World Wildlife Fund Ecoregion NA 1203 – California montane chaparral and woodlands

Image courtesy of CA Sec. of State website

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Executive Summary

The California montane chaparral and woodland ecoregion is both delicate and diverse, both of which make its preservation extremely important. Spanning the Santa Lucia Mountains of the central California coast and the Transverse Range further to the south, the region covers altitudes from sea level to as high as 11,500 feet and covers almost 8,000 square miles. The climate is characterized by a short rainy season in the winter and warm, dry summers that contribute to the regular occurrence of wildfire. There exist very few regions similar to the coastal mountains of California anywhere else in the world, but the wide variety of oaks and evergreens found here are well adapted to the climate, and some of them actually depend on the naturally occurring fires for survival (WWF website).

Despite these treasures, only 30 percent of the montane chaparral and woodlands remains intact. The region is threatened by sprawl from nearby developed areas such as Los Angeles and is already severely fragmented by roads. Rare species, such as the California condor, are at risk of extinction because of poisoning from lead bullets in the carrion that they feed upon. Damage to rivers and streams from mining threatens a number of less well known – but no less at risk – amphibians, such as the California red-legged frog. Additional threats include air pollution, which has recently been shown to harm some of the region’s rare, endemic pines, tree-killing pathogens about which little is known so far, and suppression of the wildfire on which many species in the area depend.

Despite the extent of damage already done to California’s montane chaparral and woodlands, the diversity of the region is not lost. Current destructive practices can be slowed and future protection ensured by expanding and properly managing the national
forests, wilderness areas, and state parks throughout the region, funding essential research on the effects of air pollution and deadly plant diseases such as sudden oak death and pine pitch canker, avoiding the suppression of fire wherever possible and conducting proscribed burns where fire must be suppressed.

While the fact that only one third of the montane chaparral and woodlands in California remains is disheartening, the diversity that can be found here still surpasses expectation. We must not let the damage already done to the region discourage our conservation efforts, but rather we must be called to action by the possibility that the region can still be saved from further damage.
The western side of Southern California is draped in low, mostly evergreen shrubs and trees that are well adapted to the warm, dry weather and sparse yearly rainfall. Chaparral, as this environment is called, is found in only a few places around the world other than Southern California – the southwestern coast of South America, the southern edge of Australia, and the coastal Mediterranean (Wilson and Perlman, 2000). Collectively, these ecosystems make up the Mediterranean forests, woodlands, and scrub biome.

The World Wildlife Fund divides the chaparral of Southern California into three ecoregions: California coastal sage and chaparral (NA1201), California interior chaparral and woodlands (NA1202), and California montane chaparral and woodlands (NA1203) (WWF website). The biodiversity in the latter of these three will be the focus of this paper.

**Where Are We?**

The montane chaparral of Southern California is split into two sections by lower elevation areas that are characterized by different flora, fauna, and ecosystems (Figure 1). The northern of these two parts is a roughly 50 kilometer wide stretch which starts at Point Piños and runs south along the coast to just above San Louis Obispo. This section includes the Ventana wilderness, part of the Santa Lucia mountain range, and a large portion of Los Padres National Forest. The southern section begins at the southern coast of Santa Barbara county, running about 70 kilometers inland, and stretches east through Ventura and into Los Angeles county, where is splits. From there, one branch of the ecoregion runs inland (northeast) about 180 kilometers and the other stretches southeast
through Los Angeles, San Bernardino, and Riverside counties, finally ending 100 kilometers northeast of San Diego. This section includes most of the Transverse mountain range and parts of San Bernardino and Angeles National Forests (UT website).

The total area of the combined segments of the ecoregion is 20,400 square kilometers. While the region does border the coast in two places, it is mostly mountainous (montane), with peaks in the Transverse range as high as 3,500 meters (WWF website).

**Causes of Regional Biodiversity and its Significance**

*This Place Rocks – History & Geology*

The infamous San Andreas fault runs southeast down the California coast, and as such, through both the northern and southern section of the montane chaparral. There are several other faults running through the area as well, but the San Andreas is the largest. These faults are more than just background features, they are the very reason that the mountains exist. For the last six million years the tectonic plates on either side of each of these faults have been sliding along each other, creating a pressure that forces rock
upwards, creating mountains and exposing rock that has been buried or undersea for millions of years (Los Padres NF website).

The rock that is exposed by the process that created these mountains is composed of crustal basement rocks and layered sedimentary. The crustal basement rocks make up what was the deeper of the two layers, consisting of hard, dense rocks that formed at high temperatures and pressures deep under the surface of the earth. These rocks, exemplified by quartzite and marble, can range in age from 130 to 1,300 million years. The layer of sedimentary rock (Figure 2) formed on top of the crustal basement layer at the bottom of the Pacific Ocean. Erosion of crustal basement rocks in the older Sierra mountain range and the decomposed remains of sea life created a horizontally layered rock as thick as 6 kilometers on the ocean floor from about 120 million to 24 million years ago (Los Padres NF website).

