduous Riparian	Cottonwood Willow Riparian Forest
Mesquite	Dry Desert Riparian	Cottonwood Willow Riparian Forest
Mixed Broadleaf	Evergreen Riparian	Mixed Broadleaf Deciduous Riparian Forest

Channel Morphology

Data collected since 1998 on the Coronado NF used the Southwestern Region Riparian Area Survey and Evaluation System (USDA, 1989) and include channel morphology information. No similar data collection is known for areas off the Coronado NF. Channel morphology is expressed using two measurements; "entrenchment ratio" and "width to depth ratio".

"Entrenchment ratio" is the width of the flood-prone area to the surface width of the bankfull channel (Rosgen 1996). The expected range of ratio values vary with stream type. Ratios in five of the 13 Coronado NF sub-basins are within the expected range, while eight are outside of the range. Of these eight, seven have ratios higher than expected, indicating aggradation. One sub-basin is below the expected range, indicating incisement, or gullying. In all cases, management changes have been made to address the problem.

"Width to depth ratio" is the bankfull channel width divided by mean depth of the bankfull channel (Rosgen 1996). As with entrenchment ratios, the expected range of width to depth ratios varies with stream type. In channels within the Coronado NF, ratios in 12 of the 13 sub-basins are within the expected range. The width to depth ratio of one Coronado NF sub-basin is outside of the expected range, and management changes have been made to address the problem.

Riparian Area Conditions and Trends

Riparian areas represent only 0.6 percent of the land area within the total area of the 13 sub-basins when considering all ownerships, and only 0.3 percent of the land area on the Coronado NF (Lefevre and Halverson, 2007). Several sub-basins contain no mapped riparian areas, and others contain mapped riparian areas only outside National Forest Systems lands. These sub-basins include major river systems, such as the San Pedro, Santa Cruz and Gila rivers (appendix C). However, as seen in appendix C, the Coronado NF contains the majority of all

riparian areas mapped in the San Simon, Wilcox Playa, and Whitewater Draw sub-basins (Lefevre and Halverson, 2007). Riparian areas mapped in these sub-basins are unique because the sub-basins do not include major rivers. Riparian vegetation communities cover approximately 9,700 acres (less than one percent) of the Coronado NF, but are disproportionately important because the water that supports these communities, surface and subsurface, is rare.

Livestock grazing, transportation systems, managed recreation, unmanaged recreation (especially off-highway vehicle use), prospecting for minerals, water withdrawals, border related activities (including undocumented immigration, smuggling and consequent law enforcement actions), flooding, wildfires, are all disturbances that exist in many riparian areas (Baker, et. al., 2007). Of these, flooding and fire are natural disturbances influenced by, but not controlled by management. Flood frequency is controlled largely by precipitation events, but all the other disturbances listed can have an effect on flood size and frequency. All riparian vegetation types are affected similarly by these disturbances, except fire. Fire frequency varies by riparian forest type. Fires are more frequent in montane willow and cottonwood willow riparian forests (14 and 15 of the last 22 years), and the average acres burned is small (51 to 66 acres per year) (Schussman and Smith, 2006). An assessment of Fire Regime Conditions Class indicates that in the future, fires will be more frequent and more severe. Because of this, flooding frequency and severity will also been altered.

Table 8. Fire Regime Condition Class[4] (FRCC) evaluation for 3 riparian vegetation types

Fire Regime Condition Class	Cottonwood Willow (%)	Mixed Broadleaf Deciduous (%)	Montane Willow (%)
I	6	16	6
II	77	29	45
III	17	56	48

Historic over-grazing and poorly planned transportation systems caused damage to many channels within the Coronado NF in the past. Management changes have been made, and are continuing to be made, to address these situations. Recreation management has had limited success in riparian areas, whereas prospecting is generally well managed to protect riparian areas. Water withdrawals will almost certainly continue, as will fire and flood frequency and severity at unnatural levels. The general trend of either static or down for vegetation measures can be at least partly explained by the drought that has been ongoing since 1999. Mature and sapling trees have been lost to the drought, and riparian tree reproduction is not surviving, resulting in lower canopy closure. The general trend of up, or of not known but currently within the expected range for channel characteristics, is a result of generally improved range management in riparian areas and careful management of recreation, prospecting, and road location and maintenance. Data collection and monitoring is ongoing.

Air Quality

Both current and historic visibility conditions, as well as trends, are documented through the Interagency Monitoring of Protected Visual Environments network (Colorado State University 2006). This includes data from the Chiricahua National Monument. The pollutants that contribute to visibility impairment also contribute to atmospheric deposition and other ecosystem

effects. The National Atmospheric Deposition Program network contains nitrate and sulfate data for the Chiricahua National Monument site: in the last 3 years, the precipitation-weighted mean concentration is 1.24 mg/L for nitrate and 0.77 mg/L for sulfate.

EPA lists non-attainment areas in the State of Arizona, including Pima County, in the Federal Register (40 CFR 81– Designation of Areas for Air Quality Planning Purposes) and on their website. The State and Local Air Monitoring Stations network contain data for criteria pollutants, including sulfur dioxide, nitrogen oxides, particulate matter, and ozone.

Real-time data are available at the Pima County Department of Environmental Quality Air Info Now website. Although air standards are largely attained in Pima County, there are potential problems with ozone levels being close to the standards. There have been no exceedances of the PM2.5 standard in Pima County since monitoring began in 1999. Nitrogen dioxide averages about 30 percent of the standard and sulfur dioxide averages about 7 percent of the standard in Pima County, with little change in concentration over 15 years. Carbon monoxide concentrations have been declining in Pima County, and are currently about 20 percent of the standard (http://www.deq.pima.gov/air/pdf/2004AnnualDataSummary.pdf).

Table 9. Criteria Pollutant Summary Report

Criteria Pollutant Area Summary Report

As of March 02, 2006

State: Simple Name / Pollutant	Nonattainment Area Name	Population (1000s)	Number of Counties	Classification
AZ: Ajo				
PM-10	Ajo (Pima County), AZ	8	1	Moderate
AZ: Douglas (Cochise County)				
PM-10	Douglas (Cochise County), AZ	16	1	Moderate
SO2	Douglas (Cochise County), AZ	16	1	Primary
AZ: Hayden/Miami				
PM-10	Hayden/Miami, AZ	4	2	Moderate
SO2	Hayden (Pinal County), AZ	2	1	Primary
SO2	Miami (Gila County), AZ	2	1	Primary
AZ: Nogales				
PM-10	Nogales, AZ	25	1	Moderate
AZ: Paul Spur (Cochise County)				
PM-10	Paul Spur, AZ	1	1	Moderate
AZ: Phoenix-Mesa				
8-Hr Ozone	Phoenix-Mesa, AZ	3,086	2	Subpart 1
PM-10	Phoenix, AZ	3,112	2	Serious
AZ: Rillito (Pima County)				
PM-10	Rillito, AZ	1	1	Moderate
AZ: San Manuel				
SO2	San Manual (Pinal County), AZ	8	1	Primary

Air Quality Conditions and Trends

Natural visibility conditions, and efforts to attain the national visibility goal of “no anthropogenic impairment,” are defined by the Regional Haze Rule and State Implementation Plans. States are developing milestones for visibility to reach natural conditions by the year 2064 (ADEQ 2003). Natural events that impair visibility include volcanic and seismic activity, wildland fires, high winds, and other natural disasters (EPA 1996, 1998). The State of Arizona Department of Environmental Quality also has a policy on exceptional and natural events that discusses fire (April 28, 1999).

Deciview (dv) is a metric used to quantify departure from natural visibility conditions. The haze index (HI) measures visibility from calculated light extinction measurements. Uniform changes

in the haze index correspond to incremental changes in visual perception from pristine to highly impaired conditions. The HI calculates dv directly from the total light extinction [the measurement unit for extinction is “bext”, expressed in inverse megameters (Mm-1)] as follows: HI = 10 ln (bext/10).

If the Regional Haze Rule and State Implementation Plan conditions are met, visibility conditions will steadily improve. By 2064, visibility on the 20 percent average best days could improve by 4.3 dv (i.e., from a current 6.1 dv to 1.79 dv at the Chiricahua Wilderness and from a current 6.0 dv to 1.76 dv at the Galiuro Wilderness). On the 20 percent worst days, visibility might improve by only 1.8 dv by the year 2018. These estimates are available through the Western Regional Air Partnership and Arizona State Implementation Plan.

In general, wet sulfate deposition is stabilizing in the west, but wet nitrate deposition is increasing. At the Chiricahua National Atmospheric Deposition Program site, nitrate concentrations are increasing, but sulfate concentrations are more stable. If visibility conditions are improved, then atmospheric deposition levels should also decline.

Reports of the Western Regional Air Partnership and the State Implementation Plan list emission levels that correspond to future growth and implementation of new regulations and standards. EPA has also estimated changes in air emissions due to new regulations. For example Arizona sources would reduce emissions of nitrogen oxides by 63 percent, and mercury by 69 percent by 2020 due to the Clear Skies Initiative, although sulphur dioxide emissions would remain unchanged (http://www.epa.gov/air/clearskies/state/az.html).

Sustainability Discussion: Ecosystem Diversity

Vegetation

There are nine major vegetation communities represented on the Coronado NF. With the notable exception of the Madrean oak woodlands, conditions in these communities differ, sometimes substantially, from reference conditions. Reference conditions described in this report represent what are thought to be the vegetation communities that would result from natural disturbance regimes and biological processes. The descriptions are derived from a thorough review of empirical, peer reviewed documentation and are largely based on what is known to have existed between the years 1000 to 1880 (Schussman and Smith 2006).

Reference conditions provide a point of comparison for what would be self sustaining systems under the disturbance and climate regimes that existed when they developed. This knowledge can be used to evaluate the sustainability of current vegetation communities; however, in many cases the reference conditions are poorly understood and/or realistically unattainable in a human timeframe. It is clear that current disturbance and climate regimes are different from what existed when these communities formed. The differences are attributable to a number of causes. Climate variability has affected vegetation mortality and reproduction. Homebuilding and road development have fragmented the landscape. Invasive species are changing vegetation dynamics. Historic overgrazing and a legacy of fire suppression have altered the vegetation structure and composition in many areas. All of these changes have effects that are predicted to continue, and in some cases to increase in the foreseeable future.

Although reference conditions may not be attainable, sustaining vegetation communities as functioning systems is the goal that management aspires to (36 CFR 219.10 (1).). On the Coronado NF, this means understanding and reducing the risks to sustainability that exist in each vegetation community. It also means examining management direction to determine if management activities are contributing to the risks (see Risk Assessment, Appendix A).

The primary risk to desert communities[8] is the spread of invasive non-native grasses. For the Coronado NF, preventing fires in desert plant communities will be an important strategy for reducing the spread of these grasses. Also, a concerted effort must be made to remove or control buffelgrass if desert plant communities are to be sustained. Long term commitments to monitoring the spread of invasive non-native grasses will be necessary in order to get ahead of future threats. Because most of the affected lands are managed by other entities, the Coronado NF will need to work closely with partners and neighbors to address the problem.

There are many factors that affect the sustainability of semi-desert grasslands[6]. Domestic livestock grazing is an extensive use of Coronado NF grasslands, and is currently managed at levels that are ecologically sustainable (Holechek et al. 1999). Shrub invasion due to fire exclusion, and land fragmentation due to ex-urban development (Schussman and Smith 2006) are the primary current threats to grasslands. These two disturbances interact to make grassland restoration activities by the Coronado NF more difficult. The use of fire as a restorative process is complicated by the need to protect the developments that are increasing along Coronado NF boundaries. There will be a continuing need to work with neighboring communities and land owners to maintain, where possible, open and unfragmented landscapes

Conditions in both the interior chaparral and the madrean encinal woodlands[6] are within, or close to, the HRV. Current management under current climate conditions will sustain these these communities, although the trend in age class will be toward younger shrubs in the interior chapparal.

In spruce/fir, mixed conifer, and ponderosa pine forests[6], reducing the threat of large catastrophic, stand replacing wildfires will be necessary if these communities are to be sustained. At the same time, frequent low-intensity fires; and occasional low frequency, high-intensity fires; will need to be part of the restorative process because they play an important role in maintaining healthy forest ecosystems. Current conditions are likely the result of a legacy of fire suppression. While fire suppression will continue to be an appropriate management response to prevent catastrophic fire, especially when there are risks to life or property or to protect non- fire adapted ecosystems, the Coronado NF recognizes the importance of fire as a natural process in fire-adapted ecosystems.

Sustaining vegetation communities also means recognizing that their component processes function at broad scales. The mosaic of seral and structural stages descriptive of reference conditions was historically distributed widely across the landscape. Widespread fire suppression, drought, and die-off due to disease create whole landscapes at risk of destruction by wildfire because of continuous fuel loading. Treatments will need to be considered to create large areas within landscapes that have a lower risk of destructive fire (Betancourt et al. 2004). Areas within recently burned landscapes provide practical opportunities for this approach (Millar et al. 2007).

Finally, much of what is known about managing vegetation is based on assumptions about climate and disturbance regimes that may no longer be valid. Future success in sustaining vegetation communities will require an adaptive management strategy. This means systematic observation (monitoring) and analysis of treatment results, and adaptation of treatment methods based on those results.

[8] This discussion includes the riparian areas associated with the vegetation community.

Soils

Soil erosion has been a problem in the past, mostly due to under-designed, unmaintained transportation systems coupled with a lack of herbaceous ground cover due to historic overgrazing. Current management has largely corrected these problems except for unmanaged recreation and border issues. Over the past 10 years, soil condition surveys have been conducted on 10 of the 12 mountain ranges within the Coronado NF. Most areas have improved to satisfactory conditions under existing management, and most of the remaining areas are trending toward satisfactory conditions. Exceptions to improving conditions are areas where large fires have occurred, resulting in accelerated soil erosion. Reducing the risk of large, destructive fires will be key to sustaining the soil resources within the Coronado NF. Other areas still at risk of soil erosion and compaction are areas where vehicle use is not adequately managed.

Water Quality

A total of one stream and two lakes on the Coronado NF are impaired. In addition, five streams and two lakes have TMDL plans in process. Two recent large fires resulted in eutrophic conditions in one lake, and could be a risk for the few other lakes within the Coronado NF. However, in general, water quality is being maintained or improved under current management. However, water quality degradation as a result of flooding following large fires will continue to be a risk.

Water Quantity

In the watersheds that have perennial water, lands within the Coronado NF contain a large share of the miles of perennial streams; the Coronado NF has approximately 21 percent of the land area of its component sub-basins and it has 36 percent of the miles of perennial streams. Exceptions are the Upper San Pedro River Sub-basin, the Animas Valley Sub-basin, and the Whitewater Draw Sub-basin, where there is much less perennial water. The overall amount of perennial surface water is perceived to have declined from reference conditions. There are no streamflow gaging stations to verify a decline. This perceived decline is thought to be due to prolonged drought, which may be the result of climate change. In terms of managing for sustaining water quantity within the Coronado NF, the key will be in protecting soils and vegetation, and therefore providing for natural runoff when precipitation occurs.

Riparian Systems

Riparian areas occupy less than one percent of the total land area of the sub-basins as a whole. The Coronado NF has even less. Unlike the larger riparian areas downstream, however, the riparian areas found in the sky islands are relatively free of exotic plant species such as salt-cedar. The small areal extent of the sky island riparian areas, coupled with the generally shallow saturated zone beneath them, makes them vulnerable to changes in climate and management.

Little is known about the HRV for vegetation and channel characteristics within riparian areas. General observations indicate that the trend for channel bank protection is up; for canopy closure it is down; and for vegetation it is static or down. The trend for width:depth ratio and entrenchment ratio is not known. It is believed that historic grazing and transportation systems may have damaged many channels in these sub-basins. Management changes have been made, and continue to be made, to address these situations. The general trend of either static or down for vegetation measures can be at least partly explained by the drought that has been

ongoing since 1999. Mature and sapling trees have been lost to the drought, and riparian tree reproduction is not surviving, resulting in lower canopy closure. In addition, major wildfires have resulted in changes to riparian conditions. The general trend of up or not known, but currently within the expected range, for channel characteristics is a result of generally improved range management in riparian areas and careful management of road location and maintenance. Drought and large, severe wildfires continue to be risks for riparian systems within the Coronado NF.

Air Quality

The Coronado NF is within four airsheds. The Gila River and Mexico Drainage airsheds have non-attainment areas for particulates and sulfur dioxide, neither of which are attributed to National Forest activities. The data collected indicate that all air quality attributes are improving or are static. Visibility is not being monitored on the Class I Wilderness Areas (Galiuro Wilderness and Chiricahua Wilderness), but nearby monitoring indicates the trend is up for the Chiricahua area and static for the Galiuro area. If the Regional Haze Rule and State Implementation Plan conditions are met, visibility conditions will steadily improve through 2064. It is estimated that sulphur dioxide emissions will remain unchanged through 2020.

Species Diversity

Wildlife, Fish, and Rare Plants

The Coronado NF likely has the highest biological diversity of any National Forest in the western United States of America. This is due to the fact that it is situated at a convergence zone of ecological regions and vegetation communities. To the west is the Sonoran Desert; to the southeast is the Chihuahuan Desert; to the north are the Central Arizona Mountains; and to the south is Mexico's Sierra Madre Occidental. Elevations range from about 3,000 ft to nearly 11,000 ft above mean sea level. Along this elevational gradient, vegetation communities range from deserts to subalpine forests, but most of the Coronado NF is comprised of semi-desert grasslands, Madrean encinal woodlands, and Madrean pine/oak woodlands. Biological diversity is further enhanced by a long growing season, a dual rainy season, and the evolutionary consequences of isolation of the sky island mountain ranges.

The number of species inhabiting the Coronado NF and adjoining lands is not precisely known, and new species are periodically described, but conservative estimates include about 2,100 species of plants, 466 species of birds, 110 species of mammals, 91 species of reptiles, over 240 species of butterflies, and nearly 200 species of mollusks (Jones 2005).

Threatened Species, Species-of-Concern, and Species-of-Interest

Three species lists are the basis for the species diversity component of ecological sustainability. These lists include federally designated Threatened and Endangered (T & E) species, Species-of-Concern (SOC), and Species-of-Interest (SOI). Table 9 summarizes the number of plant and animal species and subspecies on these lists by taxonomic group.

Table 10. Taxonomic groups of plants and animals of the Coronado NF considered for the Forest Plan revision process. Number carried forward for further analysis are shown in parentheses. Thirty of the SOI are non-native invasive species.

Taxonomic Group	Threatened and Endangered	Species-of-Concern	Species-of-Interest	TOTAL
Amphibian	2 (2)	2 (2)	5 (5)	9 (9)
Bird	6 (4)	5 (4)	9 (9)	20 (17)
Fish	7 (7)	2 (2)	10 (10)	19 (19)
Arthropod	0	76 (30)	1(1)	77 (31)
Lichen	0	7 (3)	0	7 (3)
Mammal	6 (5)	4 (4)	17 (17)	27 (26)
Non-Vascular Plant	0	6 (2)	0	6 (2)
Vascular Plant	3 (3)	174 (124)	42 (42)	219 (169)
Reptile	1 (1)	3 (2)	11 (11)	15 (14)
Mollusk	0	60 (16)	0	60 (16)
TOTAL	**25 (22)**	**339 (189)**	**95 (95)**	**459 (306)**

There are a total of 459 species on the lists, distributed as such: 25 T & E, 339 SOC, and 95 SOI. Of these, 306 taxa will be carried forward into the plan revision process. The remaining 153 species will not be further analyzed at this point because their distribution and natural history are too poorly understood to allow us to effectively manage for them, or because of other reasons described in the criteria for screening species in the planning rule directives (FSH 1909.12). Subsets of surrogates to represent groups of species were not developed for the Coronado NF, recognizing that each species is different and selecting true surrogates would not have been possible. Detailed descriptions of the planning rule directives in the Forest Service Handbook, including information on species lists, carrying forward, and screening, can be viewed online, under FSH 1909.12 (Land Management Planning Handbook), Chapter 40 (Science and Sustainability): http://www.fs.fed.us/im/directives/fsh/1909.12/1909.12_40.doc

The composition of species on these three lists differs dramatically. Appendix D shows the T & E species, which are primarily vertebrates (88 percent of the total; 12 percent are plants and zero percent are invertebrates), whereas the SOC list (Appendix E) is very different (only six percent are vertebrates, while 40 percent are invertebrates and 54 percent are plants). The SOI list (Appendix F) has a fairly even mix of vertebrates (55 percent) and vascular plants (44 percent), while only one species (one percent) is an invertebrate. It should be noted that unlike the two other lists, the SOI list contains special interest species (seven species of game animals), as well as non-native, invasive species that threaten our native species and their habitats. The 30 non-native, invasive species include vascular plants (18 species), fishes (seven species), mammals (two species), amphibians (two species), and the invertebrate (one species).

Habitats

In order to manage the wealth of wildlife, fish, and rare plant species on the Coronado NF, their habitats must be managed. All species on the T & E, SOC, and SOI lists that were carried forward were assessed on how to best categorize their habitats. Based on literature reviews of

habitat use of all T & E, SOC, and SOI taxa, it was determined that a combination of vegetation communities and physical attributes would provide a coarse definition of habitat that would be useful to determine how to manage virtually all of the species. The vegetation communities addressed elsewhere in this document were used to define the biotic component of habitat, but there were some exceptions[9] that had to be made because of how habitat associations tend to be referenced in the literature. For our purposes, there were nine vegetation communities and seven physical attributes selected to represent plant and animal habitat associations.

Species-Habitat Associations

The link between species diversity and ecosystem diversity comes from determining the habitat associations of each of the species. First, species-habitat association information was summarized into a spreadsheet. Then this information was transcribed into tallies in matrices (one Forest-wide matrix and 12 mountain range-specific matrices). The matrices correspond to the vegetation communities and physical attributes mentioned above, having rows representing vegetation communities and columns representing physical attributes. Each intersecting cell represents a nested habitat type. Figure 3 shows the Forest-wide species-habitat association matrix and the mountain range-specific matrices are shown in the appendices (appendix G).

Figure 3. Forest-wide tallies for T & E Species, SOC, and SOI that were carried forward into forest plan revision analysis.

	Physical Attribute							
Vegetation Community	**Riparian**	**Spring**	**Lotic**	**Lentic**	**Cliff/ Rock**	**Terres-trial**	**Cave**	**Totals**
Desert Communities	**18**	**4**	**11**	**2**	**11**	**33**	**3**	**82**
Valley Grasslands	**22**	**11**	**19**	**8**	**15**	**68**	**3**	**146**
Interior Chaparral	**4**	**1**	**3**	**0**	**3**	**18**	**2**	**31**
Madrean Encinal/PJ	**35**	**16**	**21**	**6**	**26**	**77**	**7**	**188**
Madrean Pine-Oak	**30**	**11**	**11**	**5**	**23**	**50**	**3**	**133**
Ponderosa Pine	**14**	**6**	**3**	**1**	**13**	**41**	**2**	**80**
Mixed Conifer Forest	**14**	**6**	**4**	**0**	**14**	**36**	**1**	**75**
Subalpine Forest	**4**	**2**	**0**	**0**	**4**	**16**	**0**	**26**
Montane Meadow	**5**	**1**	**2**	**0**	**0**	**18**	**0**	**26**
Totals	**146**	**58**	**74**	**22**	**109**	**357**	**21**	**787**

[9] Exceptions: All grasslands at low elevations were merged into a valley grassland type. Montane meadow vegetation community was added; Pinyon-juniper was lumped with Madrean encinal. Also, as riparian situations can be found at any elevation in upland vegetation communities, it was treated as a physical attribute, rather than as three vegetation communities (cottonwood willow riparian forest, mixed broadleaf deciduous riparian forest, and montane willow riparian forest).

Note: The example in the text discusses management for the 68 of the 306 species that typically use valley grasslands in the terrestrial setting and 22 in riparian situations. Most species typically use more than one habitat type, which accounts for the totals exceeding the number of species.

Because there are nine vegetation communities and seven physical attributes, there are 63 cells in the species-habitat matrices representing 63 potential habitat types. Species were tallied into one or more of the cells corresponding to their typical use of habitats. For example, there are records of the desert tortoise (Sonoran population) in valley grasslands and even Madrean encinal woodland, but this species is really only typical in desert communities (Sonoran only), where it is superbly adapted. This species typically occurs on rocky hillsides, but not cliffs or outcrops *per se*, so it is categorized in the "terrestrial" physical attribute. The desert tortoise occurs in the Coronado NF-wide matrix, as well as the other mountain range-specific matrices where the species naturally occurs. A very specialized species might only occur in one habitat type (matrix cell), and if range-limited might occur in only one mountain range (perhaps even a very small part of that mountain range). At the other extreme, some generalized species (like some special interest SOI) might occur across numerous cells in all of the mountain ranges. It is important to note that some mountain ranges are well-explored biologically, while others are not, which helps explain some of the differences in tallies accross the mountain ranges. Also, not all mountain ranges have all habitat types (e.g., several of the smaller mountain ranges lack high-elevation vegetation communities), so these will be screened out from further analysis in the plan revision process.

Figure 3 indicates that the vegetation communities most used by T & E species, SOC, and SOI are valley grasslands, Madrean encinal (oak) woodland, and Madrean pine-oak woodland habitats. Although the "Vegetation Conditions and Trends" section of this document suggests Madrean encinal woodlands are still similar to reference conditions; the other two are not, and are trending to increases in the shrub component and excessive loads of course woody debris. Desert communities, Ponderosa pine forests, and mixed conifer forests are also frequently used by these 306 species. By looking at the mountain range-specific matrices, you see differing trends. For example, the Santa Catalina Mountains have a greater relative contribution of habitat for desert-dwelling species, while the Pinaleño Mountains have a greater relative contribution of habitat for subalpine forest-dwelling species. This makes sense, as those two mountain ranges have relatively larger proportions of those vegetative communities. Interior chaparral is either not a frequently used vegetation community, or the literature tends to not mention chaparral in habitat use statements.

Figure 3 also shows that terrestrial, riparian, and cliff/rock physical features contribute the most to the physical attributes of habitat for the 306 species. However, also note that cumulatively, low elevation (desert through Madrean pine-oak) riparian and aquatic habitats have a good representation of habitats used by the 306 species, and many of these are among the most critically threatened species because of threats to aquatic ecosystems.