*Trial by Fire – Climate and Fire Ecology*

The rise of the Sierra Nevada mountain range about six million years ago, by processes similar to those that created the Transverse range, altered the climate of California greatly. Before this event, California as a whole was becoming more arid, but the Sierras created a barrier isolating the western side of the state from this arid environment and creating a more Mediterranean climate (Status and Trends, p. 596).

The current climate of most of southwestern California is characterized by long, dry summers and cool winters. Summer is often a time of drought. Later in summer the
Santa Ana Winds blow from west to east across the mountains and through valleys (National Weather Service website). Precipitation occurs mostly during winter and spring and is usually in the form of rain, except at the highest altitudes. Most often, precipitation is light, but it can be above 2,000 milliliters per year further north and at middle and higher elevations (Status and Trends, p. 594-5).

These dry, windy summers in combination with relatively low, dense plant cover create the perfect environment for fire (Hanes, 1971). These fires usually burn all of the biological matter that is not underground. Plant material that is not consumed aids the process of regeneration. Seeds, some of which only germinate in the presence of heat or charred powdered wood (charate), sprout and underground roots regrow (Keeley, 1987). Furthermore, fire releases some of the minerals and nutrients trapped in plant matter (Debano and Conrad, 1987).

Natural fires (usually set by lightning) tend to burn an area every ten to forty years. The indigenous Chumash and Costanoan Indians used fire as a tool to shape landscape from as early as 10,000 years ago to as recently as the early 19th century (California’s Natural Resources website, Presidio of San Francisco: Native History website). They found that fire allowed them to create grazing areas for animals and to select for desirable vegetation. All of these fires, naturally occurring and deliberately set, have the additional effect of clearing the thick chaparral growth. If the undergrowth is allowed to build up too much, fire becomes more devastating than helpful to the ecosystem (Status and Trends, p. 607-8).
Lions and Tigers and Trees, Oh My! – Flora and Fauna

Despite the incredible diversity found in most chaparral, many of the plants adapted to the warm, dry climate and shallow soil display strikingly similar characteristics. Most chaparral plants are woody and evergreen with broad, waxy, sclerophyllous (literally “thick leaves”) leaves. These leaves are more rigid than most broad leaves because they are made up of cells with especially hard walls that are perfect for conserving moisture through drought (Hanes, 1971).

Montane chaparral is differentiated from the other two chaparral ecoregions by the differences caused by altitude and geology. The geological history of the mountains explains many of the differences in environment and vegetation that we can see between the montane chaparral and the coastal and interior chaparral. Because of their rocky makeup and shallow soil, the mountains of the montane chaparral are less fertile than areas with thick topsoil or large amounts of deteriorated plant matter. This means that much the vegetation of this region must be adapted to less fertile soil, or even to specialized soil types (such as serpentine soil, discussed briefly later in this section) that may only appear in small patches (WWF website, Hanes, 1971).

Despite this, the dry climate and regular fire season promotes the plant diversity that is characteristic of Mediterranean ecosystems. As noted, many chaparral plant species are fire dependent in some way, such as only germinating with heat or in the presence of charate. These include eastwood manzanitas (*Arctostaphylos glandulosa*), silktassel (*Garrya flavescens*), matilija poppies (*Romneya trichocalyx*), and all species of ceanothus (*Ceanothus spp.*). Other species, however, are not so directly fire dependent, and have managed to find their niche in this community by other means. For California
buckwheat (*Eriogonum fasciculatum*) this means resprouting from root crowns that are not consumed by fire. Other species, such as the many oaks (*Quercus spp.*), berries, and mahogany (*Cercocarpus spp.*) rely on an abundance of seeds and wide dispersal to survive fire (Keeley, 1987). US Geological Survey research ecologist Jon Keeley attributes much of the species diversity found in chaparral ecosystems to the multitude of different plant responses to the “variable burning regimes” discussed earlier (Keeley, 1987).

Variation in elevation and soil type also contribute to plant diversity in montane chaparral. Lower altitudes are dominated by scrub oak (*Q. dumosa*) and chamise (*Adenostoma fasciculatum*), both of which are common in the other local chaparral types. At higher altitudes manzanita becomes the dominant broadleaf plant, making up the understory below pines and other conifers such as Coulter pine (*Pinus coulteri*), ponderosa pine (*P. ponderosa*), bigcone Douglas fir (*Pseudotsuga macrocarpa*), and Incense cedar (*Libocedrus decurrens*) (WWF website). There are even a few populations of California redwoods (*Sequoia sempervirens*) – the tallest growing trees on earth – in the foggy valleys of the Santa Lucia Mountains. Additionally, soil restrictions create isolated areas with unique habitats such as stands of knobcone pine (*P. attenuata*) in extremely poor serpentine soil and Gowen cypress (*Cupressus goveniana*) in patches of acidic soil. Given these small, specialized environments, it comes as no surprise that only the Northern California coastal forest has as many endemic conifer species as California’s montane chaparral and woodlands. A number of these, such as Gowen cypress (*C. goveniana*), Monterey cypress (*C. macrocarpa*), Sargent cypress (*C.
sargentii), and Monterey pine (P. radiata), are restricted to as few as two or three stands (WWF website).

Animal species vary in size from mice and kangaroo rats to small predators, such as bobcats (Lynx rufus), coyotes (Canis latrans), and pumas (Bassariscus astutus). Some of the smaller creatures, however, are the most famous. While few people may have heard of the California red-legged frog (Ranatra aurora draytonii) (Figure 3) by either its common or scientific name, many have read Mark Twain’s famous short story about it, “The Celebrated Jumping Frog of Calaveras County” (Faucett, 2002). It is estimated that these frogs were abundant in California once, but they have been reduced to one quarter of their historical range (Our Living Resources, p. 132). In June of 2002 over 100 red-legged frogs – the largest native frogs in California – were discovered living in the Angeles National Forest, where only a few were thought to still reside (Faucett, 2002). The California red-legged frog is only one of more than 14 species of amphibians living in the montane chaparral, five of which are endemic (Status and Trends, p. 622, WWF website).

Perhaps the most famous of all endangered species in the ecoregion, if not in all of California, is the California condor (Gymnogyps californianus) (Figure 4). The condor has historically existed in small numbers (possibly fewer than 100 birds). The Pleistocene extinction of large mammals in California 10,000 years ago left condors with fewer carcasses off of which to scavenge, reducing their numbers from perhaps
Attempts to slow the decline of condor populations go back as far as 1937 with the establishment of the first condor sanctuary in Los Padres National Forest. Captive breeding has proven successful to a degree, but birds released back into the wild have proven susceptible to electrocution by power lines and lead poisoning from eating the carcasses of animals killed by hunters using lead bullets (Our Living Resources, p. 80-1).

**Threats to Regional Biodiversity**

In the previous section I introduced the elements of geological, ecological, and taxonomic diversity in California’s montane chaparral and woodlands. In this section I will move on to discuss factors threatening the biodiversity in the area.

David J. Rapport, Professor of Rural Planning and Development at the University of Guelph in Ontario, organizes external sources of environmental stress into five categories: The extraction of renewable resources, changes in the way land is used, human generated pollution, exotic species, and extreme natural events (Rapport, 1985). Since many environmental stressors constitute threats to biodiversity, this is also an excellent framework for considering factors that threaten the biodiversity of California’s montane chaparral and woodlands.
The Demand Curve – Resource Extraction

Generally, one would expect wood to be the most valuable forest resource in an area. Fortunately, the montane woodlands of Southern California have just enough pine and fir to be called woodlands, but not enough to make them an economically viable source of lumber. In a general technical report published by the Forest Service, John Stephenson and Gena Calcarone point out that even the relatively small amount of logging that does take place in San Bernardino and Los Padres National Forests has fallen off since the 1960’s and 70’s. Between 1980 and 1990, fewer than 5 million board feet of wood per year were extracted from Los Angeles and San Bernardino counties combined (Stephenson and Calcarone, 1999, p. 99).

Mining and oil drilling constitute a more serious risk to the area, although these are still some of the smaller threats to the biodiversity of the montane chaparral and woodlands. Most of the mining operations are small enough so as not to cause any large scale harm, except in cases where they disturb sensitive habitats. Two situations in which this is a very real problem are when mining is on mineral-rich limestone deposits where rare, endemic plants grow, and when the mining being done requires suction dredging (Figure 5). This involves sucking water and sediment up from stream beds, filtering out the desirable minerals, and discharging the filtered water and rock back into the stream. The disturbance that this causes can

Figure 0 - A dredge mine filters heavy metals, such as gold, from sediment (Bureau of Land Management in CA website)
severely damage aquatic and riparian habitats (Stephenson and Calcarone, 1999, p. 104-5).