Managing for the Species and their Habitats

As discussed above, the matrices show us which habitat types are most frequently used by T & E species, SOC, and SOI. We can easily see which habitats have the most species we need to manage for, on both the Forest-wide and mountain range-specific levels. In general, habitat types with many species tallied correspond to habitat types that could benefit from ecosystem restoration activities if they are outside of the historic range of variation. For example, in figure 3, it is apparent that large numbers of species use the terrestrial (and riparian) valley grasslands. As valley grasslands are threatened from increases in shrub cover and invasion by non-native species (see the "Vegetation Conditions and Trends" section), one course of management strategies would be to counter these threats by taking actions to decrease shrub cover and eradicate non-natives. If these measures are taken, then most species would

presumably benefit. This is a key concept in the 2008 planning rule: Manage for habitat improvement and you manage for the benefit of most of the species. However, in this scenario, it should be noted that not all species prefer open grasslands, so there still needs to be a species-by-species assessment to determine how to manage for shrub-associated species that could be negatively affected.

At this stage of the forest planning process, it is premature to know which species will benefit from our management actions during the next 5-10 (or more) years. From here we must develop realistic habitat management objectives, and guidelines, and work iteratively on a mountain range-by-mountain range and species-by-species basis to ultimately determine the forest plan components needed to effectively manage for habitats of all 306 T & E species, SOC, and SOI. Suffice to say some species will benefit from broad-brush management (e.g., reduce shrub cover in valley grasslands across all mountain ranges), while others will need specific plan components. For example, there are some single-cave-obligate pseudoscorpions that would not benefit from vegetation management and the internal microclimate and trophic character of their specific caves might need to be addressed (if potentially at risk from our management actions, such as allowing recreational use of their caves).

Existing Condition

An assessment of the existing condition must address species, habitats, and extrinsic factors, as well as the interrelationships between these components among the various ecosystems on the Coronado NF. The Coronado NF does not have the full complement of species that have been historically documented. Some terrestrial species were extirpated from the Coronado NF before the 1986 forest plan was implemented, such as the grizzly bear, Mexican gray wolf, thick-billed parrot, black-tailed prairie dog, Nokomis fritillary, and Tarahumara frog. One plant, the Canelo Hills ladies-tresses was apparently extirpated from the Coronado NF after 1986, and the Gila topminnow may also be gone. Some species such as the Aplomado falcon, ocelot, and cactus ferruginous-pygmy owl were/are locally rare at best and on the fringe of their normal range, so the Coronado NF probably provides suboptimal habitat. Currently, most terrestrial species seem to have similar abundance and distribution patterns since 1986, including uncommon species, such as the Mexican spotted owl, (Apache) Northern goshawk, and lesser long-nosed bat.

The vegetative condition and trends are discussed in the section under “Ecosystem Diversity”, so will not be repeated here. However, in summary, it can be stated that most terrestrial ecosystems are outside the historic range of variation and that there is a general trend of excessive build-up of small-diameter trees, shrubs, and coarse woody debris, at the expense of a naturally occurring understory of annuals and small perennials (such as bunchgrasses). As expected, species associated with the more open habitats are negatively affected the most. Invasive plants and animals are a growing crisis facing our natural ecosystems and their inhabitants. Large, severe landscape-level fires are far more commonplace now than in 1986, as are catastrophic insect outbreaks. Climate change is significantly changing the landscape and occupancy patterns of native and non-native species. Having said that, there have been few significant declines documented among terrestrial species associated with these recent habitat condition trends, but it would be irresponsible to think previously misguided management practices (exclusion of fire as a disturbance, overgrazing, and introduction of non-native species) and climate change will not have significant impacts in the near future.

The greatest urgency lies with aquatic-associated species and their habitats. There has been a nearly categorical decline across all aquatic species in recent years. Before 1986, many fishes, ranid frogs, gartersnakes, and some insects were far more abundant and well-distributed than

they are today. Many of these species have been federally listed, and all species of fishes and ranid frogs, if not federally listed or on the SOC list, are on the SOI list.

The threats facing aquatic organisms include, but are not limited to: a lack of water; water diversions; consolidating water into earthen stock tanks; poor water quality, including temperature, pH, hydrogen sulphide, low dissolved oxygen, and heavy metals; excessive sedimentation, as from post-fire runoff; non-native invasive species, such as bullfrogs, warmwater fishes, and crayfishes; exotic diseases, such as the fungus causing chytridiomycosis; and lack of structure, such as emergent vegetation, coarse woody debris, and overhangs (US Fish and Wildlife Service 2007).

This section differs somewhat from the “Water Quality” and “Water Quantity” sections elsewhere in this document. This is due to a number of factors: (1) this section is primarily (but not entirely) a biological assessment, as opposed to a physical assessment in the other section; (2) the biological assessment extends to cienegas, springs, wet meadows, ephemeral waters, and stockponds (i.e., anywhere there are aquatic-associated species, not just limited to perennial lakes and streams); (3) the quality and quantity assessment was done on only 5 percent of the streams and lakes; and (4) reference conditions could not be gauged, that is, it is not known when the full complement and distribution of native species was presumed to be present.

Thirty exotic species have been identified to be major threats to native plants and animals (Appendix F). Some of these have already become so widespread that entire landscapes are being invaded. For example, buffelgrass is spreading throughout the Sonoran Desert and bullfrogs are becoming established in huge areas. Some scientists suggest that the world is entering a new era—the Homogecene—because the non-native species are outcompeting the natives, and the ecosystems are becoming simpler and growing more similar to one another, with fewer dominant species (Rejmánek 2002).

Related to many of the threats mentioned above are the extrinsic factors. The focus on management of vegetation communities and physical attributes should be balanced with extrinsic factors such as climate change, urban sprawl, emerging diseases, and increased recreation. For example, the presence of structures and property on a vegetated landscape will alter the ability to use wildfire as a natural agent of change and rejuvenation.

In summary, the existing condition of most vegetation communities has changed from the reference condition. Some physical attributes have changed, and species diversity is changing. It is important to recognize that “species diversity” as a measure for ecosystem health is misleading, as we have more species now than in pre-settlement times—but this means that for each native species lost, several non-native and peripheral species have become established. Because of the intrinsic link between species and their habitats, we have a need for changing the current conditions in many cases, and for reversing trends of species diversity to trends toward more native species and fewer invasive species.

Sustainability Discussion: Wildlife, Fish, and Rare Plants

The primary goal of management for species diversity is to ensure that habitats for native species are maintained across the lands managed by the Coronado NF, if that is an achievable goal. Vegetation communities need to be managed, as needed and feasible, to be sustainable. Past vegetation management practices could generally be characterized as insufficient to bring about the needed changes. For example, very few acres across the managed lands have actually been treated to reduce high densities of shrubs and trees, although there has been recent progress. Another example is that despite eradication efforts to date, the buffelgrass population continues to expand into desert vegetation communities. In other words, the magnitude of treatments needs to increase. Habitat restoration ideally would mean achieving

resiliency and homeostasis (i.e., where the environment is capable of “managing” itself through natural processes). In most vegetation communities, this would be a point where a near-natural fire regime exists.

From a species perspective, each species will need to be evaluated as to the status and habitat requirements that will allow them to persist, as well as their threats. The number of federally listed and declining species is growing and more are on the horizon, pointing to a need to reverse this trend. If the requirements of T & E species, SOC, and SOI populations cannot be met through habitat management (usually via vegetation manipulation), there will need to be specific management identified to address the species themselves.

Finally, the effort to sustain species diversity, as with the effort to sustain ecosystem diversity, will require working across jurisdictional boundaries. All agencies and non-governmental organizations that manage wildlife, fish, rare plants, and their habitats need to work together as complete partners, rather than relying on an individual group or agency to bear the burdens of management and conservation.

References

Arizona Game and Fish Department, Research Branch. 1994. Riparian Vegetation Associated with Perennial Waters in Arizona

Arizona Department of Environmental Quality (ADEQ). 2003. Arizona State Implementation Plan (SIP) to maintain and improve air quality. http://www.azdeq.gov/environ/air/haze/download/2sip.pdf

Arizona Department of Environmental Quality (ADEQ). 2004. Status of Water Quality in Arizona -- 2004 Arizona's 2004 Integrated 305(b) Assessment and 303(d) Listings Report. Prepared by Melanie Diroll and Diana Marsh. http://www.azdeq.gov/environ/water/assessment/assess.html

Arizona Sonora Desert Museum. 2008. http://www.desertmuseum.org/invaders/invaders_buffelgrass.htm

Bahre, Conrad, J. 1991. A Legacy of Change: Historic Human Impacts on Vegetation of the Arizona Borderlands. University of Arizona Press. Tucson, Arizona.

Bailey, Robert G. 1983. Delineation of ecosystem regions. Environmental Management 7:365-373.

Baker, Malchus B. , P. F. Ffolliott, L. F. DeBano. 2003. Riparian Areas of the Southwestern United States: Hydrology, Ecology, and Management. Published by CRC Press. 408 pages

Betancourt, J., D. Breshears, and P. Mulholland. 2004. Ecological impacts of climate change. Report from a NEON Science Workshop. August 24-25, 2004, Tucson, AZ. American Institute of Biological Sciences, Washington D.C., USA.

Cleland, David T., Peter E. Avers, W. Henry McNab, Mark E. Jensen, Robert G. Bailey, Thomas King, and Walter E. Russell. 1997. National Hierarchical Framework of Ecological Units. Published in Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources, Yale University Press, New Haven & London. pp 181-200.

Colorado State University 2006. Interagency Monitoring of Protected Visual Environments (IMPROVE). http://vista.cira.colostate.edu/views/Web/Data/DataWizard.aspx

Coronado National Forest. 1986. Unpublished soil condition data on file at Coronado National Forest Supervisor's Office.

Coronado National Forest. 1998 - 2008. Unpublished reports documenting soil condition on file at Coronado National Forest Supervisor's Office.

Environmental Protection Agency (EPA). 1996. Natural Events Policy

Environmental Protection Agency (EPA). 1998. Interim air quality policy on wildland and prescribed fires.

Gori, D.F., and C.A.F. Enquist. 2003. An assessment of the spatial extent and condition of grasslands in central and southern Arizona, southwestern New Mexico, and northern Mexico. The Nature Conservancy.

Holechek, Jerry L., Milton Thomas, Francisco Molinar, and Dee Galt.1999. Stocking desert ranges: What we've learned. Rangelands 21(6) pp 8-12.

Jones, Lawrence L. C. 2005. Herpetology of the American Madrean Archipelago and adjacent valleys. pp 330-332. In: Gottfried, Gerald. J.; Gebow, Brooke S.; Eskew, Lane G.; and Edminster, Carleton B., compilers. Connecting Mountain Islands and Desert Seas: Biodiversity

and Management of the Madrean Archipelago II. 2004 May 11-15; Tucson, AZ. Proceedings RMRS-P-36. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 631 p.

Lefevre, R. E. and K. Halverson. 2007. Ecological sustainability analysis of the Coronado NF: describing the ecological niche of the forest for water and riparian resources *in* Hydrology and water resources in Arizona and the southwest – proceedings of the 2007 meetings of the hydrology section Arizona-Nevada Academy of Science volume 37.

Lowe, C.H., Jr. 1961. Biotic communities in the sub-Mogollon region of the inland Southwest. J. AZ-NV Academy of Science2:40-49.

Millar, C.I., N.L. Stephenson, and S.L. Stephens. 2007. Climate change and forests of the future: Managing in the face of uncertainty. Ecological Applications, 17(8), pp.2145-2151.

Rejmánek, Marcel. 2002. Waiting for the Homogecene. Ecology: Vol. 83, No. 5, pp. 1472-1473.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, Colorado

Schussman, Heather and David F. Gori. 2004. An ecological assessment of the Bureau of Land Management's Current Fire Management Plans: Materials and Recommendations for future fire planning. The Nature Conservancy, Tucson, Arizona.

Schussman, H. and Edward Smith. 2006 Historical Range of Variation and State and Transition Modeling of Historic and Current Landscape Conditions for Potential Natural Vegetation Types of the Southwest. The Nature Conservancy.

Turner, R.M; R.H.Webb; J.E.Bowers and J.R.Hastings. 2003. The Changing Mile Revisited: An Ecological Study of Vegetation Change with Time in the Lower Mile of an Arid and Semiarid Region. The University of Arizona Press, Tucson, Arizona.

US Fish and Wildlife Service. 2007. Chiricahua Leopard Frog (*Rana chiricahuensis*) Recovery Plan. Unpubl. Report, Southwest Region, US Fish and Wildlife Service, Albuquerque, New Mexico. 148 pp + append.

USDA Forest Service. 1981. Hydrology Notes. No. 14. Watershed Condition Hydrology Overview.

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

USDA Forest Service. 1984. Unpublished file report: riparian area study committee on file at Coronado National ForestUSDA Forest Service. 1986. Environmental Impact Statement for the Coronado National Forest Plan. 275 p.

USDA Forest Service. 1989. Riparian Area Survey and Evaluation System (RASES). Southwestern Region. 64 p.

USAD Forest Service. 2007. Use of LANDFIRE Vegetation Dynamics Models and FRCC Maps to Support Ecological Assessments and Forest Plan Revisions in the Southwest Region. LANDFIRE Data Product Applications. helpdesk@landfire.gov

USDI Geologic Survey. 1994. Hydrologic Unit Maps. Water supply paper 2294.

Vander Lee, Bruce, Ruth Smith and Joanna Bate. 2006. Chapter 4: Ecological & Biological Diversity of the Coronado National Forest in Ecological and Biological Diversity of National Forests in Region 3. The Nature Conservancy.

Appendix A: Vegetation Communities Descriptions, Conditions and Trends, and Risk Assessments

Introduction

This appendix provides descriptive information about the major vegetation communities represented on the Coronado NF, and the general species assemblages associated with them. The information presented includes a general portrayal of the landscape associated with the community, species that are expected to occur there, the representation of the community on the Coronado NF compared to representation in the broader area, disturbance processes associated with the community, reference and current conditions, and projected future trends. Where available, information about the FRCC[4] is presented. For the woodland and forested communities, predictions of future trends are modeled using the Vegetation Dynamics Development Tool (VDDT). Finally, there is an assessment of risks associated with management activities and other factors for each vegetation community. The information is presented in the order that the communities exist on the elevational gradient of the forest, from lowest elevations to highest.

Desert Communities

Description: Desert Communities

There are several types of desert communities represented on the Coronado NF, including the Sonoran and Chihuahuan deserts. Vegetation types and density will vary with geographic location, precipitation, and topography. Some areas within this vegetation community may be barren with an abundance of sand, rock, gravel, scree or tallus. Other areas may have sparse to dense vegetation cover that includes succulent species, desert grasses, desert scrub, and some herbaceous cover. Some species occurring in desert communities include: catclaw acacia (*Acacia greggii*), triangleleaf bursage (*Ambrosia deltoidea*), white bursage (*Ambrosia dumosa*), mesquite (*Prosopis* spp.), desert ironwood (*Olneya tesota*), saltbush (*Atriplex* spp.), cresosote (*Larrea tridentata*), iodine bush (*Allenrolfea occidentalis*), splitleaf brickellia (*Brickellia laciniata*), desert broom (*Baccharis sarothroides*), desert willow (*Chilopsis linearis*), Apache plume (*Fallugia paradoxa*), cheesebush (*Hymenoclea salsola*), barrel cactus (*Ferocactus* spp.), hedgehog cacti (Echinocereus spp.), cholla and prickly pear (*Opuntia* spp.), saguaro (*Carnegia gigantean*), salt grass (*Distichlis spicata*), rice grasses (*Oryzopsis* spp.), and dropseed grasses (*Sporobolus spp*.).

Typical TE/SOC/SOI Species Associations: Desert Communities

Species are typical of both the Chihuahuan and Sonoran Desert, as the Coronado NF is primarily a transition zone at the lowest elevations. Typical Sonoran Desert TE/SOC/SOI include Desert Tortoise, Cactus Ferruginous Pygmy-Owl, Pima Pineapple Cactus, and Red-backed Whiptail. Chihuahuan Desert species include Northern Aplomado Falcon and Arizona Striped Whiptail. Relatively few TE/SOC/SOI are associated with terrestrial habitats of desert communities because the Coronado NF is on the fringe of these arid habitats, which are largely managed by other agencies. Buffelgrass is an important invasive SOI in this vegetation type.

Representation of Desert Communities on the Coronado NF Compared with the Broader Area

The Coronado NF manages only a tiny fraction of desert plant communities compared with surrounding landownership entities. However, these lands make up nine percent of the

Coronado NF, and 17 percent of desert communities represented in Region 3 national forests.

Disturbance Processes: Desert Communities

The primary natural disturbance process associated with deserts is drought. Desert plants are uniquely adapted to survive drought through mechanisms such as water storage in succulents, or opportunistic germination and flowering strategies that take advantage of moisture when it is available. Fire is not a natural disturbance in deserts. Most desert plants are destroyed by fire, especially the succulents. Invasive species, primarily grasses that burn easily, are becoming more common in deserts, resulting in more fire in these plant communities. Some livestock grazing occurs in the Coronado NF deserts, primarily in the spring when good forage annuals such as filaree [10](*Erodium circutarium)*, Indian wheat *(Plantago* spp*.)* and fiddle-neck *(Amsinckia* spp*.)* are available. Livestock grazing effects are analyzed and mitigated through a National Environmental Policy Act (NEPA) process at a site specific level, and controlled through permits and annual operating plans. Effects of livestock grazing are discussed in more detail under “Semi-Desert Grassland, Disturbance Processes” section.

Reference and Current Conditions: Desert Communities

Current conditions in desert plant communities on the Coronado NF reflect a larger proportion of grasses, primarily invasive species, compared to reference conditions.

Projected Future Trends: Desert Communities

Invasive grasses are increasing in desert plant communities. There is an increased risk of wildfire associated with the presence of these species in the plant community. Fire destroys native plants, and encourages further increases in invasive grasses. Invasive grasses suppress native plants even in the absence of fire. Current trends indicate that desert plant communities are at risk of being converted to non-native grasslands.

Risk Assessment: Desert Communities

Populations of invasive, non-native grasses are increasing in desert communities in spite of concerted efforts to restrict them. Identified threats beyond agency control (see Threat Matrix below) are primarily limited to areas along the Forest boundary, however, desert communities primarily occur along the Forest boundary. These factors indicate that the risk to the sustainability of desert communities is high.

[10] Filaree is a naturalized non-native species, introduced along aboriginal trade routes prior to European settlement.

Threat Matrix: Desert Communities.

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threats
Invasive non-native species	Invasive grasses out-compete and replace native desert plants. These grasses burn easily, and so fire frequency and severity increases. Invasive grasses fill gaps needed by some species, reduce available native foods, and shift prey species assemblages. Species diversity suffers.	Fire management Permitted livestock grazing Vehicle use on roads	Seed sources on adjacent ownerships	Prevention and eradication programs can be effective in reducing noxious and invasive weed populations.
Livestock overgrazing	Livestock grazing can affect the structure and composition of desert plant communities, as well as soil structure and water infiltration. Livestock movement can be a vector for invasive plant seed. Removing native cover affects shelter, thermoregulation sites, and changes population structure	Permitted livestock grazing		Livestock grazing can be managed to mitigate negative effects.
Fire	Fire is not a natural disturbance process in desert communities. Fire kills many native desert plants. No native desert species of conservation concern are adapted to fire.	Fire management		Fire prevention and suppression are effective tools for protecting desert plant and animal communities.

Threat Matrix: Desert Communities, continued

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threats
Fragmentation	Roads are vectors for the spread of invasive plant seed. Development of private land along the forest boundary increases the risk of noxious and invasive weed introduction. For wildlife species, road kill increases, migration routes and home ranges are altered, and dispersal ability is compromised.	Road building	International law enforcement activity Development of private land along Forest boundaries	Transportation analysis and Travel Management Rule implementation can reduce risks associated with road building. Land ownership adjustments can reduce fragmentation by consolidating National Forest Lands and private lands within boundaries with high resource values. Forage available for well-managed grazing on National Forest Lands can help sustain ranching as an economic activity and reduce the threat of fragmentation.

Semi-desert Grasslands

Description: Semi-desert Grasslands

Semi-desert grassland occurs throughout southeastern Arizona and southern New Mexico at elevations ranging from 3,000 to 4,500 ft. These grasslands are bounded by Sonoran or Chihuahuan desert at the lowest elevations and woodlands or chaparral at the higher elevations. Species composition and dominance varies across the broad range of soils and topography that occur within the two states. Dominant grassland associations/types are black grama (*Bouteloua eriopoda*) grassland, blue grama (*Bouteloua gracilis*) grassland, tobossa (*Hilaria mutica*) grassland, giant sacaton (*Sporobolus wrightii*) grassland, mixed native perennial grassland, and non-native perennial grassland. Shrubs also occupy these grasslands and their abundance and species composition also varies.

Typical TE/SOC/SOI Species Associations: Semi-desert Grasslands

Semi-desert grasslands are extremely important habitats for TE/SOC/SOI plants and animals, second in diversity to Madrean Encinal Woodlands. These valley and foothill habitats are especially important for riparian, aquatic, and terrestrial species more typical of Mexico. Terrestrial TE/SOC/SOI associates of semi-desert grasslands include Madrean Valley forms, such as Pronghorn, Arizona Grasshopper Sparrow, Aplomado Falcon, Montezuma Quail, some insects (e.g., several grasshoppers), and of course, grasses, and numerous shrub and forb species. Riparian species include Black-capped Gnatcatcher, Sunrise Skipper, and Southwest Monkeyflower. Aquatic species include Sonoran Tiger Salamander, Chiricahua Leopard Frog, and Gila Topminnow. On the Coronado NF, there are more invasive SOI in this habitat type than others, including Lehman Lovegrass, Weeping Lovegrass, Northern Crayfish, and Bullfrog.

Representation of Semi-desert Grasslands on the Coronado NF Compared with the Broader Area

Semi-desert grasslands make up around 26 percent of the Coronado NF. The Coronado has the largest extent and proportion of land in grasslands of any national forest in Arizona. This represents 25 percent of all semi-desert grasslands within Region 3 national forests, and 35 percent of all grasslands in southeastern Arizona.

Disturbances: Semi-desert Grasslands

Fire is an important natural disturbance for maintaining open grasslands with low shrub cover. The historic fire return interval for semi-desert grassland ranges from 2.5 to 10 years (Schussman et al. 2006). Without frequent fire, grasslands eventually convert to shrublands (Gori and Enquist 2003). Increases in woody species density and cover in grasslands have also been correlated with wet winters, as well as some other factors such as rodent activity, livestock grazing and increases in atmospheric carbon dioxide. Livestock overgrazing leads to shrub encroachment if it is severe enough to cause soil loss.

Livestock grazing is an extensive anthropogenic disturbance on the Coronado NF. Eighty nine percent of the Forest is within designated grazing allotments, and around 55 percent is considered accessible to livestock (less than 40 percent slope). Livestock grazing is an historic use that pre-dates the establishment of the Coronado NF by several hundred years. Significant detrimental ecological changes in the region caused by overstocking of ranges occurred starting around 1870 (Hastings and Turner 1965, Cooke and Reeves 1976, and Dobyns 1981). With the establishment of the Coronado NF, livestock grazing was brought under the administrative control of the Forest Service. Grazing allotments were designated,

stocking rates were systematically reduced, management practices were implemented, and ecological conditions steadily improved (Allen 1989). Livestock grazing effects on each grazing allotment are analyzed and mitigated through a National Environmental Policy Act (NEPA) process at a site specific level, and controlled through permits, allotment management plans and annual operating plans

The effects of livestock grazing vary with timing, duration and intensity. Negative effects of heavy grazing are well documented and include changes to vegetation structure and composition, as well as changes to soil structure and water infiltration (Schussman and Smith 2006). An emerging research interest in the effects of well-managed grazing at light to moderate levels, as compared to grazing exclusion, has revealed benign or even beneficial effects to various rangeland ecosystem components or processes (Curtin 2008, Holechek 2004, Loeser et al. 2007, Sprinkle et al. 2007). Currently, stocking rates on the Coronado NF are light to moderate, which is consistent with sustaining rangeland ecosystems (Holechek et al. 1999). .

Other management practices that cause disturbance in semi-desert grassland are road building, recreation management, fire management, and grassland restoration activities. As with livestock grazing, the direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

Current disturbances that are contributing to the loss of native grasslands are the invasion of non-native grass species (primarily *Eragrostis lehmanniana*), shrub invasion, and outright destruction of grasslands due to ex-urban development. The latter disturbance occurs outside of the boundaries of the Coronado NF, but makes it increasingly difficult to sustain grassland dependent organisms and processes within the boundaries.

Reference and Current Conditions: Semi-desert Grasslands

Reference conditions are an open aspect with native grasses as the primary species, and low (less than 10 percent) shrub cover. Currently, 27 percent of grasslands on the Coronado NF exist in an open native condition, 52 percent are shrub invaded, and 21 percent are open non-native grasslands. Of the shrub invaded areas, the majority (42 percent) have the potential to be restored to an open native condition. In summary, 69 percent of grasslands on the Coronado are either in the open native or restorable native types, with the remainder in non-native or former grassland types (Gori and Enquist 2003).

Projected Future Trends: Semi-desert Grasslands

The success of recent landscape level treatments (prescribed fire and mechanical) to reduce shrub cover in existing and former grasslands indicate that the grasslands within the Coronado NF can be sustained. There are several confounding factors that need to be carefully monitored to assess treatment effectiveness. One of these is the response of non-native grasses to fire, and whether fire treatments will lead to increases in non-native grasslands. Others are related to changes in climate, particularly precipitation patterns. In general, summer rains will favor regeneration of grasses, while increases is shrub cover has been correlated with winter rains. The effectiveness of any treatment will be heavily influenced by precipitation amounts and patterns in following years.

Risk Assessment: Semi-Desert Grasslands

Fifty-two percent of semi-desert grasslands are shrub invaded, of these, 42 percent are considered restorable. Projected trends are toward increased shrub cover unless restoration treatment efforts are increased. Given this trend, and because of identified threats beyond agency control (see Threat Matrix below) the risk to sustainability of semi-desert grasslands is moderate to high.

Threat Matrix: Semi-desert Grasslands.

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threats
Fragmentation	Disruption of ecological processes, destruction of wildlife habitat and disruption of wildlife migration patterns	Permitted livestock grazing Land exchanges Road building	Development of private land within and along forest boundaries International law enforcement activity	Forage available for well-managed grazing on National Forest Lands can help sustain ranching as an economic activity and reduce the threat of fragmentation. Land ownership adjustments can reduce fragmentation by consolidating National Forest Lands and private lands within boundaries with high resource values. Transportation analysis and Travel Management Rule implementation can reduce risks associated with road building.
Fire exclusion	Increased woody species density and cover and changes in wildlife species assemblages	Active and passive fire suppression		Prescribed burning and wildland fire use can be effective tools for restoring grasslands.

Threat Matrix: Semi-desert Grasslands, continued.

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threats
Livestock overgrazing	Livestock grazing can affect the structure and composition of semi-desert grasslands, as well as soil structure and water infiltration. Species diversity may be reduced.	Permitted livestock grazing		Livestock grazing can be managed to mitigate negative effects. Positive effects to native plant communities have been observed with well managed grazing.
Invasive non-native species	Changes in fire regime, decreased plant and animal species richness. Cover and opening matrices for wildlife may be altered, and species diversity may be reduced.	Prescribed fire and fire use Permitted livestock grazing	Seed sources on adjacent ownerships	Burn plans and grazing management can be effective in mitigating the spread of invasive non-native species.
Off road vehicle use	Soil erosion and compaction, destruction of vegetation.	Recreation management		Implementation of the Travel Management Rule can restrict off road vehicle use.

Interior Chaparral

Description: Interior Chaparral

The interior chaparral vegetation community is typically found on mountain foothills and lower slopes where low-elevation desert landscapes transition into wooded evergreens. Interior chaparral consists of mixed shrub associations including but not limited to the following species: manzanitas (*Arctostaphylos* spp.), crucifixion thorn (*Canotia holacantha*), desert ceanothus (*Ceanothus greggii*), mountain mahogany (*Cercocarpus montanus*), little-leaved mountain mahogany (*Cercocarpus intricatus*), antelope bushes (*Purshia* spp.), silktassles (*Garrya* spp.), Stansbury cliffrose (*Purshia stansburiana*), shrub live oak (*Quercus turbinella*), and sumacs (*Rhus* spp.)

Typical TE/SOC/SOI Species Associations: Interior Chapparal

Interior chaparral has few TE/SOC/SOI species associations, and none, with the possible exception of the Ball's Monkey Grasshopper, are chaparral specialists. Species in chaparral are fire-adapted, because the ecosystem experiences frequent crown fires naturally.

Representation of Interior Chaparral on the Coronado NF Compared with the Broader Area

The interior chaparral makes up approximately one percent of the Basin and Range Section and less than one percent of the Sonoran Desert Section within the boundaries of the Coronado NF. Because of the small proportion of Interior Chaparral in the Sonoran Desert Section, the rest of this discussion will deal with the Basin and Range Section and its component subsections.

The six subsections in the Basin and Range Section which overlap the Coronado NF and contain Interior Chaparral are shown below. The following is the percent of Interior Chaparral within each subsection and the percent within the Coronado NF boundaries of each subsection:

Subsection	Percent of Subsection	Percent of Coronado NF
Animas Valley Plains Desert Grass-Shrubland	<1%	<1%
Animas Mts. Oak-Juniper Woodland	3%	3%
Sulphur Springs Plains Desert Grass-Shrubland	2%	8%
Santa Catalina Mts. Sierra Madre Interior Chapparral	14%	9%
San Rafael Sierra Madre High Plains Grassland	2%	3%
Santa Catalina Mts. Encinal Woodland	8%	10%

The interior chaparral makes up ten percent or less of any one portion of the six ecoregion subsections found within the Coronado NF. In general, the proportional amount of the interior chaparral vegetation type on the Coronado NF is similar to that of the surrounding landscape.

Disturbances

Fire and drought are the primary disturbance processes in the interior chaparral vegetation community. Over the period of 1982 to 2003, fires occurred in 21 out of 22 years. An average of 790 acres burned per year (much less than 1 percent per year) with the largest fire at just over 4,000 acres. Large fires occur infrequently; most of the fires (17 out of 21) between 1982 and 2003 were smaller than 1,000 acres. The historic fire return interval ranges from 20 to 100 years. Based on FRCC ratings and reference conditions, historic fire frequency may have been lower and severity may have been lower than current conditions.

As measured by FRCC, current fire frequency and severity are altered and the probability of uncharacteristic fire is higher now than it was historically. Approximately 47 percent of the interior chaparral on the Coronado NF is in FRCC III, which means a high probability of uncharacteristic fire. Forty-eight percent of the interior chaparral is in FRCC II, which is a moderate departure from the natural fire regime with an elevated probability of uncharacteristic fire. Only 5 percent is in FRCC I, which indicates near natural conditions and risk.

Management practices that may cause disturbance in interior chapparal are road building, recreation management, fire management, livestock grazing and grassland restoration activities. The direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

Current and Reference Conditions

The distribution of interior chaparral structural classes for reference (historic) and current conditions is displayed below.

Structural Class	Reference	Current
Recently Burned:	2%	22%
Shrub, open canopy:	5%	35%
Shrub, closed canopy:	93%	43%

Trends and Projected Future Conditions: Interior Chapparal

Indications are that fire is occurring more frequently in the interior chapparal vegetation community than it did historically. This trend toward recently burned and open canopy is expected to continue. However, the overall structure as chapparal as shrub land has been stable over the historical record and is expected to persist, although changes at the species level may be occurring with more frequent fire (Schussman and Smith 2006).

Risk Assessment: Interior Chaparral

Around half of the interior chaparral vegetation community has a high probability of uncharacteristic fire, and the other half has only an elevated probability of uncharacteristic fire. Projected trends are toward more fires, and more open canopy cover. However, the interior chaparral is a fire adapted ecosystem, and the basic structure as a shub dominated type is not expected to change. There are no identified threats beyond agency control (see Threat Matrix below). Given these factors, the risk to sustainability of the interior chaparral is low.

Threat Matrix: Interior Chaparral

Threat	Effect	Management activities that may contribute to or reduce threat	Factors beyond agency control	Management options to reduce threat
Uncharacteristic fire	Frequent fires can change vegetation composition.	Prescribed fire or fire use		Appropriate management response to fire in interior chaparral can be used to suppress uncharacteristic fire.
Habitat conversion	Destruction of chaparral vegetation.	Grassland restoration		Grassland restoration projects can be designed to maintain shrub cover where needed

Madrean Encinal Woodland

Description: Madrean Encinal Woodland

The Madrean encinal woodland vegetation community occurs on foothills, canyons, bajadas and plateaus between the semi-desert grasslands and Madrean pine-oak woodlands. This vegetation community is dominated by Madrean evergreen oaks such as Arizona white oak (*Quercus arizonica*), Emory oak (*Quercus emoryi*), gray oak (*Quercus grisea*), Mexican blue oak (*Quercus oblongifolia*), and Toumey oak (*Quercus toumeyi*). Chihuahuan pine (*Pinus leiophylla* var. *chihuahuana*). Arizona cypress (*Cupressus arizonica*), pinyon (*Pinus* subsection *cembroides*), and juniper trees (*Juniperus* spp.) and interior chaparral species may be present, but do not co-dominate. The ground cover is dominated by warm-season grasses such as threeawns (*Aristida* spp.), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), Rothrock grama (*Bouteloua rothrockii*), Arizona cottontop (*Digitaria californica*), plains lovegrass (*Eragrostis intermedia*), curly-mesquite (*Hilaria belangeri*), green sprangletop (*Leptochloa dubia*), muhly grasses (*Muhlenbergia* spp.), or Texas bluestem (*Schizachyrium cirratum*).

Typical TE/SOC/SOI Species Associations: Madrean Encinal Woodland

This vegetation type is the most widespread and typical type on the Forest. Not surprisingly, there are more species of TE/SOC/SOI associated with Madrean encinal woodlands than any other vegetation type. Many of these species are more typical of Mexico than elsewhere in the US. All physical attributes (riparian, aquatic, rock, cave) have characteristic species in this vegetation type. Some of the many species include: Jaguar, New Mexico and Arizona Ridge-nosed Rattlesnake, Mexican Stoneroller, Tarahumara Frog, Elegant Trogon, Huachuca Giant Skipper, Black Bear, Arizona Gray Squirrel, Giant Spotted Whiptail, Pygmy Sonorella (and many other talussnails), lichens (no common names), Spreading Marina, Chiricahua Mock Pennyroyal, and many other vascular plants.

Representation of Madrean Encinal Woodland on the Coronado NF Compared with the Broader Area

This is the most abundant and widespread vegetation type on the Coronado NF, covering approximately 748,000 acres (or 42 percent). The Coronado NF manages the second largest portion (11 percent) of the Madrean encinal woodland relative to other landowners throughout the States of Arizona and New Mexico. This represents the largest amount of Madrean encinal woodlands under a single management entity. The largest portion (19 percent) is managed by various private landowners, and 9 percent are managed by state land departments.

Madrean Encinal Woodland is approximately 5 percent of the Basin and Range Section and less than 1 percent of the Sonoran Desert Section. Because of the small proportion of Coronado NF land and Madrean encinal woodland in the Sonoran Desert Section, the rest of this discussion will deal with the Basin and Range Section and its component sub-sections.

The six subsections in the Basin and Range Section are shown below, along with the current proportion of area containing Madrean encinal woodland and the proportion of Coronado NF land within each subsection that contains Madrean encinal woodland:

Subsection	Percent of Subsection	Percent of Coronado NF
Animas Valley Plains Desert Grass-Shrubland	4%	46%
Animas Mts. Oak-Juniper Woodland	36%	61%
Sulphur Springs Plains Desert Grass-Shrubland	7%	46%
Santa Catalina Mts. Sierra Madre Interior Chapparral	29%	36%
San Rafael Sierra Madre High Plains Grassland	24%	39%
Santa Catalina Mts. Encinal Woodland	34%	41%

The Madrean encinal woodland makes up 5 percent of the land area of the Basin and Range Section, and from seven to 36 percent of the sub-sections overlapping the Coronado NF. This vegetation community makes up 42 percent of the Coronado NF as a whole, and from 36 to 61 percent of any one portion of the Coronado NF within a subsection. In all cases, the Madrean encinal woodland vegetation type is more abundant on the Coronado NF compared to the surrounding landscape.

Disturbances: Madrean Encinal Woodland

Fire and drought are natural disturbances in Madrean encinal woodland. Fires occurred every year over the period of 1982 to 2003, with an average of 6,000 acres burned per year (just under 1 percent per year). The smallest area of Madrean encinal woodland burned in this time was 61 acres, the largest just over 40,000 acres. Large fires occur infrequently; a total of three fires larger than 10,000 acres have occurred over the last 22 years.

Domestic livestock grazing at moderate levels is a widespread use of the Coronado NF Madrean encinal woodlands. Well managed livestock grazing is a sustainable disturbance in oak woodlands (Holechek et al. 1999), and can be used as a management tool to reduce the risk of wildfire. See the “Disturbances: Semi-Desert Grassland” section for a more detailed description of the effects of livestock grazing. Livestock grazing effects are analyzed and mitigated through a National Environmental Policy Act (NEPA) process at a site specific level, and controlled through permits, allotment management plans and annual operating plans.

Other management practices that cause disturbance in Madrean encinal woodland are road building, recreation management, fire management, and ecosystem restoration activities. As with livestock grazing, the direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

Current and Reference Conditions: Madrean Encinal Woodland

The distribution of Madrean encinal woodland structural classes for reference (historic) and current conditions is displayed below.

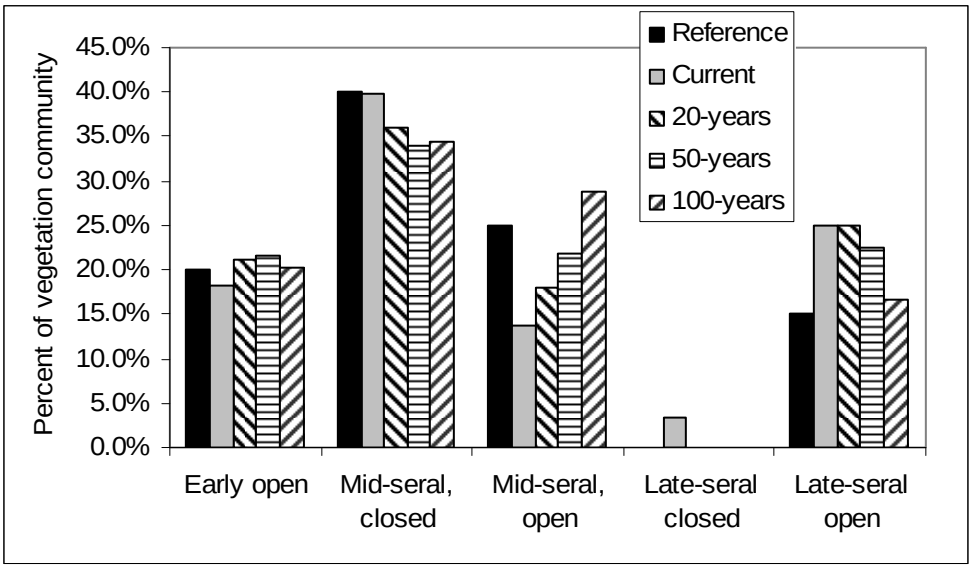
Structural Class	Reference	Current
Early Seral (Post-stand replacing fire):	20%	18%
Mid-seral, closed canopy:	40%	40%
Mid-seral, open canopy:	25%	14%
Late-seral, closed canopy:	0%	3%
Late Seral, open canopy:	15%	25%

As measured by FRCC, current fire frequency and severity are altered and the probability of uncharacteristic fire is higher in this system. Approximately 38 percent of the Madrean encinal woodland in the Basin and Range Section is in FRCC III, which means a high probability of uncharacteristic fire. Fifty-eight percent of the Madrean encinal woodland is in FRCC II, which is moderate departure from natural and elevated probability of uncharacteristic fire. Only 6 percent is in FRCC I, which indicates near natural conditions and risk.

The historic fire return interval in Madrean encinal woodland ranges from 2.5 to 10 years (Schussman et al. 2006).Based on FRCC ratings historic fire frequency may have been higher and severity may have been lower than current conditions.

Trends and Projected Future Conditions: Madrean Encinal Woodland

The 20-100 year projections under current management show decreasing amounts of mid-seral closed and increasing amounts of mid-seral open(figure below), with both trending toward reference conditions. The early-seral open and mid-seral closed are currently close to reference, however, the mid-seral closed is projected to decrease. Both late-seral stages expected to trend toward reference conditions under current management.



Risk Assessment: Madrean Encinal Woodland

The Madrean encinal woodland is the most extensive vegetation community on the Coronado NF. Thirty-eight percent of it has a high probability of uncharacteristic fire; however, the larger percentage (58 percent) has only an elevated probability of uncharacteristic fire. Projected trends are toward reference conditions. Identified threats beyond agency control (see Threat Matrix below) are primarily limited to areas along the Forest boundary. Given these factors, the risk to sustainability of the Madrean encinal woodland is low.

Threat Matrix: Madrean Encinal Woodland.

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threat
Fire exclusion	Increased woody species, changes in woody species composition.	Fire suppression Permitted livestock grazing		Prescribe fire and fire use, along with well managed grazing, can be used to allow beneficial fires in Madrean oak woodlands.
Uncharacteristic fire	Increases in stand densities result in higher fire intensities.	Fire suppression	Legacy of fire suppression	Appropriate management response can reduce the threat of uncharacteristic fire.
Over- harvesting of fuelwood	Increased stems per acre, decreased crown volume and depth, decreased tree height and foliage volume.	Fuelwood permits		Fuelwood sales can be designed to prevent over-harvesting of fuelwood.
Off road vehicle use	Soil erosion and compaction, destruction of vegetation.	Recreation management		Implementation of the Travel Management Rule can restrict off road vehicle use.

Threat Matrix: Madrean Encinal Woodland, continued

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threat
Fragmentation	Disruption of ecological processes, destruction of wildlife habitat and disruption of wildlife migration patterns	Permitted livestock grazing Land exchanges Road building	Development of private land within and along forest boundaries International law enforcement activity	Forage available for well-managed grazing on National Forest Lands can sustain ranching as an economic activity and reduce the threat of fragmentation of private lands. Strategic direction in Lands programs can emphasize maintaining open space. Transportation analysis and Travel Management Rule implementation can reduce negative effects associated withroad building.
Livestock overgrazing	Livestock grazing can affect the structure and composition of Madrean oak woodlands, as well as soil structure and water infiltration.	Permitted livestock grazing		Livestock grazing can be managed to mitigate negative effects. Positive effects to native plant communities have been observed with well managed grazing.

Madrean Pine Oak Woodland

Description: Madrean Pine Oak Woodland

The Madrean pine oak woodland vegetation community is dominated by open to closed canopy of evergreen oaks such as Arizona white oak (*Quercus arizonica*), alligator juniper (*Juniperus deppeana*), Chihuahua pine (*Pinus leiophylla*) and other various pines with a grassy understory. Madrean pine-oak woodlands usually occupy foothills and mountains ranging from approximately 4000 to 7000 ft. in elevation. Climate generally consists of mild winters and wet summers with mean annual precipitation ranging from about 10 to 25 inches; half of the precipitation typically occurs in summer, with the remainder occurring during the winter and spring.

Typical TE/SOC/SOI Species Associations: Madrean Pine Oak Woodland

The literature often lumps this habitat with Madrean oak woodland, cumulatively referring to them as Madrean Evergreen Woodland, so it is difficult to separate out species associations between these types, and many species occur in both, although a working assumption is that Madrean species requiring grassy openings are present in the Madrean oak woodlands, but not Madrean pine-oak woodlands. This is a biologically diverse ecosystem, especially for invertebrates and plants, associated with all physical attributes (rock, cave, terrestrial, aquatic). TE/SOC/SOI typical of this vegetation type include Chiricahua Fox Squirrel, many land snails, Lichen Grasshopper (in rocky areas), some notothenid moths, Patagonia Eyed Silkmoth, Catalina Beardtongue (in rocky areas), Huachuca Mountain Lupine, Pinaleño Mountains Rubberweed, and Purple-spike Coralroot.

Representation of Madrean Pine Oak Woodland on the Coronado NF Compared with the Broader Area

Madrean pine oak woodland covers approximately eight percent of the Coronado NF. It makes up less than 1 percent (approximately 172,000 acres) of the Basin and Range (Section 321A), and much less than 1 percent (3,500 acres) of the Sonoran Desert (Section 322B). Because of the small proportion of Coronado NF land and Madrean pine oak woodland in the Sonoran Desert Section, the rest of this discussion will deal with the Basin and Range Section and its component sub-sections.

The six subsections in the Basin and Range Section are shown below, along with the current proportion of area containing Madrean pine oak woodland and the proportion of Coronado NF land within each subsection that contains Madrean pine oak woodland:

Subsection	Percent of Subsection	Percent of Coronado NF
Animas Valley Plains Desert Grass-Shrubland	<1%	<1%
Animas Mts. Oak-Juniper Woodland	<1%	<1%
Sulphur Springs Plains Desert Grass-Shrubland	<1%	4%
Santa Catalina Mts. Sierra Madre Interior Chapparral	12%	16%
San Rafael Sierra Madre High Plains Grassland	<1%	<1%
Santa Catalina Mts. Encinal Woodland	5%	8%

The Madrean pine oak woodland makes up < 1 percent of the land area of the Basin and Range Section, and from <1 to 12 percent of the subsections overlapping the Coronado NF. This vegetation community makes up 8 percent of the Coronado NF as a whole, and from < 1 to 16 percent of any one portion of the Coronado NF within a subsection. The Madrean pine oak woodland vegetation type is slightly more abundant on the Coronado NF compared to the surrounding landscape.

Disturbances: Madrean Pine Oak Woodland

Fire and drought are the primary natural disturbances associated with the Madrean pine oak woodland. Fires occurred 18 of 22 years over the period of 1982 to 2003, with an average of 1,800 acres burned per year, approximately one percent per year. The smallest area of Madrean pine oak woodland burned in this time was 0 acres, the largest just over 24,000 acres. Large fires occur infrequently; a total of 6 fires larger than 1,000 acres have occurred over the last 22 years, while 13 years less than 100 acres burned.

As measured by FRCC, current fire frequency and severity are altered and the probability of uncharacteristic fire is higher in this system. Approximately 73 percent of the Madrean pine oak woodland on the Coronado NF is in FRCC III, which means a high probability of uncharacteristic fire. Twenty six percent of the Madrean pine oak woodland is in FRCC II, which is moderate departure from natural and elevated probability of uncharacteristic fire. Only one percent is in FRCC I, which indicates near natural conditions and risk.

The historic fire return interval in Madrean pine oak woodland ranges from 3 to 8 years (Schussman et al. 2006). Based on FRCC ratings historic fire frequency may have been higher and severity may have been lower than current conditions.

Some domestic livestock grazing at light to moderate levels occurs in the Madrean pine oak woodlands within the Coronado NF. Other management practices that may cause disturbance in the Madrean pine oak woodland vegetation community are road building, recreation management, fire management, and ecosystem restoration activities. The direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

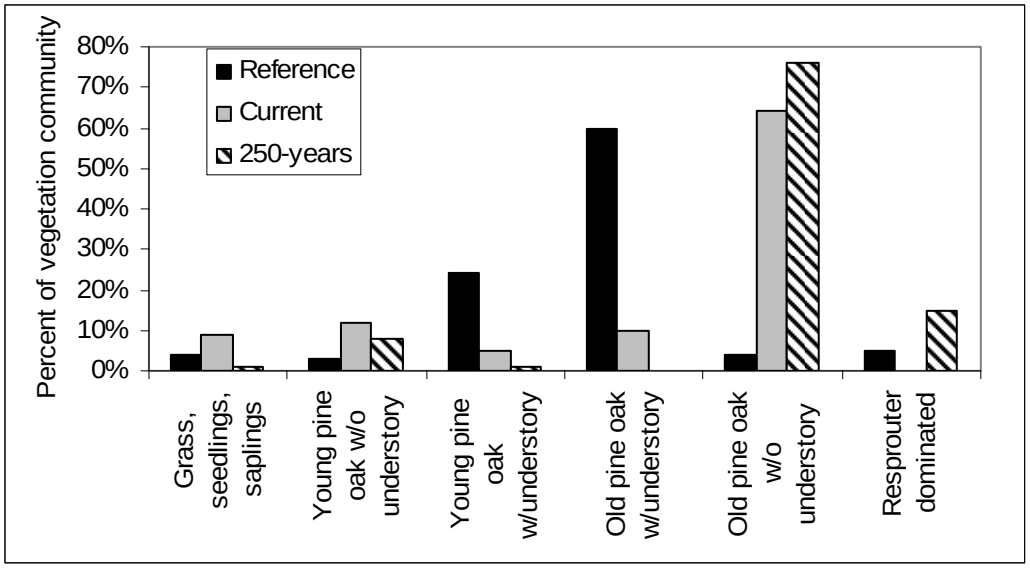
Reference and Current Conditions: Madrean Pine Oak Woodland

The distribution of Madrean pine oak woodland structural classes for historic (reference) and current conditions is displayed below.

Structural Class	Reference	Current
Grass, seedling, saplings:	4%	9%
Young pine oak w/o understory:	3%	12%
Young pine oak w/understory:	24%	5%
Old pine oak w/understory:	60%	10%
Old pine oak w/o understory:	4%	64%
Resprouter dominated:	5%	0%

Trends and Projected Future Conditions: Madrean Pine Oak Woodland

The 250 year projections under current management show increasing amounts of old pine oak without understory and decreasing amounts of young and old pine oak with understory (figure below). The young pine oak without understory stage will move closer to reference conditions, but substantial deviations from reference conditions for all other stages are expected under current management.



Risk Assessment: Madrean Pine Oak Woodlands

The high proportion of the Madrean pine oak woodlands type (99 percent) with an elevated or high probability of uncharacteristic fire, the high percentage deviating from reference conditions, projected trends away from reference conditions, and identified threats beyond agency control (see Threat Matrix below), all indicate a high risk to the sustainability of the Coronado NF Madrean pine oak woodland.

Threat Matrix: Madrean pine oak woodlands.

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threat
Uncharacteristic fire	High intensity fires can change vegetation composition and structure, and cause accelerated soil erosion. Habitat for most TE/SOC/SOI would be lost in areas of severe fire and there would be direct mortality of certain species.	Prescribed fire or fire use Fuels management		Appropriate management response to fire in Madrean pine oak woodland can be used to suppress uncharacteristic fire. Fuels management can be effective in reducing the risk of uncharacteristic fire.
Fire exclusion	Increased woody species, changes in woody species composition.	Fire suppression Permitted livestock grazing		Prescribe fire and fire use, along with well managed grazing, can be used to allow beneficial fires in Madrean pine oak woodlands.

Ponderosa Pine

Description: Ponderosa Pine

The ponderosa pine forest is widespread in the Southwest occurring at elevations ranging from 6,000-9,000 ft on igneous, metamorphic, and sedimentary parent soils with good aeration and drainage, and across elevational and moisture gradients. The dominant species in this system is Ponderosa pine (*Pinus ponderosa*). Other trees, such as Gambel oak (*Quercus gambelii*), Douglas-fir (*Pseudotsuga menziesii*), pinyon pine (*Pinus edulis*), and juniper spp. (*Juniperus* spp.) may be present. There is typically a shrubby understory mixed with grasses and forbs, although this type sometimes has grasslands interspersed between widely spaced clumps or individual trees. This system is adapted to drought during the growing season, and has evolved several mechanisms to tolerate frequent, low intensity surface fires. This vegetation type covers approximately 62,000 acres (or 3.5 percent) of the Coronado NF.

Typical TE/SOC/SOI Species Associations: Ponderosa Pine

On the Coronado NF, there are few pure, large stands of Ponderosa (and Apache) pine.Standsare mostly transitional between other types or in small patches. However, there are a surprising number of species typical of, or finding optimal habitat in, this habitat type. Most of these are plants. TE/SOC/SOI include Northern (Apache) Goshawk, Slevin's Bunchgrass Lizard (in open, grassy stands), Abert's Squirrel (non-native SOI), Arizona Gray Squirrel, Lemmon's Beggar-ticks, Mexican Hemlock-Parsley, Giant-trumpets, Chiricahua Mountains Larkspur, Chiricahua Gentian, and many other plants, plus Arizona Mantleslug, Pinaleño Mountainsnail (in rocks), and Heart Vertigo.

Representation of Ponderosa Pine on the Coronado NF Compared with the Broader Area

Ponderosa Pine is less than 1 percent (approximately 69,000 acres) of the Basin and Range (Section 321A), and much less than 1 percent (195 acres) of the Sonoran Desert (Section 322B). Because of the small proportion of forest land and Ponderosa pine in the Sonoran Desert Section, the rest of this discussion will deal with the Basin and Range Section and its component sub-sections.

Within the Basin and Range Section, there are 6 subsections which overlap the Coronado NF. These subsections are shown below, along with the current proportion of area containing Ponderosa pine and the proportion of Coronado NF land within each subsection that contains Ponderosa pine:

Subsection	Percent of Subsection	Percent of Coronado NF
Animas Valley Plains Desert Grass-Shrubland	<1%	0%
Animas Mts. Oak-Juniper Woodland	<1%	0%
Sulphur Springs Plains Desert Grass-Shrubland	<1%	<1%
Santa Catalina Mts. Sierra Madre Interior Chapparral	2%	2%
San Rafael Sierra Madre High Plains Grassland	<1%	0%
Santa Catalina Mts. Encinal Woodland	4%	6%

The Ponderosa pine makes up less than 1 percent of the land area of the Basin and Range Section, and from less than 1 to 4 percent of the sub-sections overlapping the Coronado NF.