Recently, there has been a strong push to open Los Padres National Forest to oil and gas drilling. An environmental impact statement has yet to be published on the likely effects of doing so. The yield of such an operation, as predicted by geologists would be under one percent of the total oil reserves in the United States. Other environmental impacts aside, this would probably involve opening up more roadless areas in the ecoregion. Efforts to extract resources from an area invariably require accessing the area. The requisite roads contribute to habitat fragmentation, an issue that we will deal with more heavily in the following section (WWF website; Stephenson and Calcarone, 1999, p. 36-38).

You Can’t Always Get What You Want – Land Use Change

About 30 percent of the montane chaparral and woodland remains intact. The rest has been urbanized, intentionally altered for human purposes, or otherwise disturbed (in which case what grows back is not always what was there in the first place – see section IV on exotic species for more information). Because most of the ecoregion is mountainous, it is not as threatened by urbanization as other nearby regions, such as the flatter coastal sage and interior chaparral. So far higher altitudes remain less developed, while lower areas, such as valleys between ranges, are becoming significantly urbanized. This selective development contributes to habitat fragmentation by creating isolated areas of intact habitat at higher altitudes (WWF website).

Urbanization inevitably leads to higher recreational use of nearby non-urbanized lands. While recreation does not have to cause ecological damage, it often does,
especially when associated with the large human populations supported by areas within and near the ecoregion (Stephenson and Calcarone, 1999, p. 92-95). One of the most tangible dangers of recreation in California is the toll that hunting can take on the endangered California condor. The condor is not hunted, but as a scavenging bird, it is at risk from consuming lead from bullets in the bodies of deer or coyotes. In high enough doses, the lead exposure from consuming hunters’ bullets can kill a condor (Knight Ridder Newspapers, 2002).

Urbanization and recreation require a network of roads throughout and between cities and recreational areas. On their own, roads contribute to fragmentation in the area at least as much as urbanization (Figure 6). Not only does a large system of roads isolate undisturbed areas from one another, but it also increases access to once undisturbed areas. This leads to a greater likelihood of disturbance by humans and increased susceptibility to exotic species that can take advantage of the habitats on the edges of fragments (WWF website; Wilson and Perlman, 2000).

Certain habitats are at risk of disturbance even without roads. Aquatic and riparian habitats can be damaged or destroyed for miles in either direction by dams.
Dams, which are usually built to regulate the supply of water for human populations and to generate power, flood habitats upstream and alter the water flow to habitats downstream. Often this change means long periods of very low flow followed by intermittent releases of large quantities of water. This change can make it difficult for native organisms to live and reproduce in the streams (Stephenson and Calcarone, 1999, p. 14-16).

Don’t Trust Air You Can’t See – Pollution

Of all the various types of pollution created by humans, none are as destructive to the montane woodlands as air pollution. Not only is oxidant air pollution worse in the Southern California mountains than almost anywhere else in North America, but two species of conifers in these mountains, ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*P. jeffreyi*), are especially susceptible to damage from the ozone gas that it contains. These can include injury to the pine’s foliage ranging from relatively minor harm to abscission (when a plant initiates removal of a particular structure because of disease or extreme damage), crown thinning, and stunted growth (Planning for Biodiversity: Abstracts website).

These ozone vulnerable species are eventually replaced by more resistant species, such as white fir (*Abies concolor*), incense cedar (*Libocedrus decurrens*), sugar pine (*P. lambertiana*), and California black oak (*Fagus kelloggii*). This change in forest composition puts much more of the forest at risk, as these ozone tolerant species generally have lower branches and thinner bark making them much more vulnerable to fire damage (Miller, 1996).
Foreign Exchange – Exotic Species

Exotic species of plants, animals, and pathogens in Southern California number in the thousands, but thankfully those that are harmful are far less numerous. Non-native plant species are the most abundant of the three types of exotics in the montane chaparral and woodlands, and most of the most invasive of these are grasses. Many of them do not compete with local species in native habitats, but instead tend to overtake disturbed sites. A few species, however, compete directly with native species. Those specifically invading the montane regions include French broom (*Genista monspessulana*), which is toxic to humans and livestock, spotted knapweed (*Centaurea maculosa*), a strong competitor for already scarce moisture and minerals, three species of oats, and cheatgrass (*Bromus tectorium*), which increases fire frequencies (Stephenson and Calcarone, 1999, p. 78-82).

Many non-native animals in the region stream or shore dwelling, and thrive in already modified aquatic and riparian habitats. In many cases, this makes it difficult to discern whether the threat to native organisms is the habitat modification or the introduced species. Evidence of some native species thriving in altered habitats suggests that the exotic organisms are an independent threat. Of these, the most salient threat is probably the bullfrog (*Rana catesbeiana*). Brought west by humans because of its large size – which means larger frog legs on the dinner table – the bullfrog preys on smaller reptiles and amphibians such as the endangered California red-legged frog to satisfy its proportionately larger hunger (Science Now bullfrog website, Stephenson and Calcarone, 1999, p. 82-88).
In terms of sheer killing power, the greatest threat probably comes from exotic pathogens. Two recently discovered diseases endanger the lives of several native tree species. The lesser threat comes from pine pitch canker fungus (*Fusarium circinatum*), which is spread by native bark and twig beetles. Infected trees lose branches to the disease, and eventually develop a large canker from which resin flows (Figure 7). The fungus may kill up to a fourth of Monterey pines (*P. radiata*) in infested stands, and could affect populations of Bishop pine (*P. muricata*), Coulter pine (*P. couteri*), knobcone pine, ponderosa pine (*P. ponderosa*), gray pine (*P. sabiniana*), Torrey pine (*P. torreyana*), and even Douglas fir (*Pseudotsuga menziesii*) (California Forest Health website, UC Center for Forestry website; Stephenson and Calcarone, 1999, p. 78).

The greater threat is from another more recently discovered sudden oak death fungus (*Phytophthora ramorum*) (Figure 8). The name turns out to be a misnomer both because the fungus has been associated so far with 26 different plant species in 15 different families (and only five of which are in the oak family) and because it takes up to ten years to kill a tree. The name developed from the fact that most of the species for which the fungus is fatal are oaks. Unfortunately, many of the associated species for which the disease is not fatal help to spread the fungus. California bay laurel (*Umbellularia californica*) and members of the Rhododendron family (*Rhododendron spp.*) act as a reservoir for the disease, developing infections on their leaves that spread spores in the rain (California Oak
Mortality Task Force website). The fungus was only discovered in the 1990’s, making it difficult to gather precise information as to how many trees have fallen to the disease so far, but the numbers are thought to be in the thousands, with many more trees infected (Bernman, 2002; Fields, 2002).

*The Eternal Flame – Extreme Natural Events*

Regular fires have been one of the most powerful forces shaping the ecosystems of the montane chaparral in Southern California. Fires are also a danger to human settlements though, and this has contributed to the popular view that fire has only the power to destroy. For about a century this view was the driving force in a remarkably successful campaign to suppress fires. In recent decades fire suppression efforts have been less effective, and individual fires have become more and more ravenous as measured by the acreage that they consume (Status and Trends, p. 45). Additionally, we have relented somewhat in our effort to suppress all fires. Humans are beginning to learn that fire is not just a destroyer, but a regenerator. Fire turns overabundant biomass into new soil nutrients. In the end, fires actually increase ecosystem fertility and biodiversity (Our Living Resources, p. 222-3). When fire is suppressed, the small plants and undergrowth that it usually clears out continue to build up, severely increasing the risk of major wildfires – fires that burn

![Figure 1 - A young oak killed by the Sudden Oak Death fungus (Nature Conservancy Wildland Invasive Species Team website)](image-url)
larger and hotter than the standard fire regimen, consuming even very large trees and actually damaging soil fertility. During the long time that plants require to regrow in this damaged soil, the land easily erodes, damaging lower elevation riparian habitats (Los Padres NF Fire Management website). As mentioned earlier, air pollution can further increase the risk of high fire damage, and the pines that are more ozone tolerant tend to have thin bark and low branches that make them ideal fuel for wildfires.

While we have an understanding of the negative effects of many of the threats discussed so far, the consequences of the last threat that we will discuss, global climate change (often referred to as global warming) are mostly guesswork thus far. Some of the evidence that is used to make projections for the future is historical – throughout the West, including California, average temperature has risen between 2 and 5°F, and rainfall has increased up to 50% through the 20th century. The two major projections for climate change in the next century, the Hadley and Canadian models, are based on computer representations of ecological, hydrological, and socioeconomic systems. Both of the two major predictive models for climate change project a further increase in temperature during the 21st century, from 10°F as to as high as 15°F. The two models also predict an additional 50-100% increase in rainfall in the montane chaparral and woodlands of California (Figure 9) (Climate Change Impacts website).

We can hardly say for certain what the actual effects of these changes will be, but the Hadley and Canadian models project that the chaparral and woodland that now make up most of the ecoregion could begin to convert to coniferous forest and thicker woodland (Climate Change Impacts website). What this will mean for the biodiversity of the area is hardly within our capacity to tell, but some inferences can be made. The
diversity of the region, in combination with fragmentation, could hamper species’ attempts to migrate in order to adapt to climate change. Invasive species that exploit disturbed ecosystems might find that climate change enables them to more easily outcompete native species. Finally, it is possible that even if climate change does alter the amount of total rainfall, it may not affect yearly precipitation patterns (wet winters followed by dry summers). If this occurs, hotter temperatures could increase natural fire frequency especially if total yearly precipitation increases. Such an increase would likely spur growth of understory plants that serve as fuel for fires in the dry summers (Climate Change Impacts website).