This vegetation community makes up 3.5 percent of the Coronado NF as a whole, and from 0 to 6 percent of any one portion of the forest within a subsection. The Ponderosa pine vegetation type is as abundant on the Coronado NF as it is on the surrounding landscape.

Disturbances: Ponderosa Pine

Fire and drought are the primary natural disturbances in Ponderosa pine forests within the Coronado NF. Fires occurred 7 of 22 years over the period of 1982 to 2003, with an average of 390 acres burned per year (less than 1 percent per year). The smallest area of Ponderosa pine burned in this time was 0 acres, the largest just over 4,000 acres. Large fires occur infrequently; a total of 2 fires larger than 1,000 acres have occurred over the last 22 years, while in 18 of those years less than 100 acres burned.

As measured by FRCC, current fire frequency and severity are altered and the probability of uncharacteristic fire is higher in this system. Approximately 81 percent of the Ponderosa pine on the Coronado NF is in FRCC III, which means a high probability of uncharacteristic fire. Eighteen percent of the Ponderosa pine is in FRCC II, which is moderate departure from natural and elevated probability of uncharacteristic fire. Only 1 percent is in FRCC I, which indicates near natural conditions and risk.

The historic fire return interval in Ponderosa pine ranges from 2 to 17 years (Schussman et al. 2006). Based on FRCC ratings, historic fire frequency may have been higher and severity may have been lower than current conditions.

Management practices that may cause disturbance in the Ponderosa pine vegetation community are road building, recreation management, fire management, and ecosystem restoration activities. The direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

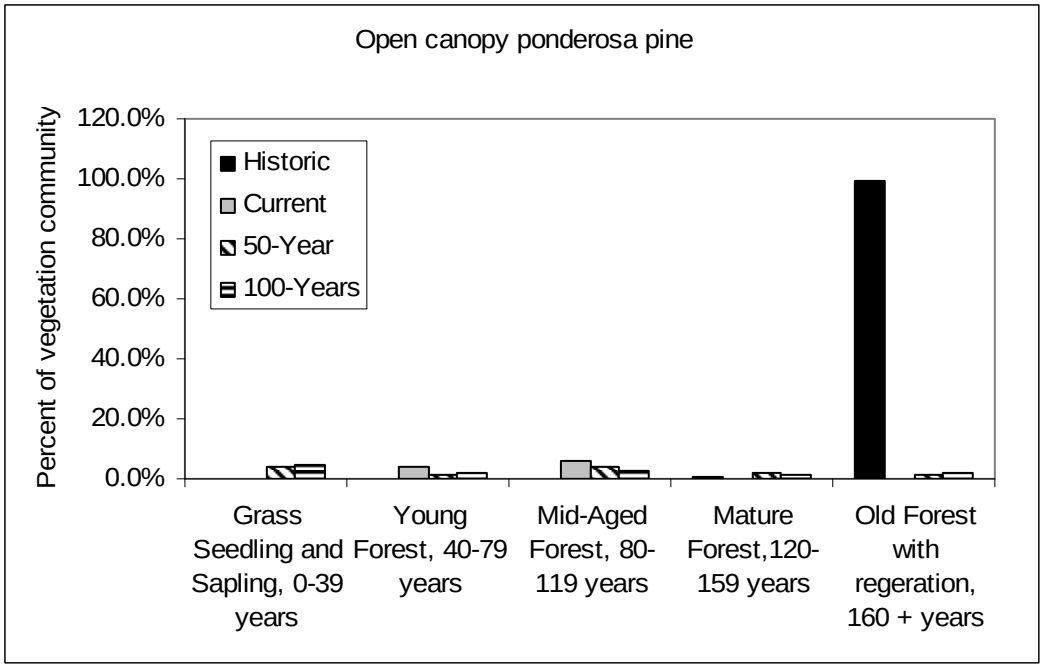
Reference and Current Conditions: Ponderosa Pine

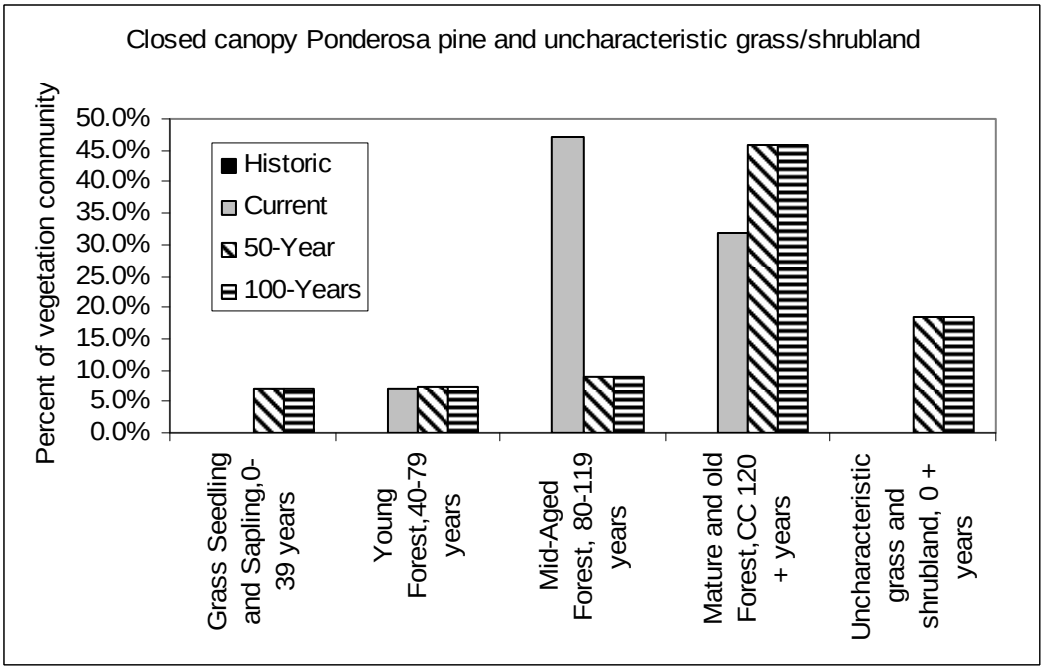
The distribution of Ponderosa pine structural classes for historic (reference) and current conditions is displayed below.

Structural Class	Reference	Current
Open forest states (Canopy closure <30%):		
Grass, seedling, saplings:	0%	1%
Young forest:	0%	4%
Mid-aged forest:	<1%	6%
Mature forest:	<1%	<1%
Old forest with regeneration:	99%	<1%
Closed forest states (Canopy closure >30%):		
Grass, seedling, saplings:	0%	1%
Young forest:	0%	7%
Mid-aged forest:	0%	47%
Mature and old forest:	0%	32%
Uncharacteristic grass and shrubland:	0%	1%

Trends and Projected Future Conditions: Ponderosa Pine

The 50 and 100 year projections under current management show increasing amounts of closed canopy ponderosa pine of all ages, as well as increasing amounts of uncharacteristic grassland and shrubland (figures below). Substantial deviations from reference for all other stages are expected under current management.





Risk Assessment: Ponderosa Pine

The high proportion of the ponderosa pine type (99 percent)) with an elevated or high probability of uncharacteristic fire, the high percentage deviating from reference conditions, projected trends away from reference conditions, and identified threats beyond agency control (see Threat Matrix below), all indicate a high risk to the sustainability of the Coronado NF ponderosa pine vegetation type.

Threat Matrix: Ponderosa Pine

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threat
Uncharacteristic fire	High intensity fires can change vegetation composition and structure, and cause accelerated soil erosion.	Fire management Fuels management	Legacy of fire suppression Climate change	Appropriate management response to fire can be used to suppress uncharacteristic fire. Fuels management can be effective in reducing the risk of uncharacteristic fire.
Insects and pathogens	Insects and pathogens are natural elements that can cause defoliation and mortality of trees, but in stands with dense trees the outbreaks can reach epidemic proportions.		Legacy of fire suppression Climate change	Management options to treat insects and pathogens are limited, and only effective at a small scale.
Fire exclusion	Increased density of small-diameter trees and a concomitant decrease in bunchgrasses and openings between trees.	Fire management Fuels management		Prescribed fire and fire use can be used to allow beneficial fires in Ponderosa pine.

Mixed Conifer Forest

Description: Mixed Conifer Forest

The mixed conifer forest spans a variety of dominant and co-dominant species in both dry and mesic environments in the Rocky Mountain and Madrean Provinces. In the Rocky Mountains, montane conifer forests may be found at elevations between 5,000 and 10,000 ft., situated between ponderosa pine, pine-oak, or pinyon-juniper woodlands and spruce-fir or sub-alpine conifer forests. Dominant and co-dominant vegetation varies in elevation and moisture availability. In the lower and drier elevation portions within this vegetation community, Gambel oak (*Quercus gambelii*) and ponderosa pine (*Pinus ponderosa*) may co-dominate. In higher and more mesic areas ponderosa pine may co-dominate with Douglas fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*). Other vegetation that may be present but does not co-dominate in these higher and mesic areas include Englemann spruce (*Picea engelmannii*) and Colorado blue spruce (*Picea pungens*). In the Madrean Province, this vegetation community can be characterized by large and small-patch forests and woodlands dominated by Douglas fir or white fir with Madrean oaks such as silverleaf oak (*Quercus hypoleucoides*) and netleaf oak (*Quercus rugosa*). The understory vegetation is comprised of a wide variety of shrubs, grasses, graminoids (sedges, etc.), and forbs; the compositions depends on soil type, aspect, elevation, disturbance history and other factors.

Typical TE/SOC/SOI Species Association: Mixed Conifer Forest

This habitat is restricted to the high elevations of only the highest sky islands, and tends to have a boreal flora and fauna. Typical TE/SOC/SOI include Mexican Spotted Owl, Pungent Talussnail (and many other land mollusks), Band-tailed Pigeon, Elk (non-native SOI), Mt. Graham Red Squirrel, Twin-spotted Rattlesnake, Black Bear, and Coues' White-tailed Deer.

Representation of Mixed Conifer Forest on the Coronado NF Compared with the Broader Area

Mixed conifer forests are less than one percent (approximately 51,000 acres) of the Basin and Range Section, and much less than one percent (only 3 acres) of the Sonoran Desert Section. Because of the small proportion of Coronado NF land and mixed conifer in the Sonoran Desert Section, the rest of this discussion will deal with the Basin and Range Section and its component subsections.

The six subsections in the Basin and Range Section are shown below, along with the current proportion of area containing mixed conifer and the proportion of Coronado NF land within each subsection that contains mixed conifer:

Subsection	Percent of Subsection	Percent of Coronado NF
Animas Valley Plains Desert Grass-Shrubland	<1%	0%
Animas Mts. Oak-Juniper Woodland	<1%	0%
Sulphur Springs Plains Desert Grass-Shrubland	<1%	<1%
Santa Catalina Mts. Sierra Madre Interior Chapparral 1%	2%	
San Rafael Sierra Madre High Plains Grassland	0%	0%
Santa Catalina Mts. Encinal Woodland	2%	3%

The mixed conifer forests make up less than 1 percent of the land area of the Basin and Range Section, and from 0 to 2 percent of the sub-sections overlapping the Coronado NF. These vegetation communities make up 2 percent of the Coronado NF as a whole, and from 0 to 3 percent of any one portion of the Coronado NF within a subsection. The mixed conifer vegetation type is slightly more abundant on the Coronado NF than it is on the surrounding landscape.

Reference and Current Conditions: Mixed Conifer Forest

The distribution of mixed conifer structural classes for historic (reference) and current conditions is displayed below.

Structural Class	Reference	Current
Open forest states		
Grass/forb with aspen or oak ramets:	1%	2%
Young forest:	0%	1%
Mid-aged forest:	29%	24%
Mature and old forest:	49%	20%
Closed forest states		
Young forest:	21%	11%
Mid-aged forest:	0%	20%
Mature and old forest:	0%	47%

Disturbances: Mixed Conifer Forest

Fire and drought are the primary natural disturbances in Coronado NF mixed conifer forests. In this vegetation type, fires occurred in 16 of 22 years over the period of 1982 to 2003, with an average of 1100 acres of mixed conifer burned per year (3 percent per year). The smallest area burned in this time was 0 acres, the largest over 13,000 acres. Large fires occur infrequently; a total of 5 fires larger than 1,000 acres have occurred over the last 22 years. No fires at all occurred in 6 years over that time period.

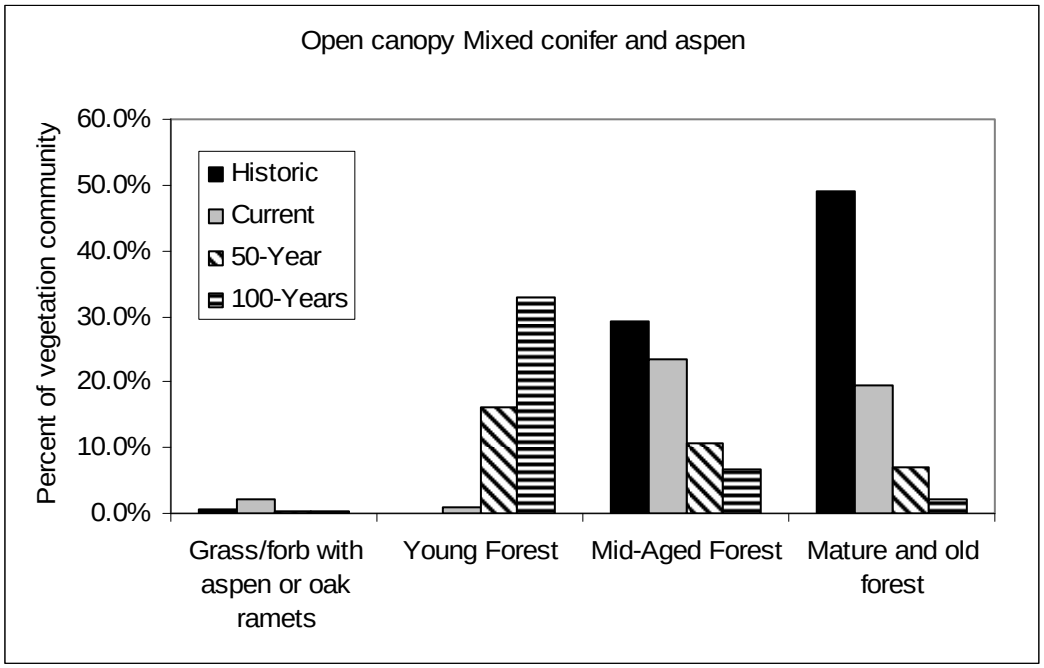
As measured by Fire Regime Condition Class (FRCC), current fire frequency and severity are altered and the probability of uncharacteristic fire is higher in these systems. Approximately 88 percent of the mixed conifer on the Coronado NF is in FRCC III, which means a high probability of uncharacteristic fire. Four percent is in FRCC II, which is moderate departure from natural and elevated probability of uncharacteristic fire. Only 8 percent is in FRCC I, which indicates near natural conditions and risk.

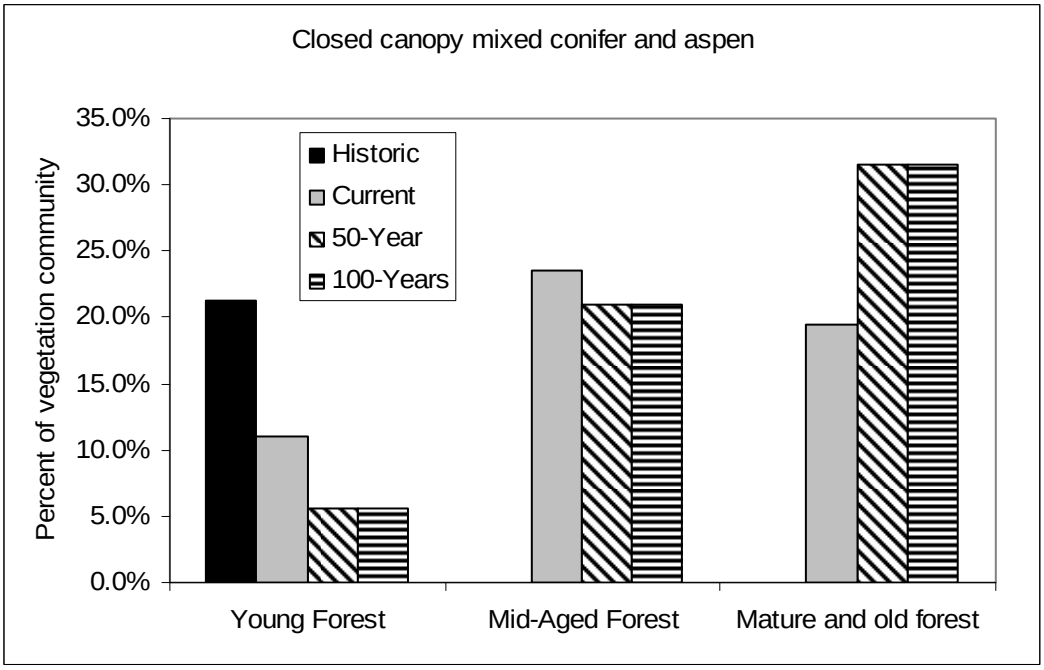
The historic fire return interval ranges from 10 to 22 years (Schussman et al. 2006). Based on FRCC ratings historic fire frequency may have been higher and severity may have been lower than current conditions.

Management practices that may cause disturbance in the mixed conifer vegetation community are road building, recreation management, fire management, and ecosystem restoration activities. The direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

Trends and Projected Future Condition: Mixed Conifer Forest

The 50 and 100 year projections under current management show increasing amounts of closed canopy mixed conifer, particularly in the mature/old forest class (figure below). There will be declines in the amount of open canopy mid-aged and mature/old mixed conifer forest.





Risk Assessment: Mixed Conifer Forest

The high proportion of the mixed conifer forest (92 percent)) with an elevated or high probability of uncharacteristic fire, the high percentage deviating from reference conditions,

projected trends away from reference conditions, and identified threats beyond agency control (see Threat Matrix below), all indicate a high risk to the sustainability of the Coronado NF mixed conifer vegetation type.

Threat Matrix: Mixed Conifer

Threat	Effect	Management activities that may contribute to or reduce threat	Factors beyond agency control	Management options to reduce threat
Uncharacteristic fire	High intensity fires can change vegetation composition and structure, and cause accelerated soil erosion.	Prescribed fire or fire use Fuels management	Legacy of fire suppression Climate change	Appropriate management response to fire can be used to suppress uncharacteristic fire. Fuels management can be effective in reducing the risk of uncharacteristic fire.
Insects and pathogens	Insects and pathogens are natural elements that can cause defoliation and mortality of trees, but outbreaks in overly dense stands can reach epidemic proportions.		Legacy of fire suppression Climate change	Management options to treat insects and pathogens are limited, and only effective at a small scale.

Spruce-Fir

Description: Spruce-Fir

Also known as sub-alpine conifer forests, spruce-fir forests range in elevation from 9,500 to 11,500 ft. along a variety of gradients including gentle to very steep mountain slopes. Englemann spruce (*Picea engelmannii*) and sub-alpine fir (*Abies lasiocarpa*) or corkbark fir (*Abies lasiocarpa var. lasiocarpa*) dominate this vegetation community either mixed or alone. Douglas-fir (*Pseudotsuga menziesii*) along with mixed conifer and quaking aspen (*Populus tremuloides*) stands may also be present in this system for long periods without regeneration. Herbaceous species may include but are not limited to red baneberry (*Actaea rubra*), starry false Solomon's seal (*Maianthemum stellatum*), fleabane (*Erigeron eximius*), blackberry (*Rubus pedatus*), and sub-alpine lupine (*Lupinus arcticus spp. Subalpinus*). Natural disturbances in this vegetation community are blow-downs, insect outbreaks and stand replacing fires.

Typical TE/SOC/SOI Species Associations: Spruce-Fir

This habitat type has relatively few species, most of which are cold-adapted, more typical of boreal forests, than the Sierra Madre Occidental; it is essentially limited to the Pinaleño Mountains. Most of the species are terrestrial, rather than riparian or aquatic, and many of these are rock-associates. TE/SOC/SOI include Mt. Graham Red Squirrel, Pinaleño Monkey Grasshopper, Cross Snaggletooth, Heliograph Peak Fleabane, White-flowered Cinquefoil, Mt. Graham Beardtongue, New Mexico Lupine, Timberland Blue-eyed Grass, and Heller's Whitlow-grass.

Current conditions: Spruce-Fir

This vegetation type covers approximately 3,800 acres (<1 percent) of the Coronado NF, but is important because of its relationship to the federally listed endangered species the Mount Graham red squirrel. On the forest, this vegetation type is distributed structurally as follows:

Grass, seedlings and saplings, open: 80%

Young forest, open to closed: 10%

Old/mature forest, multi-storied: 10%

Reference Conditions: Spruce-Fire

The reference status of Spruce-fir is distributed over the following structural classes, with current distribution included again for reference:

Structural Class	Reference	Current
Grass, seedlings and saplings, open:	25%	80%
Young forest, open to closed:	35%	10%
Old/mature forest, multi-storied:	40%	10%

These percent distributions were the same at all scales historically.

Disturbance: Spruce-Fir

In the spruce-fir vegetation type, a stand-replacing insect outbreak took place between 1999 and 2001 (Koprowski et al 2005, Lynch 2006, Coronado National Forest 2005). In addition, one fire has been recorded in the 23 years from 1982 to 2005. The Nuttall-Gibson Complex was stand-replacing over 40 percent of what was left of the spruce-fir type following the insect outbreak (University of Arizona 2008).

No Fire Regime Condition Class (FRCC) evaluation was conducted on spruce-fir.

Henri Grissino-Mayer's fire history study of the Pinaleños suggested a fire return interval for this forest type of 300 to 400 years due to a lack of trees older than this age and evidence of a catastrophic fire in 1685.

Other management practices that may cause disturbance in the spruce-fir vegetation community are road building, recreation management, fire management, and ecosystem restoration activities. The direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

Trends/Projected Future: Spruce-Fir

The 50 to 250 year projections under current management have not been made due to uncertainty of the effects of an introduced spruce aphid population and warmer than normal winters (Lynch 2006).

Risk Assessment: Spruce-Fir

The very small amount of the spruce-fir vegetation within the Coronado NF, along with identified threats beyond agency control (see Threat Matrix below) and limited management options to reduce those threats, indicate a high risk to the sustainability of the Coronado NF spruce-fir vegetation type.

Threat Matrix: Spruce –Fir.

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threat
Uncharacteristic fire	High intensity fires can change vegetation composition and structure, and cause accelerated soil erosion.	Fire management Fuels management	Climate change	Appropriate management response to fire can be used to suppress uncharacteristic fire. Fuels management can be effective in reducing the risk of uncharacteristic fire.
Insects and pathogens	Insects and pathogens are natural elements that can cause defoliation and mortality of trees, but outbreaks in overly dense stands can reach epidemic proportions. The exotic spruce aphid is not a natural element, and is causing extensive tree mortality.		Climate change	Management options to treat insects and pathogens are limited, and only effective at a small scale.

Riparian Communities

Description

There are several major distinct riparian communities within the Coronado NF.

Cottonwood Willow Riparian Forest

This system is typically found at lower elevations along rivers and streams in unconstrained valley bottoms. Dominant woody species include cottonwood spp. (*Populus spp*.), willow species (*Salix spp*.), and mesquite spp. (*Prosopis spp*.). Various grasses and forbs are also present. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded and the water table can be severely depleted. In addition, many of the areas with this riparian community have experienced an increase in invasive species such as salt cedars (*Tamarix spp*.), and Russian olive (*Elaeagnus angustifolius*). The vegetation is dependent upon on seasonal flooding and high water tables for germination, growth and survivorship of the woody dominants.

Mixed Broad Leaf Deciduous Riparian Forest

Located in the Madrean and Chihuahuan provinces, mixed broadleaf deciduous riparian forests are found along rivers and streams starting at low elevations (approximately 4,000 ft.) and climbing up to montane elevations of approximately 9,000 ft. The vegetation is a mix of riparian woodlands and shrublands with a variety of vegetation associations. The dominant vegetation is likely to depend upon a suite of site-specific characteristics including elevation, substrate, stream gradient, and depth to groundwater. For example, one vegetation association is dominated by bigtooth maple with mixed stands of Gambel oak, some scattered conifers and possibly some quaking aspen (*Populus tremuloides*). Other sites can be dominated by a mixture of the following woody species: boxelder, narrowleaf cottonwood, Fremont cottonwood (*Populus fremontii*), Arizona sycamore (*Platanus wrightii*), velvet ash (*Fraxinus velutina*), Arizona walnut (*Juglans major*), Arizona cypress (*Cupressus arizonica*) and willows (*Salix exigua and others*). The forest often contains oaks (*Quercus gambelii, Q. emoryi, Q. arizonica*) and conifers (*Pinus ponderosa, Juniperus deppeana*) from upstream and adjacent uplands. Exotic species such as Russian olive (*Elaeagnus angustifolia*) and salt cedar (*Tamarix spp*.) are common in some stands, especially at lower elevations. Vegetation can be dependent upon annual or periodic flooding for growth and reproduction, especially at lower elevations.

Montane Willow Riparian Forest

The Montane Willow Riparian Forest stretches along various elevational gradients from lower elevations (3,500 ft.) in mountain canyons and valleys to higher mountainous elevations (10,000ft.). At lower elevations this riparian community can be found along perennial and seasonally intermittent streams. Here, the dominant woody vegetation includes cottonwood spp. (*Populus spp*.), Arizona sycamore (*Platanus wrightii*), Arizona Walnut, (*Juglans major*), velvet ash (*Fraxinus velutina*), and soapberry (*Sapindus saponaria*). Shrubs include willow spp. (*Salix spp*.), cherry (*Prunus spp.*) and Arizona alder (*Alnus oblongifolia*). At higher elevations, this riparian community is found along streambanks, seeps, fens, and isolated springs. At higher elevations, this riparian community are shrub and herb dominated. Dominant shrubs include alder species (Alnus spp.), birch species (Betula spp.), redosier dogwood (*Cornus sericea*), and a variety of willow species (*Salix spp*.).