Figure 1 - Two major models for Global Climate Change, the Canadian and the Hadley, offer projections for temperature and rainfall in the western United States during the 20th and 21st centuries (Climate Change Impacts website)
What is Being Done to Protect Regional Biodiversity?

So far I have discussed the geological, ecological, and taxonomic diversity in California’s montane chaparral and woodlands and current threats to this diversity. In the following section I will consider current efforts to protect the area, and in addition I will propose further measures that may help safeguard the future of the ecoregion.

This Land is My Land; This Land is Your Land - Managed Areas

The managed areas in the montane chaparral and woodlands discussed herein will be some of the largest in the ecoregion. This approach is not to be considered a judgment against the value of smaller managed areas and reserves, but rather is being used because larger areas give us a better idea of what large-scale efforts are being made to protect biodiversity throughout the ecoregion.

The managed areas covering the largest expanse of the ecoregion are national forests (Figure 10). There are three national forests that include land in the montane chaparral: Los Padres (708,225 hectares), Angeles (over 260,000 hectares), and San Bernardino (over 280,000 hectares) (US Forest Service website).

Figure 1 – National parks in California montane chaparral and woodlands. The ecoregion is outlined in red (TNC Internet Map Server and US Forest Service website).
Since national forests, unlike national parks, are open to limited resource extraction, this does not necessarily mean that any organisms and ecosystems in the forest are protected. Logging, mining, damming, road construction, and other resource extraction operation and land use changes are regulated by the National Forest Service, which is run by the Department of Agriculture. Ongoing debate exists between the Forest Service and ecologists (as well as within the Forest Service itself) as to exactly what level of development is acceptable in national forests. While logging and mining both occur in these national forests, neither constitutes a current major threat to biodiversity in the region (Stephenson and Calcarone, 1999, p. 99, 104-105). Recently, the larger debate has been over whether or not oil drilling in the national forests is acceptable. The proposal is still pending further study by the forest service, but is being fiercely debated at both the political and local levels (Gable, 2003). Thus the situation with California’s National Forests seems to be that their biodiversity is relatively safe at present, but its future safety is not necessarily guaranteed.

In addition to national forests, there are several areas in the ecoregion that are denoted as wilderness areas under the control of the United States Forest Service (Figure 11). The largest of these are Ventana (96,840 hectares), Sespe (88,913 hectares), San Rafael (79,880 hectares), and Dick Smith (27,115 hectares) (National Wilderness Preservation System website). The Forest Service policy on wilderness areas states that the land is not to be developed or otherwise allowed to be disturbed by human influence. Wilderness land is used only for “primitive recreation” (operationalized as recreation that does not have an adverse impact on the wilderness area) and scientific study (US Forest Service Wilderness Policy website).
Other managed areas in the ecoregion are relatively small in comparison to the National Forests and wilderness areas. These smaller areas include military reservations, Indian reservations and state parks (Nature Conservancy Internet Map Server website).

The only of these that claims a dedication to preserving native biodiversity is the California state park system. The mission of the California Department of Parks and Recreation, which manages the state parks, is to protect biodiversity and cultural and natural resources for the benefit of the people of California. This means protecting the ecological health of intact parks, and restoring areas of parks that were already in poor ecological health when they were designated (California State Parks website).

*Thank You Sir, May I Have Another? - What Else Is Being Done?*

There are certain potential threats that are most easily regulated on managed land, such as resource extraction and land use change. While these can certainly be threats on land that is not managed, they are become far easier to control on a piece of land that is being managed with a particular ecological goal in mind. Often the purpose of denoting a
managed area is to limit the amount of resource extraction, or to prevent that parcel of land from being developed or otherwise altered. Other issues, however, have to be dealt with wherever they occur, regardless of whether this is in a state park, undeveloped private land, or a suburban yard. These include pollution damage, fire, and to a lesser extent, the spread of exotic species, especially pathogens. We are now going to consider some of these issues, while still basing most of our information on how they are being dealt with in managed areas in the ecoregion (this method is utilized primarily because of the difficulty in obtaining data on the private sector).