Typical TE/SOC/SOI Species Associations: Riparian Areas

Riparian areas have a wide variety of plant associates that vary by elevation and other factors. Because riparian areas offer a mesic and aquatic interface in an otherwise xeric landscape, species diversity is extremely high and conservation issues are great. Typical TE/SOC/SOI include adult phases of animals with aquatic larvae, including a multitude of insects (e.g., caddisflies, damselflies, and stoneflies) and all amphibians on the lists. Most species of bats on the lists use the riparian areas for foraging. Land mollusks are often thought of as being upland rock associates, but many are typical inhabitants of riparian areas (e.g., Wet Canyon Talussnail, Madera Talussnail, and Cave Creek Woodlandsnail) due to the mesic microclimates. Many TE/SOC/SOI birds are riparian, including Bell's Vireo, Elegant Trogon, and Western Yellow-billed Cuckoo. Not surprisingly, many plant species on the list are riparian associates, including Gentry's Indigo Bush, Chiricahua Mountain Alum-root, California Satintail, Southwest Monkeyflower, and Frog's-bit Buttercup.

Representation of Riparian Areas on the Coronado NF Compared with the Broader Area

Riparian vegetation types cover approximately 9,700 acres (less than one percent) of the Coronado NF. Also riparian vegetation types are less than one percent of both the Basin and Range (Section 321A) and Sonoran Desert (Section 322B) sections, but are important because of the arid environment in the Southwest. Because of the small proportion of forest land and riparian areas in the Sonoran Desert Section, the rest of this discussion will deal with the Basin and Range Section and its component sub-sections.

Within the Basin and Range Section, there are 6 subsections which overlap the Coronado NF. These subsections are shown below, along with the current proportion of area containing riparian vegetation types and the proportion of Coronado NF land within each subsection that contains riparian vegetation:

Subsection	Percent of Subsection	Percent of Coronado NF
Animas Valley Plains Desert Grass-Shrubland	0.3%	0.0%
Animas Mts. Oak-Juniper Woodland	0.3%	0.1%
Sulphur Springs Plains Desert Grass-Shrubland	0.9%	0.4%
Santa Catalina Mts. Sierra Madre Interior Chapparral	1.6%	2.0%
San Rafael Sierra Madre High Plains Grassland	0.2%	0.3%
Santa Catalina Mts. Encinal Woodland	0.5%	0.2%

Riparian vegetation types make up less than one percent of the land area of the Basin and Range Section, and from less than 1 to 1.6 percent of the sub-sections overlapping the Coronado NF. This vegetation community makes up 0.5 percent of the Coronado NF as a whole, and from less than 1 to 2 percent of any one portion of the forest within a subsection. In general, this vegetation type is as abundant or less abundant on the Coronado NF as compared to the surrounding landscape. Except in the Santa Catalina Mountains Sierra Madre Interior Chaparral subsection, where riparian vegetation is more abundant.

Disturbances: Riparian Areas

Fire frequency varies by riparian forest type. Based on data from 1982 through 2003, no acres have burned in Gallery Coniferous Riparian and in Wetlands/Cienegas. Fires in Mixed Broadleaf Deciduous Riparian have occurred 5 times in the last 22 years, and burned from

less than 1 acre up to approximately 300 acres. Fires are more frequent in Montane Willow and Cottonwood Willow riparian forests (14 and 15 of the last 22 years), and the average acres burned is small (51 to 66 acres per year).

Other management practices that may cause disturbance in riparian areas are road building, recreation management, fire management, and livestock grazing. The direct, indirect and cumulative effects of these activities are analyzed and mitigated through site specific NEPA processes.

Trends and Projected Future Conditions: Riparian Areas

The general trend is either static or down for vegetation measures in riparian areas. Mature and sapling trees have been lost to the drought, and riparian tree reproduction is not surviving, resulting in lower canopy closure. The general trend is up, or is not known but currently within the expected range for channel characteristics.

Risk Assessment: Ripararian Areas

Riparian areas are of very limited extent on the Coronado NF, and take on the risk to sustainability of the surrounding vegetation communities. In addition, there are a number of identified threats to riparian areas that are beyond agency control (see Threat Matrix below). Given these considerations, the risk to sustainability of riparian areas ranges from low to high.

Threat Matrix: Riparian Areas

Threat	Effect	Management activities that may contribute to threat	Factors beyond agency control	Management options to reduce threat
Uncharacteristic fire	High intensity fires can change vegetation composition and structure, and cause accelerated soil erosion	Fire management	Climate change	Appropriate management response to fire can be used to suppress uncharacteristic fire. Fuels management can be effective in reducing the risk of uncharacteristic fire.
Livestock overgrazing	Livestock grazing can affect the structure and composition of desert plant communities, as well as soil structure and water infiltration. Livestock movement can be a vector for invasive plant seed.	Permitted livestock grazing		Livestock grazing can be managed to mitigate negative effects. Positive effects to native plant communities have been observed with well managed grazing.
Off road vehicle use	Soil erosion and compaction, destruction of vegetation	Recreation management	Illegal activities	Implementation of the Travel Management Rule can restrict off road vehicle use.
Water diversions	Vegetation mortality	Mining Special use permits Permitted livestock grazing	Water rights held by others	Water diversions are mitigated through mining plans of operation, the special use permitting process, or livestock grazing allotment management plans.

References: Appendix A

Allen, Larry S. 1989. Livestock and the Coronado National Forest. Rangelands 11(1).

Cooke, Ronald U. and Richard W. Reeves. 1976. Arroyos and Environmental Change in the American Southwest. Clarendon Press. Oxford, England.

Coronado National Forest. 2005. STATUS PAPER: Mt. Graham Forest Insect Outbreaks Engelmann Spruce and Spruce Beetle. Unpublished document on file at Coronado National Forest.

Curtin, Charles G. 2008. Emergent Outcomes of the Interplay of Climate, Fire and Grazing in a Desert Grassland. Desert Plants 24(2).

Dobyns, Henry F. 1981. From Fire to Flood. Ballena Press. Soccoro, N.M.

Gori, D.F., and C.A.F. Enquist. 2003. An assessment of the spatial extent and condition of grasslands in central and southern Arizona, southwestern New Mexico, and northern Mexico. The Nature Conservancy.

Grissino-Mayer, H. D, Basin, C. H, Swetnam, T.W. 1994. Fire history and age structure analysis in the mixed-conifer and spruce-fir forest of Mt. Graham. A final report submitted to the Mt Graham Red Squirrel Study Committee. Laboratory for Tree Ring Research. University of Arizona March 30, 1994.

Hastings, James R. and Raymond M. Turner. 1965. The Changing Mile. University of Arizona Press. Tucson.

Holechek, J.L., M. Thomas, F. Molinar and D. Galt. 1999. Stocking desert rangelands: What we have learned. Rangelands 21(6): 8-12.

Holechek, J.L., T. Baker and J. Boren. 2004. Impacts of controlled grazing versus grazing exclusion on rangeland ecosystems: What we have learned. Range Improvement Task Force Report No. 57, 44 pp. New Mexico State University, Las Cruces, NM.

Koprowski, J. L., M. I. Alanen, and A. M. Lynch. 2005. Nowhere to run and nowhere to hide: response of endemic Mt. Graham red squirrels to catastrophic forest damage. Biological Conservation 126 (2005) 491- 498.

Loeser,M.R.R., T.D. Sisk and T.E. Crews. 2007. Impact of grazing intensity during drought in an Arizona grassland. Conservation Biology 17(5):1425-1434.

Lynch , Ann M. 2006 Forest insect activity on the Coronado N.F., 1940-2005. Report for the Cronado N.F./Regional Analysis Team. Rocky Mountain Research Station, USDA Forest Service, Tucson AZ. September 2006.

Schussman, Heather and Edward Smith. 2006 Historical Range of Variation and State and Transition Modeling of Historic and Current Landscape Conditions for Potential Natural Vegetation Types of the Southwest. The Nature Conservancy.

Schussmand, Heather, Carolyn Enquist and Michael List. 2006. Historic Rire Return Intervals for Arizona and New Mexico: A Regional Perspective for Southwestern Land Managers. The Nature Conservancy in Arizona.

Sprinkle, Jim, Mick Holder, Chas Erikson, Al Medina, Dan Robinette, George Ruyle, Jim Maynard, Sabrina Tuttle, John Hays Jr., Walt Meyer, Scott Stratton, Alix Rogstad, Kevin Eldredge, Joe Harris, Larry Howery, and Wesley Sprinkle. 2007. Dutchwoman Butte Revisited: Examining paradigms for livestock grazing exclusion. Rangelands 29(6).

University of Arizona. Accessed October 2, 2008. Mt. Graham Biology Program Clark Peak and Nuttall Fires – Wildfires within red squirrel habitat. http://ag.arizona.edu/research/redsquirrel/fire.html#Nuttal_fire

Appendix B: Generalized Terrestrial Ecosystem Survey Descriptions and Maps

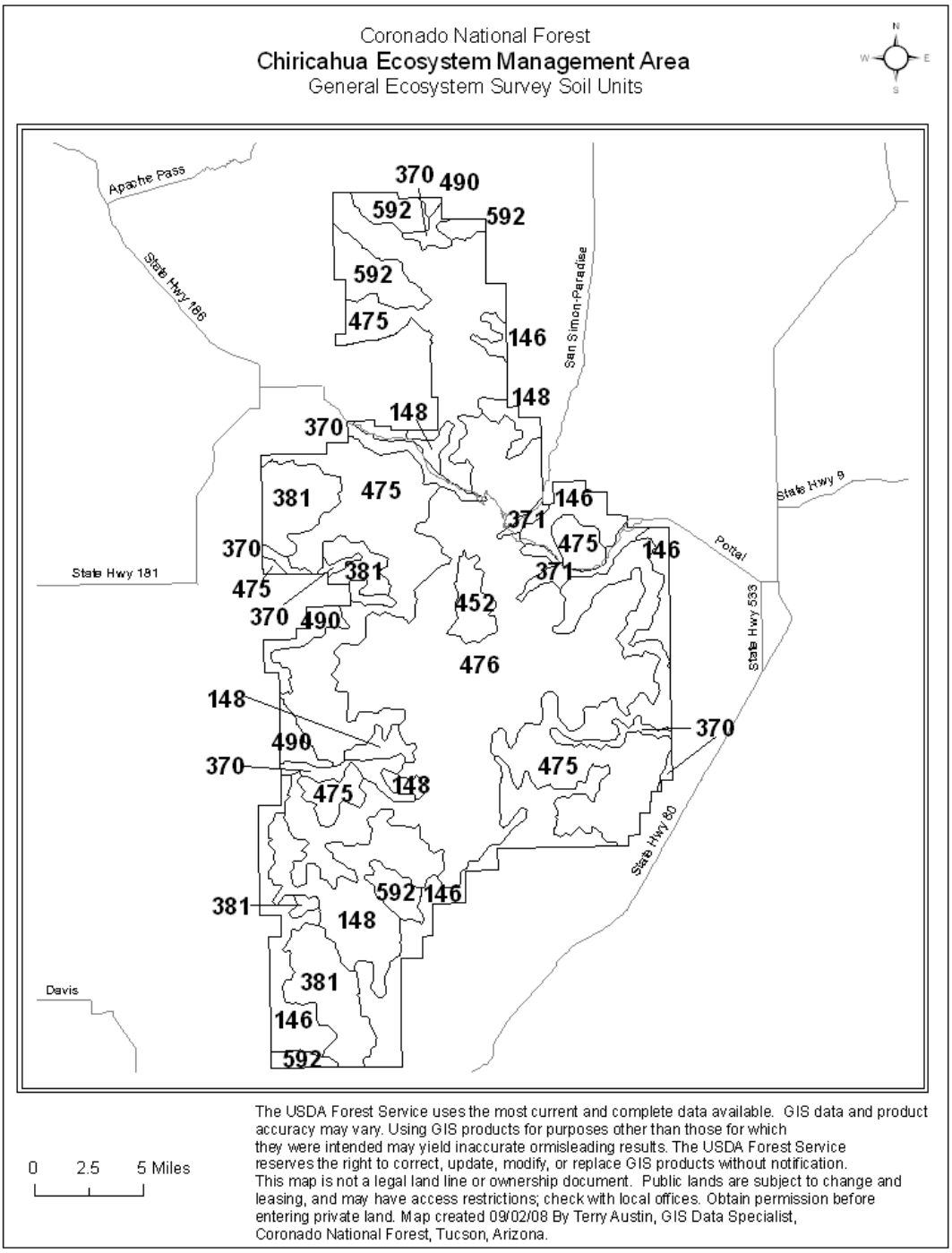
GES Unit	Landform	Elevation (m)	Soil Name	Average Gradient %	Surface Texture/ Modifier	Soil Depth	Parent Material	Climate Class	Erosion Hazard	Coronado NF Acres (from GIS)	Percent of Coronado NF
101	Elevated Plains	900-1000	Aridic Haplustalfs and Aridic Ustochrepts	0 to 15	Gravelly loam	Deep	Alluvium	LSM	Slight	6,594	0.4
144	Elevated Plains and Hills	1700–2100	Vertic Haplustalfs, Typic Haplistalfs, and Vertic Ustochrepts	0 to 40	Clay loam	Deep	Basalt	HSM	Slight to severe	2,388	0.1
146	Elevated Plains and Hills	1300–2100	Typic Haplustalfs and Aridic Haplustalfs	0 to 40	Gravelly loam	Deep	Alluvium	HSM	Slight to moderate	147,767	8.3
147	Elevated Plains	1700-1800	Typic Haplustalfs and Typic Argiustolls	0 to 15	Loam/ gravelly	Deep	Alluvium	HSM	Slight	25,485	1.4
148	Elevated Plains and Hills	1700-2100	Typic Haplustalfs and Lithic Haplustalfs	0 to 40	Cobbly to very stony loam	Shallow to deep	Sandstone	HSM	Slight to severe	24,070	1.3
235	Elevated Plains	400-900	Ustochreptic Camborhids and Ustalfic Haplargids	0 to 15	Very gravelly sandy loam	Deep	Alluvium	LSM	Slight	14,799	0.8

GES Unit	Landform	Elevation (m)	Soil Name	Average Gradient %	Surface Texture/ Modifier	Soil Depth	Parent Material	Climate Class	Erosion Hazard	Coronado NF Acres (from GIS)	Percent of Coronado NF
240	Elevated Plains	1100-1300	Ustochreptic Calciorthids and Ustalfic Haplargids	0 to 15	Very gravelly / sandy loam	Deep	Alluvium	HSM	Slight	2,369	0.1
303	Hills, Mountains, and Escarpments	400-1600	Lithic Torriorthents, Typic Ustochrepts, Lithic Ustochrepts, and Granite rock outcrop	40 to 120	Extremely cobbly sandy loam	Shallow to moderately deep	Granite	LSM	Moderate	86,311	4.8
370	Valley Plains	1700-2700	Fluventic Ustochrepts, Typic Ustifluvents, Typic Ustochrepts, and Riverwash	0 to 15	Extremely gravelly sandy loam	Deep	Alluvium	HSM	Slight	53,772	3.0
371	Valley Plains	1700-2100	Fluventic Ustochrepts, Aquic Ustifluvents, Typic Ustifluvents, and Riverwash	0 to 5	Extremely gravelly sandy loam	Deep	Alluvium	HSM	Slight	3,366	0.2

GES Unit	Landform	Elevation (m)	Soil Name	Average Gradient %	Surface Texture/ Modifier	Soil Depth	Parent Material	Climate Class	Erosion Hazard	Coronado NF Acres (from GIS)	Percent of Coronado NF
381	Elevated Plains and Escarpments	1700–2200	Lithic Ustorthents and Rhyolite rock outcrop	0 to 40	Extremely gravelly to cobbly sandy loam	Shallow	Rhyolite	HSM	Slight	50,793	2.8
451	Hills and Mountains	2500-3000	Typic Dystrochrepts and Dystric Cryochrepts	15 to 40	Very gravelly sandy loam	Deep	Granite	LSC	Moderate	1,467	0.1
452	Mountains and Escarpments	2500-3800	Typic Dystrochrepts, Dystric Cryochrepts, and Granite/Rhyolite rock outcrop	40 to 120	Extremely cobbly sandy loam	Deep	Granite, Rhyolite	LSC	Severe	7,134	0.4
466	Elevated Plains, Hills, and Mountains	2900-3800	Dystric Cryochrepts and Typic Dystrochrepts	0 to 40	Cobbly to very gravelly sandy loam	Deep	Granite	LSC	Slight	6,061	0.3
472	Hills, Mountains, and Escarpments	1300-2200	Lithic Ustochrepts and Granite/rhyolite rock outcrop	15 to 40	Extremely cobbly sandy loam	Shallow	Granite Residuum	HSM	Moderate	41,033	2.3

GES Unit	Landform	Elevation (m)	Soil Name	Average Gradient %	Surface Texture/ Modifier	Soil Depth	Parent Material	Climate Class	Erosion Hazard	Coronado NF Acres (from GIS)	Percent of Coronado NF
475	Hills, Mountains and Escarpments	1300-2200	Lithic Ustochrepts, Typic Ustochrepts, and Granite/rhyolite rock outcrop	40 to 80	Extremely cobbly sandy loam	Shallow	Granite, Rhyolite	HSM	Moderate	589,702	33.0
476	Hills, Mountains and Escarpments	1700-2800	Lithic Ustochrepts, Typic Dystrochrepts, Typic Ustochrepts, and Granite/rhyolite rock outcrop	60 to 100	Extremely cobbly sandy loam	Deep	Granite	LSC	Moderate	312,259	17.5
483	Hills, Mountains and Escarpments	1000-2300	Typic Ustochrepts, Lithic Ustochrepts, Lithic Haplustolls, and Limestone rock outcrop	40 to 120	Extremely cobbly loam to sandy loam	Shallow to Moderately deep	Limestone	LSM	Severe	66,824	3.7
485	Elevated Plains and Hills	1000-1600	Typic Ustochrepts	0 to 40	Extremely cobbly to very gravelly sandy loam	Deep	Granite	LSM	Slight to Moderate	13,188	0.7

GES Unit	Landform	Elevation (m)	Soil Name	Average Gradient %	Surface Texture/ Modifier	Soil Depth	Parent Material	Climate Class	Erosion Hazard	Coronado NF Acres (from GIS)	Percent of Coronado NF
490	Elevated Plains and Hills	1300-2100	Aridic Ustochrepts, Typic Ustochrepts, Aridic Haplustalfs, and Typic Haplustalfs	0 to 25	Very cobbly sandy loam	Deep	Granite, Rhyolite	HSM	Moderate to Severe	288,107	16.1
592	Hills and Escarpments	1300-2100	Lithic Haplustolls, Lithic Calciorthids, and Limestone rock outcrop	40 to 120	Loam/ extremely cobbly	Shallow	Limestone Residuum	HSM	Severe	41,422	2.3


Coronado National Forest
Chiricahua Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
Apache Pass
State Hwy 186
San Simon-Paradise
State Hwy 9
Portal
State Hwy 181
State Hwy 533
State Hwy 80
Davis
370 490
592
592
592
475
146
148
148
370
381
475
146
371
370
475
146
381
371
475
370 490
452
476
148
490
370
370
475
148
592 146
381
148
381
146
592
0 2.5 5 Miles
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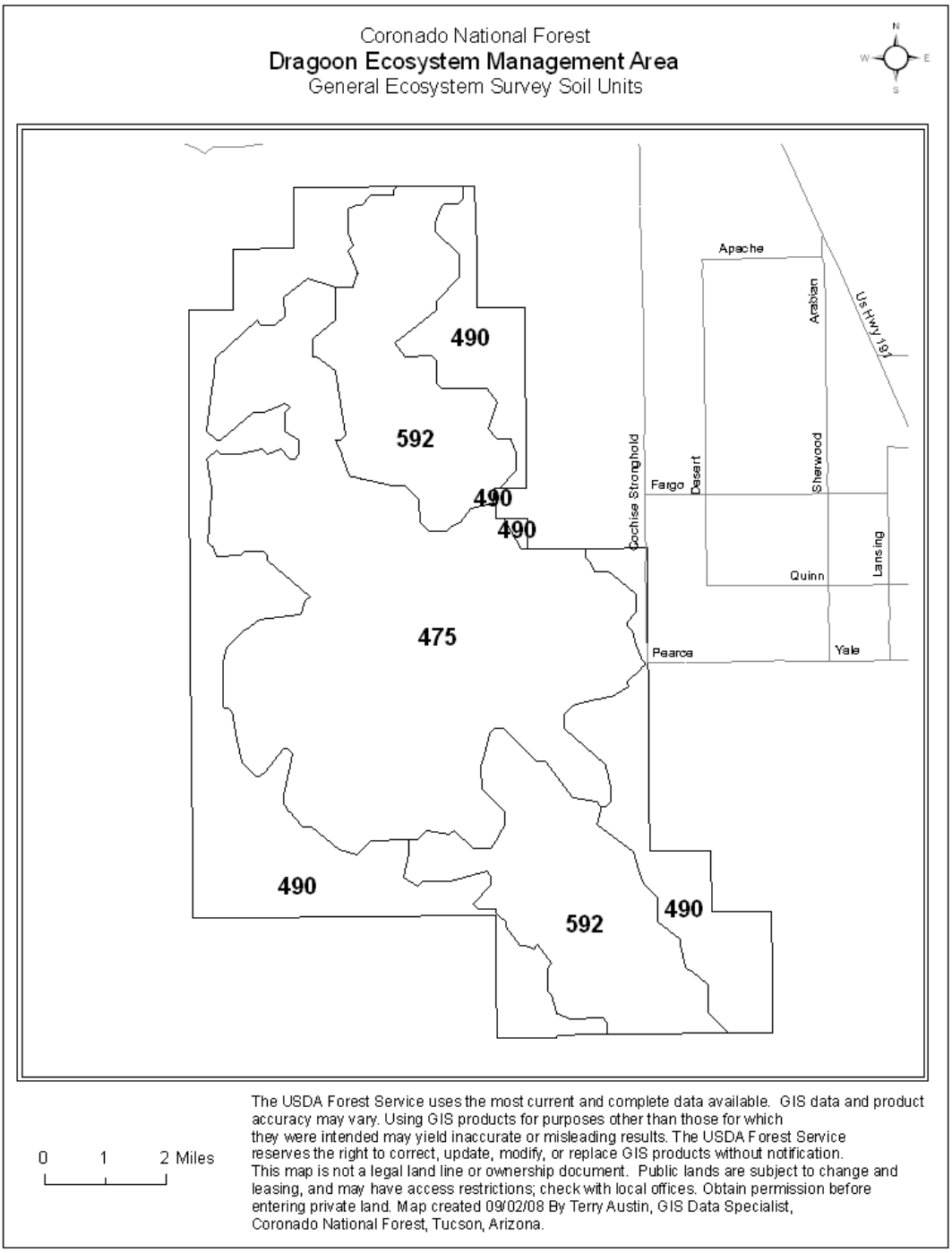
Coronado National Forest
Dragoon Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
490
592
490
490
475
490
592
490
Apache
Arabian
Us Hwy 191
Cochise Stronghold
Fargo
Desert
Sherwood
Quinn
Lansing
Pearce
Yale
0 1 2 Miles
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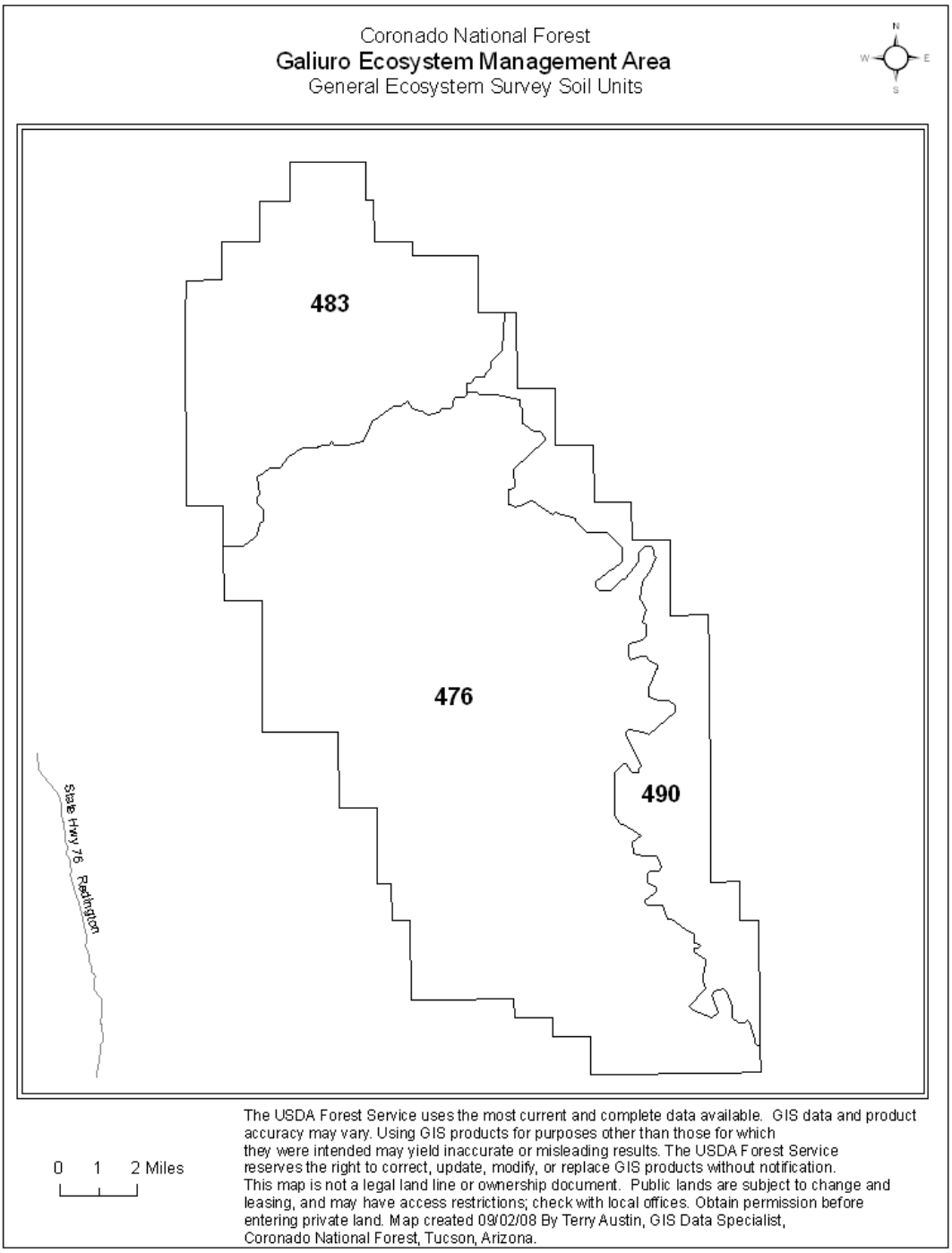
Coronado National Forest
Galiuro Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
483
476
490
State Hwy 76
Redington
0 1 2 Miles
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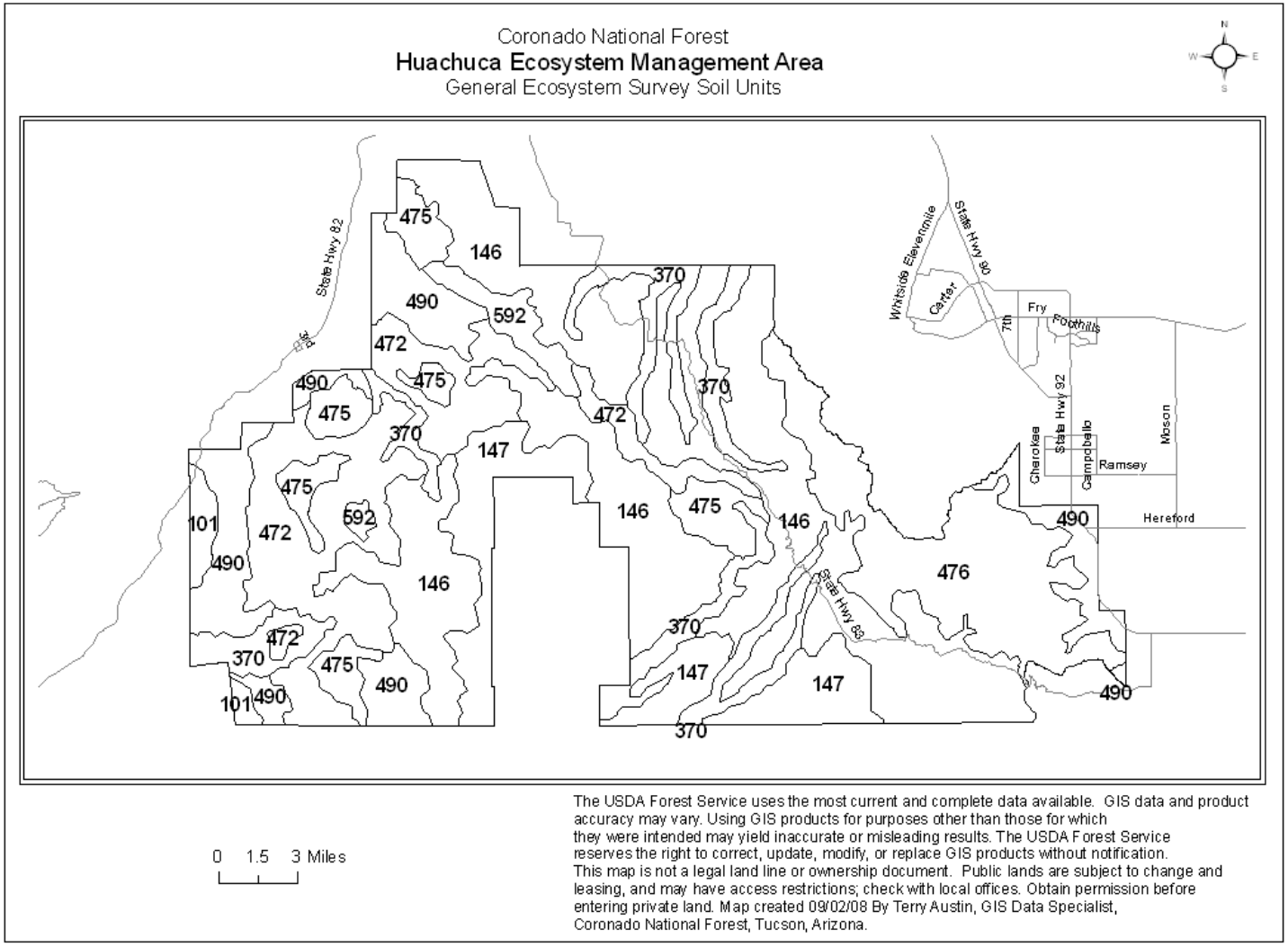
Coronado National Forest
Huachuca Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
State Hwy 82
Whitside Elevenmile
State Hwy 90
Carter
Fry
Foothills
7th
State Hwy 92
Cherokee
Campobello
Ramsey
Mason
Hereford
State Hwy 92
475
146
370
490
592
472
490
475
475
370
472
370
147
475
101
472
592
146
475
146
490
476
146
370
472
370
475
147
147
490
490
101
490
370
0 1.5 3 Miles
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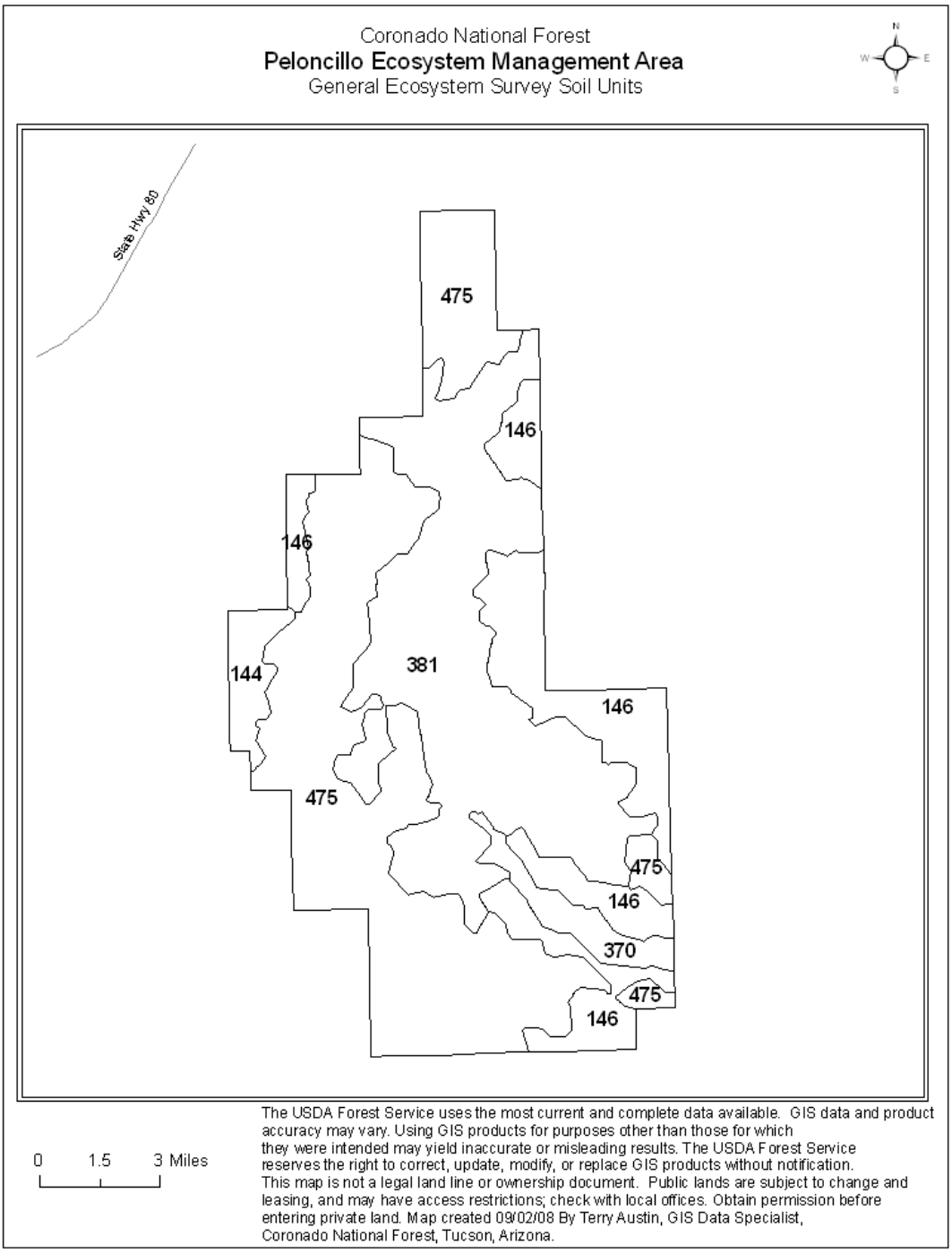
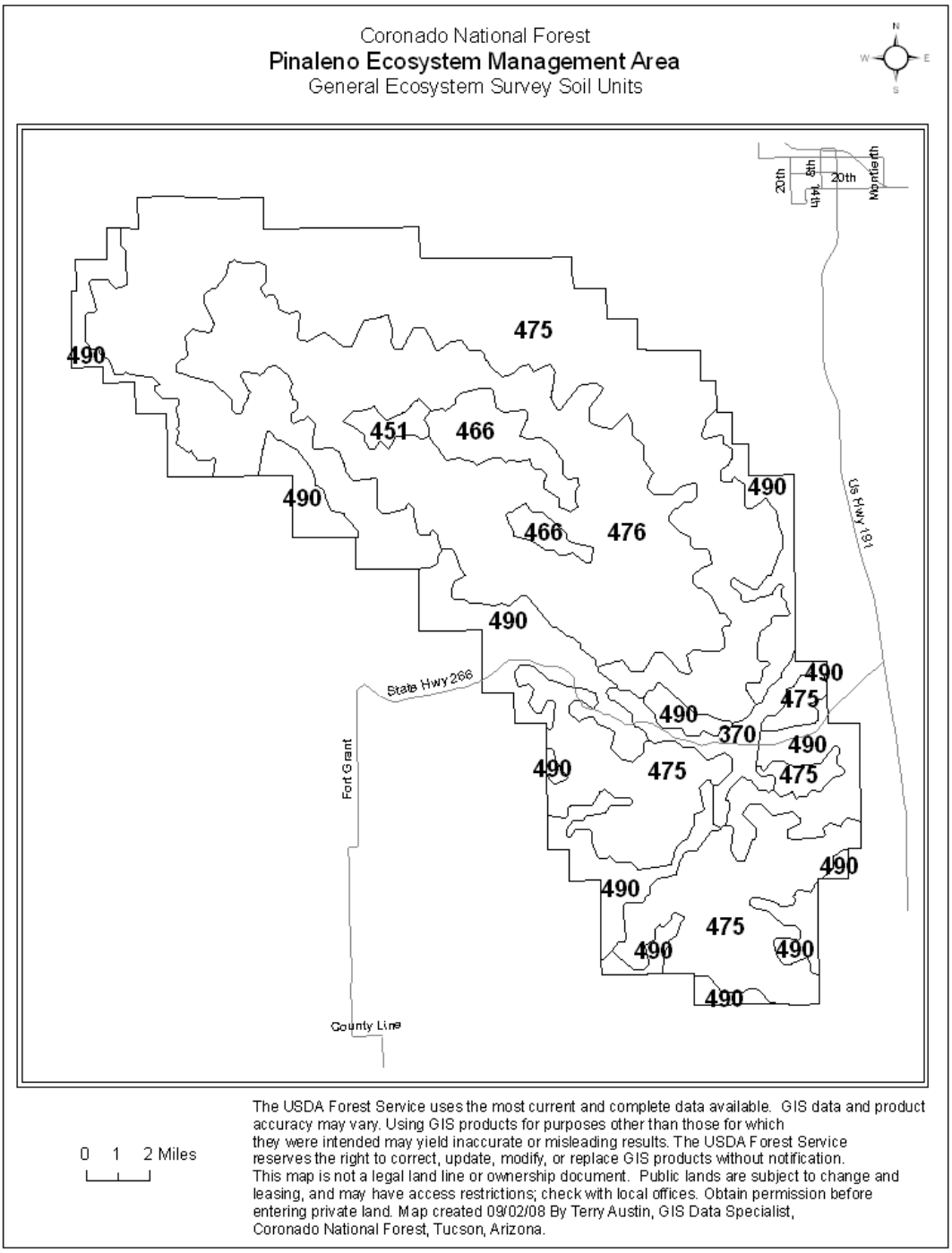

Coronado National Forest
Peloncillo Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
State Hwy 80
475
146
146
144
381
146
475
475
146
370
475
146
0 1.5 3 Miles
The USDA Forest Service uses the most current and complete data available. GIS data and product accuracy may vary. Using GIS products for purposes other than those for which they were intended may yield inaccurate or misleading results. The USDA Forest Service reserves the right to correct, update, modify, or replace GIS products without notification. This map is not a legal land line or ownership document. Public lands are subject to change and leasing, and may have access restrictions; check with local offices. Obtain permission before entering private land. Map created 09/02/08 By Terry Austin, GIS Data Specialist, Coronado National Forest, Tucson, Arizona.


Coronado National Forest
Pinaleno Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
20th
8th
14th
20th
Monticello
Us Hwy 191
475
490
451
466
490
490
466
476
490
State Hwy 266
490
475
490
370
490
Fort Grant
490
475
475
490
490
475
490
490
490
County Line
0 1 2 Miles
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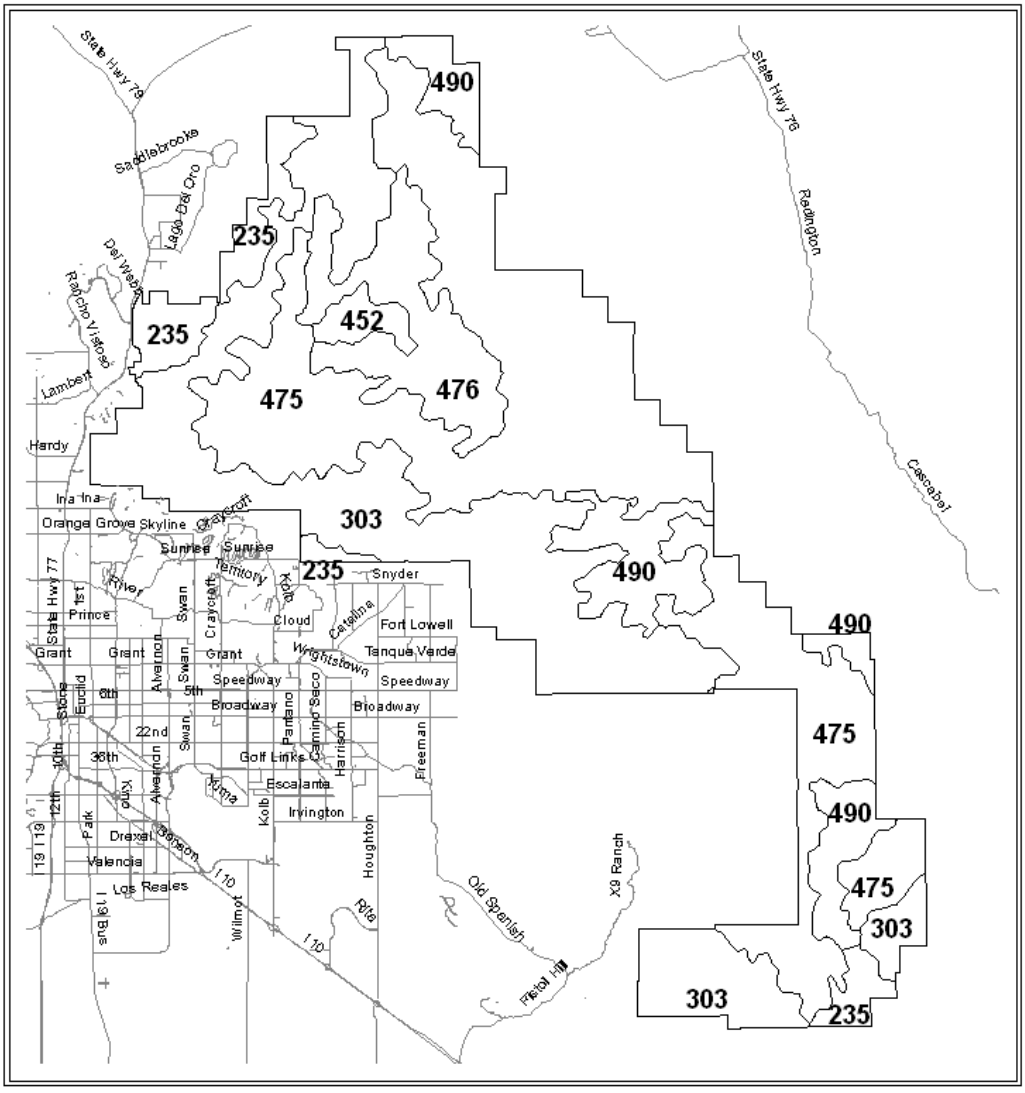
Coronado National Forest
Santa Catalina Ecosystem Management Area
General Ecosystem Survey Soil Units



0 1.5 3 Miles

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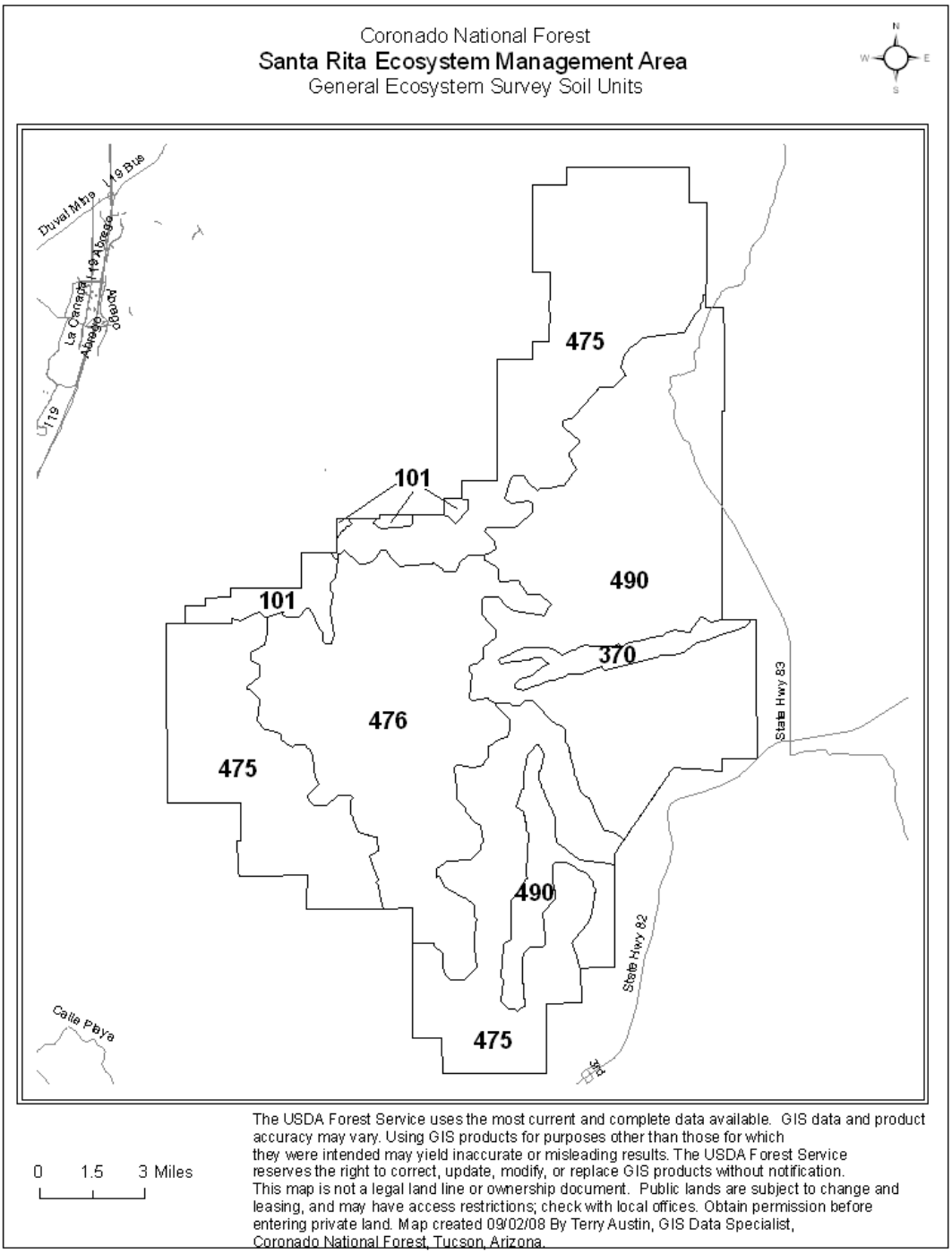
Coronado National Forest
Santa Rita Ecosystem Management Area
General Ecosystem Survey Soil Units
N
W
E
S
Duval Mine
I-19 Bus
I-19 Frntge
Arado
La Canada
Arado
I-19
475
101
490
101
370
476
475
State Hwy 83
490
State Hwy 82
475
Calle Playa
0 1.5 3 Miles
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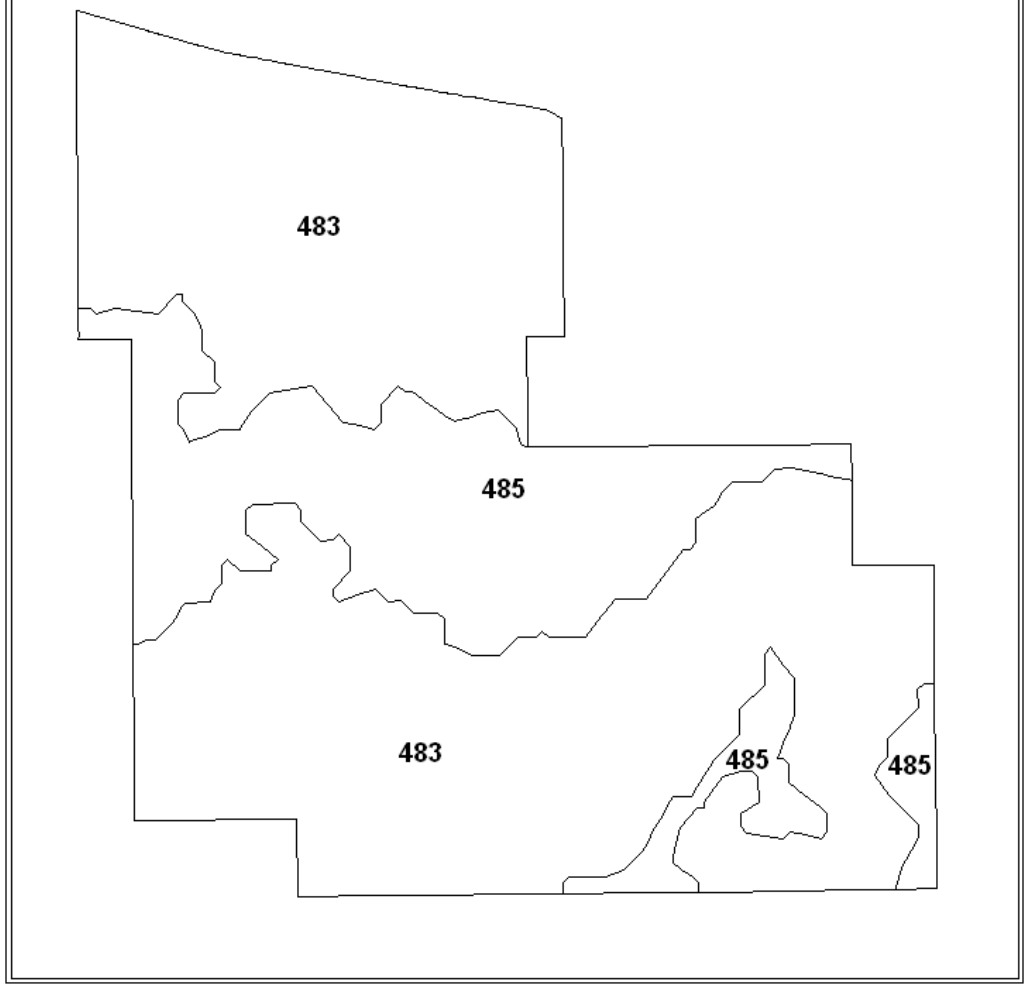
Coronado National Forest

Santa Teresa Ecosystem Management Area

General Ecosystem Survey Soil Units



0 0.5 1 Miles

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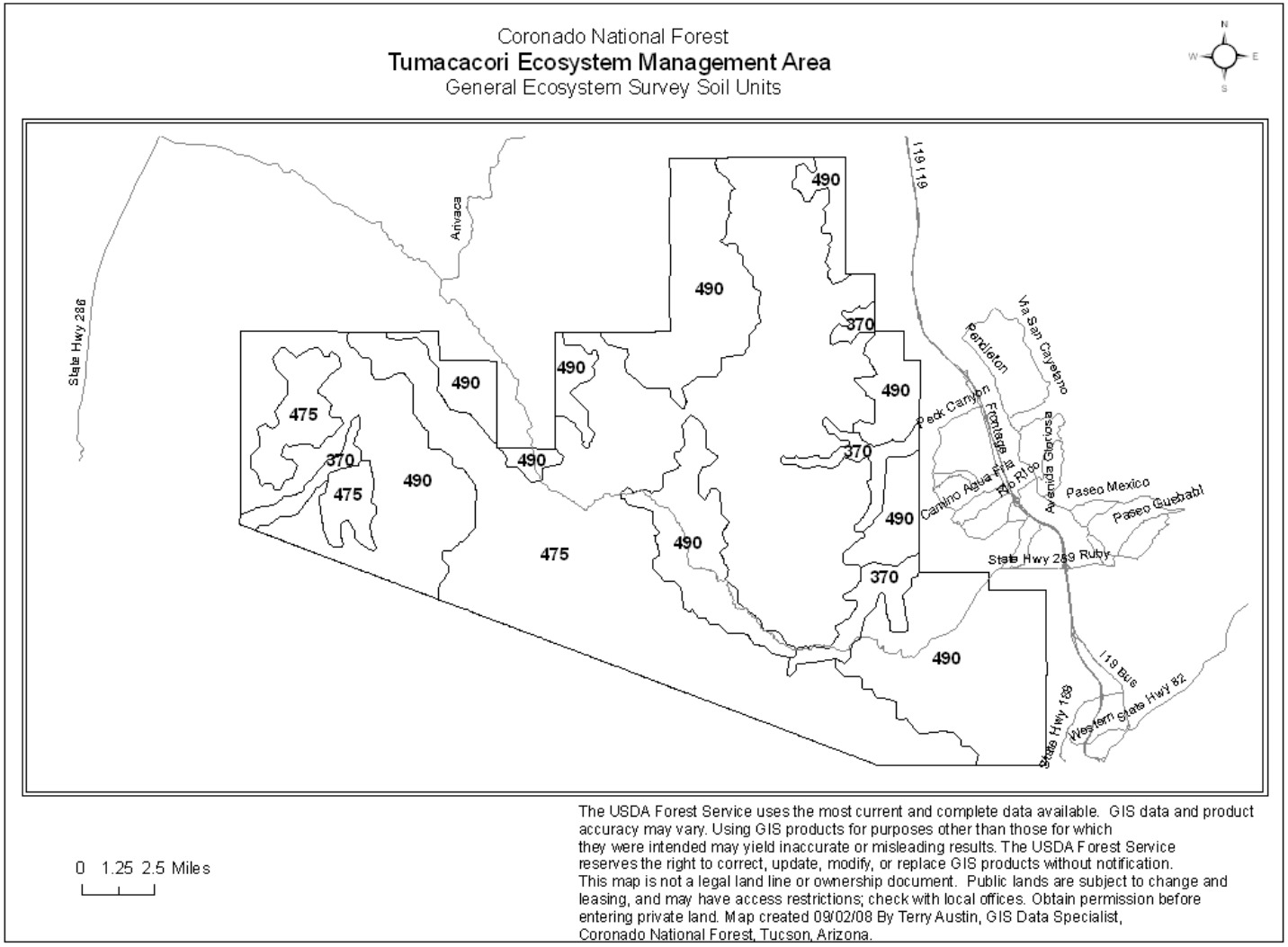