The fire regime of Southern California was disrupted because we thought that fire could only be destructive – a force that was harmful not only to people and their homes, but to the natural environment as well. As we have discussed in the previous papers, recurring small fires are actually an essential part of the chaparral ecosystem. The fire prevention campaign of the last century or so has led to the buildup of small understory plants which increase the risk of very large and destructive fires (Status and Trends, p. 47). Recently, this new knowledge has changed the way that we think about managing fires. Often this still means rushing to put out fires set by humans, and even those caused by ‘natural’ sources, such as lightning. The major change has been in the development of what are called “fuel management programs” usually involving a combination of proscribed burns and construction of fuel breaks, or areas across which fire will not burn because of a lack of fuel (Los Padres NF Fire website). These methods are necessary in much of the ecoregion because of the proximity of human development to areas prone to fire.
In terms of pollution caused by humans, the most hazardous type by far in the montane chaparral and woodlands is air pollution. It is clear that the ozone present in oxidant air pollution seriously damages ponderosa and Jeffrey pine (*Pinus ponderosa* and *P. jeffreyi* respectively) (Planning for Biodiversity: Abstracts website). The extent of damage is still being assessed, and further data are needed by environmental protection agencies in order to make any changes in current ambient air quality standards (Miller, 1996).

Exotic invasive species vary both in the danger that they present to native biodiversity and in the way that they are viewed by different types of landowners or stewards. A government agency that is managing an area might see a particular invasive as very dangerous, but a private landowner may not even be aware that the species is non-native, let alone that it might outcompete native species. Many of the invasive plants in the montane chaparral are grasses that can quickly dominate a large area. The thick growth of these grasses uses up resources that could otherwise be used by native species and provides a plentiful and fast-growing fuel for fires (Stephenson and Calcarone, 1999, p. 78-82). Research is progressing on plants that might be able to compete with these invasives, but in many cases, these too are non-native species. Introduction of other...
non-natives will, at best, merely increase exotic biodiversity, leaving native species no better off (TNC Wildland Invasive Species Team website – Spotted Knapweed).

In terms of invasive animal species, the threat is even less likely to be seen by landowners who don’t have a vested interest in the protection of biodiversity. The most threatening invasive animal in the area is the Bullfrog (*Rana catesbeiana*) (Figure 12), which is only a threat to the native (and often very rare) frog species. Control has been attempted by introducing fish that might prey on the bullfrog, but with little success. Again, there is no guarantee that the species being introduced to control the Bullfrog will themselves native to the area.

The most serious threat from any invasive species in the ecoregion is from exotic pathogens. As mentioned previously, pine pitch canker (*Fusarium circinatum*) (Figure 13) and sudden oak death (*Phytophthora ramorum*) are fungi that each have the potential to kill members of several different tree species. Because both of these pathogens were discovered relatively recently, most of the work being done right now is research to determine how they can best be dealt with. Short of this, land managers are

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**Figure 1** - Distribution of Pine Pitch Canker in and around California montane chaparral and woodlands (Pitch Canker Task Force website)
able to remove diseased trees, but this may not always be early enough to halt the spread of the pathogens (Pitch Canker Task Force website). In the case of sudden oak death, the threat is considered so great that a ruling was made restricting movement of hosts and possible carriers of *P. ramorum* (California Oak Mortality Task Force website). No such legislation has been passed regarding pine pitch canker.

**What More Can Be Done?**

*Keep off the Grass! – Change in Managed Areas*

As discussed earlier, most of the managed land in the ecoregion is under the control of the US Forest Service. While some of this land is designated wilderness, much of it is national forest, which is open to limited logging, mining, and possibly oil drilling in the near future. Because of the relatively low resource availability in the area, I recommend re-designation of sections of the current national forest as wilderness (not necessarily increasing the total managed area, simply changing what practices are acceptable on already managed land). This would further limit the threats presented by mining operations – especially dredge mining – to local endemic species and riparian ecosystems. Should this occur, the loss of the land for economic use will not be excessive, given the limited nature of the resource extraction that currently occurs in the area. On the other hand, significant portions of the national forest must remain open to resource extraction to avoid the backlash of private industry and local loggers, miners, and other individuals who make their living off of resource extraction.

In addition to the current managed areas, some new wilderness and national and state parks might be designated. The advantage of increasing wilderness would be that
new areas could be connected to established areas, effectively creating corridors that would allow for unhindered movement of animals across areas of differing altitudes, climates, and ecosystems. Such corridors, if they are oriented to allow north-south migration, could prove essential for the survival of some species should the climate of the area drastically change over time. While a state or national park could accomplish the same goals, they may not prove as easily managed in combination with wilderness land, since each type of managed area is under the control of a different state or federal government agency. On the other hand, having areas managed by a variety of government agencies could prove an advantage since agencies often have different ideas of how the land ought to be managed. While the Forest Service manages land for current and future resource use, the goal of the National Park Service, under the Dept. of the Interior, is simply to preserve “unimpaired” wilderness for “the enjoyment of future generations” (National Park Service Mission website). To this end national parks are open to the public, but not for the purpose of resource extraction.