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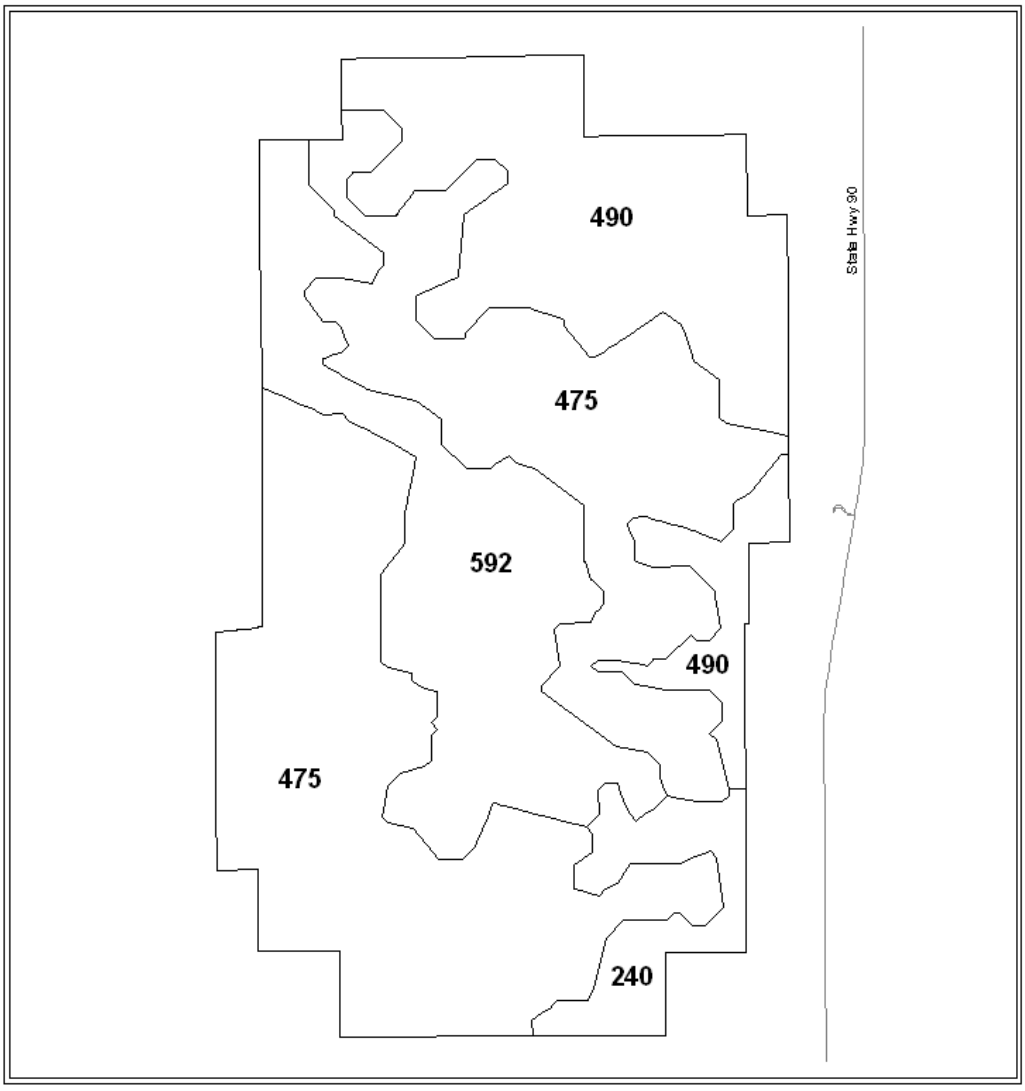
Coronado National Forest

Whetstone Ecosystem Management Area

General Ecosystem Survey Soil Units



0 0.5 1 Miles

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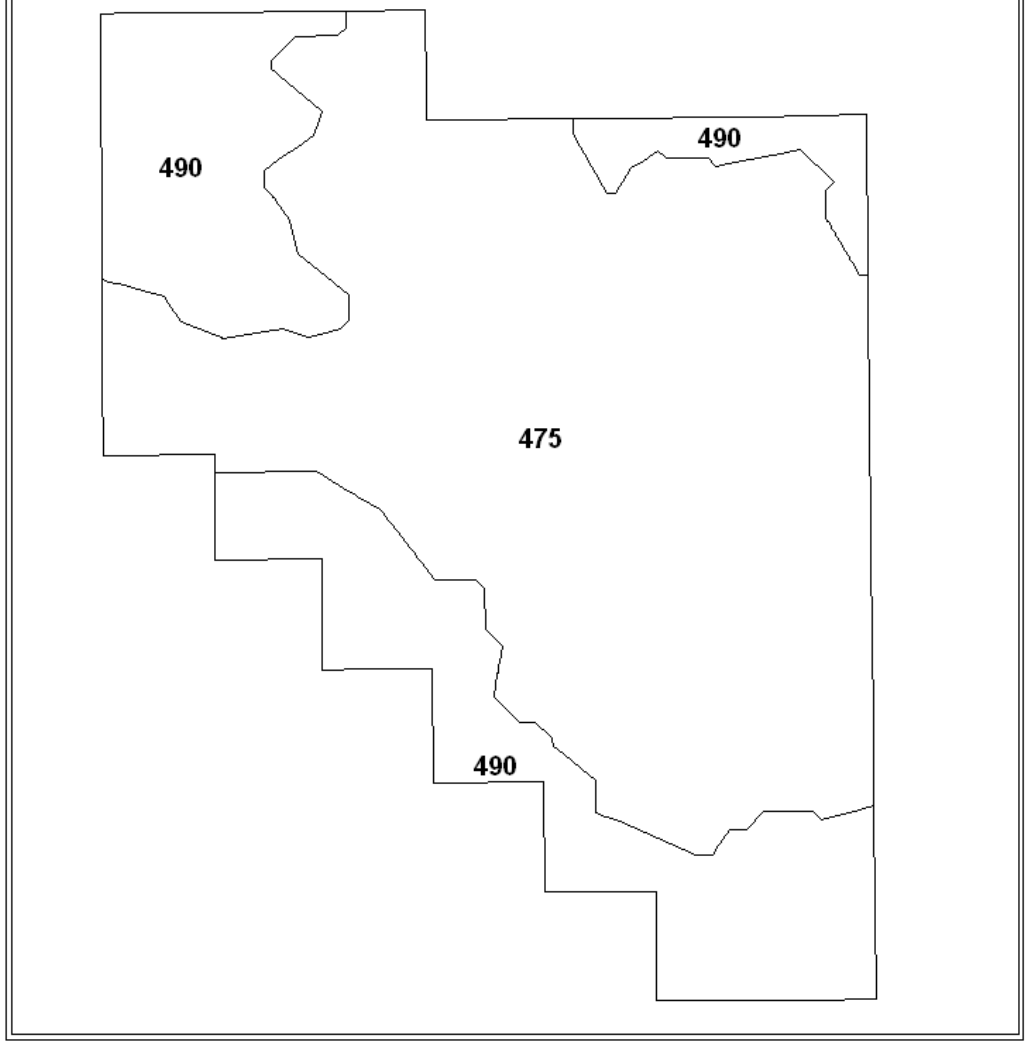
Coronado National Forest

Winchester Ecosystem Management Area

General Ecosystem Survey Soil Units



0 0.4 0.8 Miles

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Appendix C: Sub-basins (HUC4) and percentages of riparian areas within Coronado NF boundaries

HUC4	HUC4 Name	Sub-basin Area (mi^2)	USFS Area (mi^2)	USFS Area as percent of Sub-basin	Percent of riparian area in Sub-basin that is on National Forest
15040003	Animas Valley	2221	42	2%	No riparian areas recorded
15040005	Upper Gila-San Carlos Reservoir	2784	247	9%	8%
15040006	San Simon	2242	283	13%	97%
15050201	Willcox Playa	1653	270	16%	78%
15050202	Upper San Pedro	1797	253	14%	2%
15050203	Lower San Pedro	1986	365	18%	2%
15050301	Upper Santa Cruz	2209	691	31%	7%
15050302	Rillito	929	278	30%	11%
15050304	Brawley Wash	1390	44	3%	No riparian areas recorded
15080200	Rio de la Concepcion	135	99	74%	No riparian areas recorded
15080301	Whitewater Draw	1188	125	11%	87%
15080302	San Bernardino	428	48	11%	0%
15080303	Cloverdale	135	28	21%	No riparian areas recorded

Appendix D: Threatened and Endangered Species, Coronado National Forest

See text for explanation of “carried forward”.

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Area[11]
	Amphibians		
Ambystoma tigrinim stebbinsi	Sonoran Tiger Salamander	Y	6
Rana chiricahuensis	Chiricahua Leopard Frog	Y	1, 2, 3, 4, 5, 6, 10
	Birds		
Colinus virginianus ridgewayi	Masked Bobwhite	Y	4
Empidonax traillii eximus	Southwestern Willow Flycatcher		
Falco femoralis septentrionalis	Northern Aplomado Falcon	Y	1, 2
Haliaeetus leucocephalus	Bald Eagle	Y	1 thru 12
Pelecanus occidentalis californicus	Brown Pelican		
Strix occidentalis lucida	Mexican Spotted Owl	Y	1 thru 12
	Mammals		
Canis lupus baileyi	Mexican Gray Wolf	Y	1,2,11
Leopardis pardalis	Ocelot		
Leptonycteris mexicana	Mexican Long-nosed Bat	Y	1
Leptonycteris yerbabuenae	Lesser Long-nosed Bat	Y	1 thru 12
Panthera onca	Jaguar	Y	1,2,4,5,6
Tamiasciurus hudsonicus grahamensis	Mt. Graham Red Squirrel	Y	8

[11] Ecosystem Management Areas: 1 = Peloncillo, 2 = Chiricahua, 3 = Dragoon, 4 = Tumacacori, 5 = Santa Rita, 6 = Huachuca, 7 = Whetstone, 8 = Pinaleño, 9 = Winchester, 10 = Galiuro, 11 = Santa Teresa, 12 = Santa Catalina.

	Vascular Plants		
Lilaeopsis schaffneriana var. *recurva*	Huachuca Water Umbel	Y	6
Spiranthes delitescens	Canelo Hills Ladies'-tresses	Y	6
Coryphantha scheeri var. *robustispina*	Pima Pineapple Cactus	Y	5,6
	Reptiles		
Crotalus willardi obscurus	New Mexico Ridge-nosed Rattlesnake	Y	1
	Fishes		
Gila ditaenia	Sonora Chub	Y	4
Gila intermedia	Gila Chub	Y	12
Gila purpurea	Yaqui Chub	Y	2
Meda fulgida	Spikedace	Y	10,11
Oncorhyncus apache	Apache Trout	Y	8
Poeciliopsis o. occidentalis	Gila Topminnow	Y	6
Tiaroga (=*Rhinichthys*) *cobitis*	Loach Minnow	Y	10,11

Appendix E: Species-of-Concern, Coronado National Forest

See text for explanation of “Carried Forward” and Appendix D for Ecosystem Management Area codes.

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Amphibians			
Hyla wrightorum	Arizona Treefrog	Y	6
Rana tarahumarae	Tarahumara Frog	Y	5
Birds			
Charadrius montanus	Mountain Plover		
Coccyzus americanus occidentalis	Western Yellow-billed Cuckoo	Y	5,6
Euptilotis neoxenus	Eared Quetzal	Y	1,2
Falco peregrinus anatum	American Peregrine Falcon	Y	1 thru 12
Glaucidium brasilianum cactorum	Cactus Ferruginous Pygmy-owl	Y	5, 6, 12
Chelicerates			
Chitrellina chiricahuae	A Cave Obligate Pseudoscorpion	Y	2
Stygobromus arizonensis	Arizona Cave Amphipod	Y	2,5,6
Thymoites minero	A Cave Obligate Spider		
Tuberochernes ubicki	A Cave Obligate Pseudoscorpion	Y	5
Insects			
Adopaeoides prittwitzi	Sunrise Skipper	Y	1,5,6
Aeshna persephone	Persephone's Darner	Y	2,6
Agathymus evansi	Huachuca Giant-skipper	Y	6
Agylla septentrionalis			
Alexicles aspersa			
Amblycheila baroni	Montane Giant Tiger Beetle		
Ameletus falsus	False Ameletus Mayfly	Y	2,12
Amphinemura apache	A Stonefly		
Amphinemura venusta	A Stonefly		
Argia pima	Pima Dancer	Y	2,12
Argia sabino	Sabino Dancer	Y	4,12
Astylis biedermani	A Notodontid Moth	Y	2, 6
Autochton pseudocellus	Sonoran Banded-skipper		
Automeris patagoniensis	Patagonia Eyed Silkmoth	Y	2,6

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Aztecacris gloriosus	Atascosa Gem Grasshopper		
Catocala frederici	An Underwing Moth		
Chimarra adella	A Caddisfly		
Chimarra primula	A Caddisfly	Y	2
Cicindela fulgoris erronea	Glittering Tiger Beetle		
Cicindela hornii	Horn's Tiger Beetle		
Cicindela nevadica citata	Nevada Tiger Beetle		
Cicindela oregona maricopa	Maricopa Tiger Beetle	Y	1,2,8,11
Cisthene coronado			
Cloeodes peninsulus	A Mayfly	Y	2
Conalcaea cantralli	A Grasshopper		
Culoptila moselyi	A Caddisfly		
Cymbiodyta arizonica	Arizona Cymbiodytan Water Scavenger Beetle		
Dythemis maya	Mayan Setwing		
Enallagma semicirculare	Claw-tipped Bluet		
Eumorsea balli	Ball's Monkey Grasshopper	Y	6
Eumorsea pinaleno	Pinaleño Monkey Grasshopper	Y	8
Euphydryas chalcedona chuskae	Chalcedon Checkerspot		
Grammia allectans			
Hemileuca stonei	Stone's Buckmoth		
Heterelmis stephani	Stephan's Heterelmis Riffle Beetle	Y	5
Heterocampa amanda	A Notodontid Moth		
Heterocampa incongrua	A Notodontid Moth		
Hypaurotis crysalus intermedia	Colorado Hairstreak		
Inopsis funerea			
Lepidostoma acarolum	A Caddisfly		
Leuronotina ritensis	Lichen Grasshopper		
Libellula composita	Bleached Skimmer		
Limnephilus granti	A Caddisfly		
Melanoplus chiricahuae	A Spur-throat Grasshopper		
Melanoplus desultorius	Red Whiskers Grasshopper	Y	1 thru 12
Melanoplus magdalenae	A Spur-throat Grasshopper		

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Melanoplus pinaleno	A Spur-throat Grasshopper	Y	8
Mesocapnia werneri	A Stonefly		
Metrichia arizonensis	A Caddisfly		
Micrasema arizonica	A Caddisfly		
Microdynerus arenicolus	Antioch Potter Wasp		
Nectopsyche dorsalis	A Caddisfly	Y	6
Ochrotrichia argentea	A Caddisfly		
Ochrotrichia rothi	A Caddisfly		
Ochrotrichia spinulata	A Caddisfly		
Oeneis alberta daura	Alberta Arctic		
Oligocentria delicata	A Notodontid Moth	Y	2,3,5,6
Ophiogomphus arizonicus	Arizona Snaketail	Y	5,6,8,10,11,12
Palaemnema domina	Desert Shadowdamsel	Y	10
Piruna polingii	Four-spotted Skipperling	Y	2,6
Polycentropus gertschi	A Caddisfly		
Prorocorypha snowi	Snow's Toothpick Grasshopper		
Proserpinus terlooii	Terloo's Sphinx		
Psephenus arizonensis	Arizona Water Penny Beetle	Y	2
Pygarctia neomexicana			
Sonorarctia fervida			
Speyeria nokomis coerulescens	Bluish Fritillary	Y	5,6,12
Sphingicampa raspa	A Royal Moth	Y	5,6,
Sphinx smithi	A Sphinx Moth	Y	6
Sympetrum signiferum	Spot-winged Meadowhawk	Y	2,6
Taenionema jacobii	A Stonefly	Y	12
Tinodes parvulus	A Caddisfly		
Fishes			
Campostoma ornatum	Mexican Stoneroller	Y	2
Catostomus insignis	Desert Sucker	Y	4,10
Lichens			
Heterodermia appalachensis		Y	2,5
Leptogium rugosum	Rugose Skin Lichen	Y	2,5
Omphalora arizonica		Y	5
Xanthoparmelia ajoensis			

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Xanthoparmelia dissensa			
Xanthoparmelia huachucensis			
Xanthoparmelia nigropsomifera			
Mammals			
Microtus longicaudus leucophaeus	White-bellied [Long-tailed] Vole	Y	8
Sciurus nayaritensis chiricahuae	Chiricahua [Fox] Squirrel	Y	2
Sorex arizonae	Arizona Shrew	Y	1,2,5,6
Thomomys umbrinus intermedius	Southern Pocket Gopher	Y	4,5,6
Non-vascular Plants			
Barbula ehrenbergii	Ehrenberg's barbula moss		
Entosthodon rubiginosus	Rusty Cord-moss		
Mannia californica		Y	4,12
Plagiochasma wrightii		Y	2,4
Scopelophila cataractae	Agoyan Cataract Moss		
Tayloria splachnoides			
Vascular Plants			
Abutilon parishii	Parish's Abutilon	Y	4,5,12
Acacia millefolia	Milfoil Acacia	Y	2,3,5,7,9,12
Agastache rupestris	Thread-leaf Giant-hyssop	Y	4,5,10
Agave parviflora	Small-flower Agave	Y	4
Agave parviflora ssp. *parviflora*		Y	4,5,6
Agave toumeyana	Toumey Agave	Y	8
Ageratina (=*Eupatorium*) *lemmonii*	Lemmon's Thorough-wort		
Amoreuxia gonzalezii	Santa Rita Yellowshow	Y	5
Amsonia grandiflora	Arizona Slimpod	Y	4,6
Anoda abutiloides	False Indian-mallow	Y	12
Apacheria chiricahuensis	Cliff Brittlebush	Y	2,3
Arabis tricornuta	Rincon Mountain Rockcress	Y	2,5,6,12
Arceuthobium blumeri	Southwestern White Pine Dwarf-mistletoe	Y	2,8,10,11,12
Arceuthobium microcarpum	Western Spruce Dwarf-mistletoe	Y	8
Asclepias uncialis ssp. uncialis	Greene's Milkweed	Y	6
Astragalus allochrous var. *playanus*	Halfmoon Milk-vetch	Y	1 thru 12

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Astragalus cobrensis var. *maguirei*	Copper Mine Milk-vetch	Y	1,2
Astragalus hypoxylus	Huachuca Milk-vetch	Y	6
Astragalus tephrodes var. *brachylobus*	Ashen Milk-vetch		
Astrolepis windhamii	Windham's Scale Cloak-fern		
Boerhavia megaptera	Tucson Mountain Spiderling	Y	5
Bothriochloa wrightii	Wright's Bluestem		
Bouteloua eludens	Santa Rita Gramma	Y	4,5,12
Bouteloua parryi	Parry's Gramma	Y	1,2,3,7,9,5,12
Bouteloua rothrockii	Rothrock's Gramma	Y	1 thru 12
Brickellia baccharidea	Resin-leaved Brickell-bush		
Brickellia lemmonii var. *lemmonii*	Lemmon's Beggar-ticks	Y	2
Brickellia parvula	Mt. Davis Brickell-bush		
Brickellia simplex	Sonoran Brickell-bush	Y	2,6
Bromus mucroglumis	Arizona Brome		
Browallia eludens	Elusive New Browallia Species	Y	6
Buchnera arizonica	Arizona Bluehearts		
Carex ultra	Cochise Sedge	Y	1,2,3,4,5,6,10
Cheilanthes yavapensis	Graceful Lip Fern		
Choisya dumosa var. *mollis*	Soft Mexican-orange	Y	4
Cirsium rothrockii	Rose-color Thistle		
Conioselinum mexicanum	Mexican Hemlock-parsley	Y	5,6
Coryphantha recurvata	Recurved Corycactus	Y	4
Coursetia glabella	Smooth Baby-bonnets	Y	2,6
Crossosoma bigelovii var. *glaucum*	Bigelow's Crossosoma		
Cryptantha muricata	Pointed Cat's-eye		
Cryptantha muricata var. *denticulata*	Pointed Cat's-eye		
Cryptantha nevadensis var. *rigida*	Nevada Cat's-eye		
Cuscuta dentatasquamata	Los Pinitos Dodder		
Cuscuta erosa	Sonoran Desert Dodder		
Cuscuta mitriformis	Cochise Dodder		
Cuscuta odontolepis	Santa Rita Dodder		
Dalea tentaculoides	Gentry's Indigobush	Y	4
Dalea versicolor var. *sessilis*	Oakwoods Prairie-clover		

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Delphinium andesicola	Chiricahua Mountains Larkspur	Y	2,6
Delphinium scopulorum	Rocky Mountain Larkspur	Y	2,5
Draba helleriana var. *bifurcata*	Heller's Whitlow-grass	Y	2,8,12
Draba petrophila var. *viridis*	Rock Whitlow-grass	Y	1 thru 12
Draba standleyi	Standley's Whitlow-grass	Y	2
Drymaria effusa var. *effusa*	Pinewood Drymary	Y	4,5,6,12
Eriastrum eremicum ssp. *yageri*			
Erigeron arisolius	Arid Throne Fleabane	Y	2,3,4,5,6,9
Erigeron arizonicus	Arizona Fleabane		
Erigeron heliographis	Heliograph Peak Fleabane	Y	8
Erigeron kuschei	Chiricahua Fleabane	Y	2
Erigeron lemmonii	Lemmon's Fleabane	Y	5,6
Erigeron pringlei	Pringle's Fleabane	Y	5,8
Erigeron scopulinus	Winn Falls Fleabane		
Eriogonum arizonicum	Arizona Wild-buckwheat	Y	1,2,3,7,8,9,10,11
Eriogonum heermannii var. *apachense*	Apache Wild Buckwheat		
Eriogonum pharnaceoides var. *cervinum*	Wire-stemmed Wild-buckwheat		
Eryngium sparganophyllum	Arizona Eryngo	Y	5,12
Escobaria orcuttii	Orcutt's Foxtail Cactus	Y	1,2
Escobaria vivipara var. *bisbeeana*	Bisbee's Pincushion Cactus	Y	1,2,4,5,6,7,11,12
Eupatorium bigelovii	Bigelow's Thoroughwort	Y	8
Fraxinus gooddingii	Goodding's Ash	Y	4
Fraxinus papillosa	Chihuahua Ash	Y	1,2,3,4,5,6
Gaillardia arizonica var. *pringlei*	Arizona Blanket-flower		
Gaillardia multiceps	Onion Blanket-flower		
Galactia wrightii var. *mollissima*	Wright's Milkpea		
Gentianella amarella ssp. *wrightii*	Autumn Dwarf Gentian		
Gentianella wislizeni	Chiricahua Gentian	Y	2
Glandularia chiricahensis	Chiricahua Vervain		
Graptopetalum bartramii	Patagonia Mountain Leather-petal	Y	4
Hackelia ursina	Chihuahuan Stickseed	Y	2,5,8,10,12

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Hackelia ursina var. *diaboli*	Chihuahuan Stickseed		
Hackelia ursina var. *pustulata*	Chihuahuan Stickseed		
Hackelia ursina var. *ursina*	Chihuahuan Stickseed		
Hedeoma dentata	Arizona False Pennyroyal	Y	1 thru 12
Heliomeris multiflora var. *brevifolia*	Many-flower Viquiera		
Hermannia pauciflora	Santa Catalina Burstwort	Y	12
Heterotheca rutteri	Rutter's Golden-aster	Y	4,5,6
Heuchera glomerulata	Chiricahua Mountain Alumroot	Y	2,8,10,12
Heuchera sanguinea var. *pulchra*	Coral-bells		
Heuchera sanguinea var. *sanguinea*	Coral-bells		
Hexalectris revoluta	Chisos Coralroot	Y	5
Hexalectris spicata var. *arizonica*	Crested Coralroot	Y	2,3,4,5,6,7,9,12
Hexalectris warnockii	Purple-spike Coralroot	Y	2,6
Hieracium lemmonii	Lemmon's Hawkweed		
Hieracium rusbyi	Rusby's Hawkweed	Y	2,6,8,12
Hordeum arizonicum	Arizona Barley		
Hymenoxys ambigens	Pinaleño Mountains Rubberweed		
Hymenoxys ambigens var. *ambigens*	Pinaleño Mountains Rubberweed	Y	8
Hymenoxys ambigens var. *floribunda*	Pinaleño Mountains Rubberweed		
Hymenoxys ambigens var. *neomexicana*			
Hymenoxys quinquesquamata	Rincon Bitterweed	Y	2,5,6
Imperata brevifolia	California Satintail	Y	12
Ipomoea plummerae var. *cuneifolia*	Huachuca Mountain Morning-glory	Y	2,4,5,6
Ipomoea tenuiloba var. *lemmonii*	Lemmon's Morning-glory	Y	2,4,5,6
Ipomoea thurberi	Thurber's Morning-glory	Y	2,4,5,6
Ipomopsis tenuituba ssp. *latiloba*	Slender-trumpet Standing Cypress		
Laennecia eriophylla	Cochise Woolwort	Y	4,5,6
Lesquerella pinetorum	White Mountain Bladderpod		
Lilium parryi	Lemon Lily	Y	2,5,6
Lithospermum confine	Arizona Gromwell		

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Lomatium scabrum var. *tripinnatum*	Rough Desertparsley		
Lupinus caudatus ssp. *cutleri*	Kellogg's Spurred Lupine		
Lupinus huachucanus	Huachuca Mountain Lupine	Y	2,5,6
Lupinus neomexicanus	New Mexico Lupine	Y	2,8,12
Macromeria viridiflora var. *thurberi*	Giant-trumpets	Y	2,5,6,7,12
Macromeria viridiflora var. *viridiflora*	Giant-trumpets	Y	2,5,6,7,12
Malacothrix stebbinsii	Stebbins Desert-dandelion	Y	5,12
Mammillaria grahamii var. *oliviae*		Y	2,4,5,6
Mammillaria heyderi var. *bullingtoniana* (=*aplanata*)	Little Nipple Cactus	Y	1
Mammillaria heyderi var. *macdougalii*	Little Nipple Cactus	Y	3,4,5,7,12
Mammillaria mainiae	Main's Nipple-cactus	Y	4,12
Mammillaria wrightii var. *wrightii*	Wright Fishhook Cactus	Y	2,4,5,6
Mimulus dentilobus	Southwest Monkeyflower	Y	5
Muhlenbergia dumosa	Bamboo Muhly	Y	4,12
Nissolia wislizeni	Arizona Yellowhood	Y	6
Notholaena grayi ssp. *sonorensis*	Gray's Cloakfern		
Notholaena lemmonii	Lemmon's Cloak-fern	Y	4,12
Nothoscordum texanum	Texas False-garlic	Y	6,12
Opuntia engelmannii var. *flavispina*	Cactus Apple		
Opuntia phaeacantha var. *laevis*	New Mexico Prickly-pear	Y	4,5,12
Paspalum virletii	Virlet's Paspalum	Y	4,5
Pectis imberbis	Beardless Chinch Weed	Y	5,6
Pellaea ternifolia ssp. *arizonica*	Three-leaved Cliffbrake	Y	3,6
Penstemon deaveri	Mt. Graham Beardtongue	Y	8
Penstemon discolor	Catalina Beardtongue	Y	4,9,10,11,12
Penstemon superbus	Superb Beardtongue	Y	1,3,5,6,11,12
Pentagramma triangularis ssp. *maxonii*	Western Gold Fern		
Perityle cochisensis	Cochise Rock Daisy	Y	2
Perityle dissecta	Slimlobe Rockdaisy	Y	1,2,3,5,7,8,9,10,11,12
Phaseolus supinus	Supine Bean	Y	2,5,6,12
Phlox amabilis	Arizona Phlox		
Phlox tenuifolia	Santa Catalina Mountains Phlox	Y	10,12

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Phoradendron bolleanum ssp. *pauciflorum*	Rough Mistletoe	Y	2,3,4,5,6,7,9,12
Physalis latiphysa	Broad-leaf Ground-cherry	Y	8
Pinaropappus roseus var. *foliosus*		Y	2,6,12
Plagiobothrys pringlei	Pringle's Popcorn-flower	Y	2,3,5,7,9,12
Polemonium foliosissimum var. flavum	Leafy Jacob's-ladder	Y	8
Potentilla albiflora	White-flowered Cinquefoil	Y	8
Potentilla subviscosa var. *subviscosa*	Navajo Cinquefoil	Y	1 thru 12
Potentilla thurberi var. *atrorubens*	Thurber's Cinquefoil	Y	8
Potentilla thurberi var. *thurberi*	Thurber's Cinquefoil	Y	2,12
Potentilla wheeleri	Wheeler's Cinquefoil	Y	6
Psilactis gentryi	Gentry's Bare-ray-aster	Y	6
Ranunculus hydrocharoides var. *stolonifer*	Frog's-bit Buttercup	Y	2,6
Rhamnus crocea ssp. *pilosa*	Redberry Buckthorn	Y	2,3,5,7,9,12
Rumex orthoneurus	Blumer's Dock	Y	2,6,8
Salvia amissa	Catalina Mountain Sage	Y	9,10,12
Samolus vagans	Chiricahua Mountain Brookweed	Y	2,4,5,6,12
Scutellaria tessellata	Huachuca Mountains Skullcap	Y	2,3,4,5,6,7,9,12
Senecio multidentatus	Huachuca Mountain Ragwort		
Senecio multidentatus var. *huachucanus*	Huachuca Groundsel	Y	2,5,6
Siphonoglossa longiflora	Long-flower Tubetongue	Y	12
Sisyrinchium arizonicum	Arizona Blue-eyed-grass	Y	2,6,12
Sisyrinchium longipes	Timberland Blue-eye-grass	Y	2,8,12
Sophora arizonica	Arizona Necklace	Y	7,8
Stellaria porsildii	Porsild's Starwort	Y	2
Talinum humile	Pinos Altos Mountains Flameflower	Y	1,6
Talinum marginatum	Tepic Flameflower	Y	6
Thelypteris puberula var. *sonorensis*	Aravaipa Woodfern	Y	12
Trifolium mucronatum ssp. *lacerum*	Cusp clover		
Vauquelinia californica ssp. *pauciflora*	Arizona Limestone Rosewood	Y	1

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Viguiera dentata var. *lancifolia*	Sunflower Golden-eye	Y	4,5,6,12
Viola umbraticola var. *glaberrima*	Ponderosa Violet	Y	12
Woodsia cochisensis	Cochise Woodsia	Y	2,3,4,5,6
Woodsia phillipsii	Phillips' Cliff Fern	Y	2,6,12
Reptiles			
Aspidoscelis arizonae	Arizona Striped Whiptail	Y	8
Aspidoscelis burti xanthonota	Red-backed Whiptail	Y	4
Xantusia bezyi	Bezy's Night Lizard		
Mollusks			
Ashmunella angulata	Angulate Woodlandsnail		
Ashmunella chiricahuana	Cave Creek Woodlandsnail	Y	2
Ashmunella esuritor	Barfoot ["Barefoot"] Woodlandsnail		
Ashmunella ferrissi	Reed's Mountain Woodlandsnail		
Ashmunella lenticula	Horseshoe Canyon Woodlandsnail		
Ashmunella lepiderma	Whitetail Woodlandsnail		
Ashmunella levettei	Huachuca Woodlandsnail		
Ashmunella proxima	Chircahua Woodlandsnail		
Ashmunella varicifera	Miller Canyon Woodlandsnail		
Gastrocopta dalliana	Shortneck Snaggletooth		
Gastrocopta prototypus	Sonoran Snaggletooth	Y	2,3,6
Gastrocopta quadridens	Cross Snaggletooth		
Holospira arizonensis	Arizona Holospira		
Holospira chiricahuana	Cave Creek Holospira		
Holospira ferrissi	Stocky Holospira	Y	2,3,6
Holospira montivaga	Vagabond Holospira		
Holospira sherbrookei	Silver Creek Holospira		
Holospira tantalus	Teasing Holospira	Y	3
Holospira whetstonensis	Whetstone Holospira		
Naesiotus christenseni	Santa Rita Rabdotus		
Oreohelix barbata	Bearded Mountainsnail	Y	2
Oreohelix concentrata	Huachuca Mountainsnail		
Oreohelix grahamensis	Pinaleño Mountainsnail	Y	8

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Pallifera pilsbryi	Arizona Mantleslug		
Physella osculans	Cayuse Physa		
Pyrgulopsis thompsoni	Huachuca Springsnail	Y	6
Radiocentrum chiricahuana	Chiricahua Mountainsnail	Y	2
Radiocentrum clappi	Cave Creek Mountainsnail		
Radiodiscus millecostatus	Ribbed Pinwheel		
Sonorella apache	Apache Talussnail	Y	3
Sonorella bagnarai	Rincon Talussnail		
Sonorella bequaerti	Happy Valley Talussnail		
Sonorella binneyi	Horsehoe Canyon Talussnail		
Sonorella bowiensis	Quartzite Hill Talussnail		
Sonorella caerulifluminis	Blue Talussnail		
Sonorella christenseni	Clark Peak Talussnail		
Sonorella clappi	Madera Talussnail	Y	5
Sonorella dalli	Garden Canyon Talussnail		
Sonorella danielsi	Bear Canyon Talussnail		
Sonorella delicata	Tollhouse Canyon Talussnail		
Sonorella dragoonensis	Stronghold Canyon Talussnail	Y	3
Sonorella ferrissi	Dragoon Talussnail		
Sonorella galiurensis	Galiuro Talussnail	Y	10
Sonorella grahamensis	Pinaleño Talussnail		
Sonorella hachitana peloncellensis	Peloncillo Talussnail		
Sonorella imitator	Mimic Talussnail		
Sonorella insignis	Whetsone Talussnail		
Sonorella macrophallus	Wet Canyon Talussnail	Y	8
Sonorella magdalenensis	Sonoran Talussnail		
Sonorella micra	Pygmy Sonorella		
Sonorella neglecta	Portal Talussnail		
Sonorella odorata	Pungent Talussnail	Y	12
Sonorella optata	Big Emigrant Talussnail		
Sonorella rinconensis	Posta Quemada Talussnail		
Sonorella rosemontensis	Rosemont Talussnail		
Sonorella tryoniana	Sanford Talussnail		
Sonorella virilis	Chiricahua Talussnail	Y	2

Taxonomic Group-Scientific Name	Common Name	Carried Forward	Ecosystem Management Areas
Sonorella waltoni	Doubtful Canyon Talussnail		
Vertigo berryi	Rotund Vertigo		
Vertigo hinkleyi	Heart Vertigo	Y	6

Appendix F: Species-of-Interest, Coronado NF

See Appendix D for Ecosystem Management Area codes. All SOI are carried forward into plan revision. Thirty species are non-native invasives to control, while the others are species to conserve.

Taxonomic Group-Scientific Name	Common Name	Invasive	Ecosystem Management Areas
Amphibians			
Ambystoma tigrinim (except *A. t. stebbinsi*)	Tiger Salamander	Y	
Eleutherodactulus augusti cactorum	Western Barking Frog		4, 5, 6
Rana catesbeiana	Bullfrog	Y	
Rana subaquavocalis	Ramsey Canyon Leopard Frog		6
Rana yavapaiensis	Lowland Leopard Frog		4, 10, 11,12
Birds			
Accipiter gentilis	Northern Goshawk		1 thru 12
Ammodramus savannarum ammolegus	Arizona Grasshopper Sparrow		1,2,4,5,6
Cyrtonix montezumae	Montezuma Quail		1,2,4,5
Empidonax fulvifrons pygmaeus	Northern Buff-breasted Flycatcher		1, 2, 5, 6, 12
Meleagris gallopavo mexicana	Gould's Turkey		1, 2, 4, 5, 6, 8, 10, 12
Pachyramphus aglaiae	Rose-throated Becard		4, 6
Patagioenas fasciata	Band-tailed Pigeon		1 thru 12
Polioptilla nigriceps	Black-capped Gnatcatcher		4, 5, 6
Trogon elegans	Elegant Trogon		1, 2, 4, 5, 6
Arthropods			
Orconectes virilis	Virile Crayfish	Y	
Mammals			
Antilocapra americana	Pronghorn		1 thru 12
Cervus canadensis	Elk	Y	
Choeronycteris mexicana	Mexican Long-tongued Bat		1,2,3,4,5,6,7,12
Eumops perotis californicus	California Bonneted Bat		1 thru 12
Idionycteris phyllotis	Allen's Big-eared Bat		2, 8, 10
Lasiurus blossevillii	Western Red Bat		1,2,4,5,6,7,8,10
Lasiurus xanthinus	Western Yellow Bat		1 thru 12

Taxonomic Group-Scientific Name	Common Name	Invasive	Ecosystem Management Areas
Macrotus californicus	California Leaf-nosed Bat		4,5,10,12
Nyctinomops femorosaccus	Pocketed Free-tailed Bat		4,5,10,12
Nyctinomops macrotus	Big Free-tailed Bat		2
Odocoileus hemionus	Mule Deer		1 thru 12
Odocoileus virginanus couesi	Coues' White-tailed Deer		1 thru 12
Ovis canadensis mexicana	Desert Bighorn Sheep		10,12
Puma concolor	Mountain Lion		1 thru 12
Sciurus aberti	Abert's Squirrel	Y	
Sciurus arizonensis	Arizona Gray Squirrel		4,5,6,12
Ursus americana	Black Bear		1 thru 12
Fishes			
Agosia chrysogaster	Longfin Dace		2,4,5,6,12
Ameiurus melas	Black Bullhead	Y	
Ameiurus natalis	Yellow Bullhead	Y	
Catostomus clarkii	Desert Sucker		5, 10
Esox lucius	Northern Pike	Y	
Gambusia affinis	Western Mosquito Fish	Y	
Lepomis cyanellus	Green Sunfish	Y	
Micropterus salmoides	Largemouth Bass	Y	
Pimephales promelas	Fathead Topminnow	Y	
Rhinichthys osculus	Speckled Dace		6,7,10
Vascular Plants			
Agave schottii var. *treleasei*	Schott's Agave		12
Ailathis altissima	Tree of Heaven	Y	
Allium gooddingii	Goodding's Onion		12
Allium rhizomatum (=glandulosum)	Redflower Onion		2,6
Arundo donax	Giant Reed	Y	
Asclepias lemmonii	Lemmon Milkweed		2,5,6
Ayenia truncata (= A. glabra)	Ayenia		5
Brassica tourneforii	Sahara Mustard	Y	
Bromus rubens	Red Brome	Y	
Bromus tectorum	Cheat Grass	Y	
Capsicum annuum var. glabriusculum	Chiltepin		2,4

Taxonomic Group-Scientific Name	Common Name	Invasive	Ecosystem Management Areas
Cardaria draba	Hoary Cress	Y	
Castilleja nervata	Trans-Pecos Indian Paintbrush		2,5
Cirsium arvense	Canada Thistle	Y	
Cirsium rusbyi	Rusby's Thistle		
Cirsium vulgare	Bull Thistle	Y	
Cynanchum wigginsii (=Metastelma mexicanum)	Narrow-leaf (Wiggins) Swallow-wort		4,6,12
Eragrostis curvula	Weeping Lovegrass	Y	
Eragrostis lehmanniana	Lehmann Lovegrass	Y	
Euryops multifidus	Sweet Resinbush	Y	
Hedeoma costatum	Chiricahua Mock Pennyroyal		2
Hydrilla verticallata	Hydrilla	Y	
Limosella pubiflora	Chiricahua Mudwort		1,2
Lotus alamosanus	Sonoran Trefoil		4
Manihot davisiae	Arizona Manihot		5,12
Margaranthus solanaceus	Netted Globeberry		2,3,5,6,8,12
Marina diffusa	Spreading Marina		6
Matelea (=*Pherotrichis*) *balbisii*	Balbis (=Huachuca Milkweed Vine)		6
Muhlenbergia elongata (=M. xerophila)	Sycamore Muhly		4,5,12
Muhlenbergia palmeri (=M. dubioides)	Southwestern Muhly		4,5,6,12
Passiflora foetida (assume var. *arizonica*)	Foetid Passionflower		4,
Pennisetum ciliare	Buffelgrass	Y	
Pennisetum setaceum	Fountain Grass	Y	
Pentzia incana	Pentzia	Y	
Polemonium pauciflorum hinckleyi	Hinkley's Jacob's Ladder		2
Psilotum nudum	Whisk Fern		4
Rhynchelytrum repens	Natal Grass	Y	
Roldana hartwegii (=*Senecio hartwegii*, with syn = *S. seemannii*, *S. carlomasonii*, and *R. carlomasonii*)	Seemann (Hartweg's) Groundsel		2,4,5,6
Sisyrinchium cernuum	Nodding Blue-eyed Grass		2,4,5,12
Sorghum halepense	Johnson Grass	Y	

Taxonomic Group-Scientific Name	Common Name	Invasive	Ecosystem Management Areas
Tamarix spp.	Salt Cedar (Tamarix)	Y	
Tumamoca macdougalii	Tumamoc Globe-Berry		12
Reptiles			
Aspidoscelis burti stictogramma	Giant Spotted Whiptail		1,4,5,6,8,9,10,11,12
Crotalus pricei	Twin-spotted Rattlesnake		2,5,6,8
Crotalus w. willardi	Arizona Ridge-nosed Rattlesnake		5,6,7
Gopherus agassizii	Desert Tortoise ("Sonoran" population)		4,10,12
Gyalopion quadrangulare	Thornscrub Hook-nosed Snake		4
Kinosternon sonoriense	Sonoran Mud Turtle		1 thru 12
Sceloporus slevini	Slevin's Bunchgrass Lizard		1,2,3,5,6,7
Tantilla wilcoxi	Chihuahuan Black-headed Snake		4,5,6
Tantilla yaquia	Yaqui Black-headed Snake		1,2,4
Terrepene ornata luteola	Desert Box Turtle		1 thru 12
Thamnophis eques megalops	Northern Mexican Garternsake		4,5,6

Appendix G: Ecosystem Management Areas Species-habitat Association Matrices

Species-habitat association matrix for Peloncillo EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Total
Desert Communities	3	0	1	0	3	6	1	14
Valley Grasslands	3	0	2	1	5	18	2	31
Interior Chaparral	2	0	0	0	1	6	2	11
Madrean Encinal/PJ	8	3	3	1	4	16	3	38
Madrean Pine-Oak	8	3	3	1	2	16	2	35
Ponderosa Pine	2	3	2	1	3	12	1	24
Mixed Conifer Forest	1	2	2	0	2	9	0	16
Subalpine Forest	1	0	0	0	0	4	0	5
Montane Meadow	0	0	0	0	0	3	0	3
Total	28	11	13	4	20	90	11	177

Species-habitat association matrix for Dragoon EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	2	0	0	0	3	8	1	14
Valley Grasslands	2	1	1	1	4	20	1	30
Interior Chaparral	1	0	0	0	2	8	1	12
Madrean Encinal/PJ	2	2	1	1	8	21	2	37
Madrean Pine-Oak	2	2	1	1	7	15	1	29
Ponderosa Pine	0	0	0	0	0	10	0	10
Mixed Conifer Forest	0	0	0	0	0	7	0	7
Subalpine Forest	0	0	0	0	0	2	0	2
Montane Meadow	0	0	0	0	0	3	0	3
Totals	9	5	3	3	24	94	6	144

Species-habitat association matrix for Huachuca EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Total
Desert Communities	6	1	3	1	2	8	1	22
Valley Grasslands	7	4	6	6	4	34	1	62
Interior Chaparral	1	0	2	0	1	8	1	13
Madrean Encinal/PJ	16	9	8	4	6	48	3	94
Madrean Pine-Oak	16	7	6	4	8	37	1	79
Ponderosa Pine	7	4	1	1	6	25	0	44
Mixed Conifer Forest	6	3	1	0	3	16	0	29
Subalpine Forest	3	1	0	0	0	4	0	8
Montane Meadow	2	1	0	0	0	10	0	13
Total	64	30	27	16	30	190	7	364

Species-habitat association matrix for Santa Catalina EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	9	3	4	1	8	18	2	45
Valley Grasslands	9	4	4	1	9	31	1	59
Interior Chaparral	2	1	1	0	3	11	1	19
Madrean Encinal/PJ	11	4	2	0	10	26	2	55
Madrean Pine-Oak	12	4	0	0	7	20	2	45
Ponderosa Pine	6	3	0	0	4	22	0	35
Mixed Conifer Forest	5	3	0	0	3	17	0	28
Subalpine Forest	1	1	0	0	1	7	0	10
Montane Meadow	1	0	1	0	0	6	0	8
Totals	56	23	12	2	45	158	8	304

Species-habitat association matrix for Santa Teresa EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	3	0	3	1	2	4	1	14
Valley Grasslands	3	0	3	1	4	9	1	21
Interior Chaparral	2	0	0	0	1	4	1	8
Madrean Encinal/PJ	2	0	0	0	4	7	1	14
Madrean Pine-Oak	2	0	0	0	3	8	0	13
Ponderosa Pine	0	0	0	0	4	9	0	13
Mixed Conifer Forest	0	0	0	0	2	9	0	11
Subalpine Forest	0	0	0	0	0	3	0	3
Montane Meadow	0	0	0	0	0	3	0	3
SUMS	12	0	6	2	20	56	4	100

Species-habitat association matrix for Galiuro EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	3	0	5	1	4	5	2	20
Valley Grasslands	4	1	7	2	4	9	1	28
Interior Chaparral	1	0	0	0	2	5	1	9
Madrean Encinal/PJ	7	1	3	1	7	9	2	30
Madrean Pine-Oak	6	1	1	1	5	9	1	24
Ponderosa Pine	3	1	0	0	5	10	1	20
Mixed Conifer Forest	3	1	0	0	3	9	1	17
Subalpine Forest	1	0	0	0	0	3	0	4
Montane Meadow	0	0	0	0	0	0	0	0
Totals	28	5	16	5	30	59	9	152

Species-habitat association matrix for Winchester EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	2	0	0	0	2	5	1	10
Valley Grasslands	2	0	0	0	3	16	1	22
Interior Chaparral	1	0	0	0	1	7	1	10
Madrean Encinal/PJ	2	0	0	0	4	12	1	19
Madrean Pine-Oak	1	0	0	0	3	9	0	13
Ponderosa Pine	0	0	0	0	4	10	0	14
Mixed Conifer Forest	0	0	0	0	2	7	0	9
Subalpine Forest	0	0	0	0	0	3	0	3
Montane Meadow	0	0	0	0	0	3	0	3
Totals	8	0	0	0	19	72	4	103

Species-habitat association matrix for Santa Rita EMA.

	Physical Attributes							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	6	1	1	0	5	17	2	32
Valley Grasslands	7	4	6	2	8	41	1	69
Interior Chaparral	1	0	1	0	2	10	1	15
Madrean Encinal/PJ	15	8	8	2	10	42	4	89
Madrean Pine-Oak	14	6	2	1	10	30	1	64
Ponderosa Pine	5	2	1	0	4	20	0	32
Mixed Conifer Forest	5	2	1	0	4	12	0	24
Subalpine Forest	2	0	0	0	0	3	0	5
Montane Meadow	0	0	0	0	0	5	0	5
Totals	55	23	20	5	43	180	9	335

Species-habitat associations of Tumacacori EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	6	1	3	1	4	12	2	29
Valley Grasslands	6	2	6	2	7	36	1	60
Interior Chaparral	1	0	1	0	3	8	1	14
Madrean Encinal/PJ	17	5	5	1	11	39	2	80
Madrean Pine-Oak	12	4	1	1	8	22	1	49
Ponderosa Pine	2	0	0	0	4	14	0	20
Mixed Conifer Forest	2	0	0	0	2	9	0	13
Subalpine Forest	2	0	0	0	0	3	0	5
Montane Meadow	0	0	0	0	0	4	0	4
Totals	48	12	16	5	39	147	7	274

Species-habitat associations for Pinaleño EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	2	0	0	0	2	7	1	12
Valley Grasslands	3	1	0	0	3	12	1	20
Interior Chaparral	2	0	0	0	1	5	1	9
Madrean Encinal/PJ	6	1	0	0	4	12	2	25
Madrean Pine-Oak	7	1	0	0	3	12	1	24
Ponderosa Pine	4	2	0	0	4	18	1	29
Mixed Conifer Forest	7	3	0	0	7	21	1	39
Subalpine Forest	2	2	0	0	2	10	0	16
Montane Meadow	2	1	0	0	0	9	0	12
Totals	35	11	0	0	26	106	8	186

Species-habitat association matrix for Whetstone EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	1	0	1	0	2	7	1	12
Valley Grasslands	1	0	1	0	3	18	1	24
Interior Chaparral	1	0	0	0	1	8	1	11
Madrean Encinal/PJ	2	0	1	0	3	14	2	22
Madrean Pine-Oak	2	0	0	0	2	10	1	15
Ponderosa Pine	0	0	0	0	3	12	0	15
Mixed Conifer Forest	0	0	0	0	2	7	0	9
Subalpine Forest	0	0	0	0	0	2	0	2
Montane Meadow	0	0	0	0	0	3	0	3
Totals	7	0	3	0	16	81	6	113

Species-habitat association matrix for Chiricahua EMA.

	Physical Attribute							
Vegetation Community	Riparian	Spring	Lotic	Lentic	Cliff/ Rock	Terres-trial	Cave	Totals
Desert Communities	5	1	2	0	5	10	2	25
Valley Grasslands	8	3	5	1	6	32	2	57
Interior Chaparral	3	0	1	0	1	10	1	16
Madrean Encinal/PJ	17	7	11	1	14	42	5	97
Madrean Pine-Oak	17	7	9	1	14	35	2	85
Ponderosa Pine	8	4	3	0	11	30	1	57
Mixed Conifer Forest	8	5	3	0	11	21	1	49
Subalpine Forest	4	2	0	0	3	7	0	16
Montane Meadow	3	1	1	0	0	11	0	16
Totals	73	30	35	3	65	198	14	418

Appendix I: Invasive Species

Species Group	Common Name	Scientific Name
Amphibian	Tiger Salamander	*Ambystoma tigrinim* (non-native)
Amphibian	Bullfrog	*Rana catesbeiana*
Crustacean	Virile Crayfish	*Orconectes virilis*
Fish	Black Bullhead	*Ameiurus melas*
Fish	Yellow Bullhead	*Ameiurus natalis*
Fish	Northern Pike	*Esox lucius*
Fish	Western Mosquito Fish	*Gambusia affinis*
Fish	Green Sunfish	*Lepomis cyanellus*
Fish	Largemouth Bass	*Micropterus salmoides*
Fish	Fathead Topminnow	*Pimephales promelas*
Mammal	Elk	*Cervus canadensis*
Mammal	Abert's Squirrel	*Sciurus aberti*
Vascular Plant	Tree of Heaven	*Ailanthus altissima*
Vascular Plant	Giant Reed	*Arundo donax*
Vascular Plant	Sahara Mustard	*Brassica tournefortii*
Vascular Plant	Red Brome	*Bromus rubens*
Vascular Plant	Cheat Grass	*Bromus tectorum*
Vascular Plant	Hoary Cress	*Cardaria draba*
Vascular Plant	Canada Thistle	*Cirsium arvense*
Vascular Plant	Bull Thistle	*Cirsium vulgare*
Vascular Plant	Weeping Lovegrass	*Eragrostis curvula*
Vascular Plant	Lehmann Lovegrass	*Eragrostis lehmanniana*
Vascular Plant	Sweet Resinbush	*Euryops multifidus*
Vascular Plant	Hydrilla	*Hydrilla verticillata*
Vascular Plant	Buffelgrass	*Pennisetum ciliare*
Vascular Plant	Fountain Grass	*Pennisetum setaceum*
Vascular Plant	Pentzia	*Pentzia incana*
Vascular Plant	Natal Grass	*Rhynchelytrum repens*
Vascular Plant	Johnson Grass	*Sorghum halepense*
Vascular Plant	Salt Cedar	*Tamarix* spp.