Denoting additional managed areas of any type would have the added benefit of increasing the area in which the presence of invasive plants and animals can be most easily monitored and managed. Additionally, depending on shape and size of the new areas, it could make human access more difficult (by virtue of distance from access points) and thus less prone to disturbance. Any disturbance, such as fragmentation by hiking trails, can create niches that are easily invaded by exotic species (Stephenson and Calcarone, 1999, p. 78-82, 82-88). Optimally, the new land chosen for parks and wilderness areas would be large areas that are not already extensively fragmented from previous resource extraction or recreation. Not only will this make human access more
difficult, but it will allow humans to let fires to burn naturally without endangering human habitations, popular recreation areas, or other assets in or near national forests and wilderness areas.

*Put Another Shrimp on the Barbie – Fire Policy*

The rhetoric used during the last century to justify fire suppression still affects popular views on how fire should be managed. The Los Padres National Forest website still maintains that their values with respect to fire management are “fire prevention, suppression and a program of fuels management” (Los Padres NF Fire website). The difficulty in allowing fire to burn is risk to human interests. At the same time, in order to protect developed areas, humans have a vested interest in keeping fuel buildup low to prevent the very large wildfires that are more difficult to control.

Wide expanses of undeveloped area will aid efforts to return as much land as possible to a natural fire regime. Fire that is not close to any developed areas can be managed as needed (but not necessarily suppressed). Proscribed burning can be utilized closer to human interests where the danger of significant economic damage because of fire is great. In order to ensure public support for such a plan, park goers and local residents must be educated as to the necessity of fire for the functioning of local ecosystems so that they understand that fire is a force to be respected, not feared.

*It’s Getting Hot in Here – Response to Global Climate Change*

In addition to creating and maintaining north-south migration corridors to help species survive in the event of continued global climate change, we need to make sure that we protect against the added risk of invasive species and increased frequency of wildfire that climate change could cause. As discussed, anything that disturbs the normal
functioning of an ecosystem increases the risk of the invasion of that ecosystem by exotic species. Climate change could disturb the ecology of the entire region (obviously global climate change will very likely disturb the greater part of the worlds ecosystems, but the scope of this paper remains limited to the ecoregion). The only options for lowering this risk seem to be increased efforts to remove current invasives and control the influx of additional exotic species (especially those that thrive in warmer, wetter environments), and further controls on CO₂ emissions and other factors that exacerbate climate change. Such controls might appear in the form of tradable pollution permits for CO₂ emissions.

The rise in average temperature that is predicted to result from global climate change may increase the natural fire frequency in the area. For almost two hundred years humans have attempted to suppress all fire in the area, leaving us with little historical knowledge of what natural fire patterns looks like, and a change to that pattern caused by climate change will make it even more difficult for us to determine the natural frequency of fire. Our imperfect knowledge obviously limits us, but we still must make every attempt, following the plan laid out in the previous subsection, to ensure that undeveloped areas of the ecoregion are burned regularly, both to prevent excessive buildup of undergrowth and to preserve the species that rely on fire for their very survival. With respect to the former concern, regular proscribed burning on all land close to human developments is essential.

*Pulling an All-Nighter – Further Research*

Other dangers to biodiversity in the area, such as oxidant air pollution and the Pine Pitch Canker and Sudden Oak Death pathogens, are so new that it is difficult to propose an obvious management scheme. Government funds need to be made available
to finance further research into the dangers air pollution poses to ponderosa and Jeffrey pine. It has been noted that damage to them may lead to the succession of species that pose a high fire risk (Miller, 1996). If this is the case, the economic damage done by increasing pollution restrictions may turn out to be far less than the fire danger created indirectly by the air pollution coming from nearby Los Angeles and other cities.

Research is also necessary to determine how we can deal with the relatively new invasive pathogens pine pitch canker and sudden oak death. For now, the best we can do is to restrict the spread of these diseases. The most obvious ways to accomplish this are the removing infected plants and restricting the transport of possible carrier species. A more long-term solution is to plant and cultivate the seeds individuals among the vulnerable species that exhibit any resistance to either of these pathogens (Pitch Canker Task Force website).

*The Final Exam – Looking Toward the Future*

While the damage already done to the montane chaparral and woodlands may seem irreparable, and the additional threats to the future discouraging, we must remember that the ecoregion is still home to greater biodiversity than can be found even in many more intact areas. Highways slice across the land, but roadless holdouts still remain. Fires are often prevented from taking part in the ecology of the area, but it will still burn if we let it. Condors number only in the hundreds, but they still soar over the Santa Lucia Mountains. That so much of California’s diversity still remains should fill us with hope, and that it is still under serious threat must be our call to arms.
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