

CHAPTER 3: AFFECTED ENVIRONMENT



INTRODUCTION

This chapter provides an understanding of both the general environmental setting of the project area and a more focused description of those resources that could be affected by the implementation of the FMP alternatives. The first section, Project Setting, is presented to foster a fuller understanding of the scope of the FMP. The Affected Environment is required (by the Council on Environmental Quality NEPA regulations, Sec. 1502.15) to succinctly describe the environment of the area(s) likely to be affected by the alternatives under consideration, and focus efforts and attention on important issues. Scoping determined that the areas of the environment that could be affected by the FMP are soil resources, air quality, water quality, vegetation, wildlife, cultural resources, park visitor experience, park operations and socioeconomics.

PROJECT SETTING

Overview

The project area is located in central California, in western Marin County, approximately 40 miles northwest of the city of San Francisco (see Figure 1 and Figure 2). It is comprised of federal lands managed by the Point Reyes National Seashore, a unit of the National Park System, and is within 50 miles of the nine-county San Francisco Bay Area, the 5th largest metropolitan area in the United States (see Figure 10).

Generally, the more developed regions of the bay area surround the bay itself, with smaller cities, towns, open space and agricultural areas in an outer ring around the urban core. Forty-eight percent (159,044 acres) of the 332,800 acres in Marin County is held as parks, open space and watershed (Marin County Community Development Agency 2002). Thirty-six percent (119,808 acres) is in agricultural use. Developed lands constitute only 11% of the county while 5% of the county has future development potential.

While eastern Marin is heavily developed along the Highway 101 corridor, western Marin is primarily rural with scattered small unincorporated towns that serve agriculture, local residents and tourism. Roughly 90% of the quarter of a million residents of Marin County live in the eastern half of the County along the major transportation corridor -- State Highway 101.

Regional Context and Surrounding Communities

The project area consists of 90,311 acres of the Point Reyes National Seashore (PRNS) and the northern lands of Golden Gate National Recreation Area (GGNRA). The total project area includes 86 miles of shoreline on both the Pacific Ocean and Tomales Bay. The 71,046-acre Seashore includes beaches, coastal cliffs and headlands, marine terraces, coastal uplands, woodlands, and forests on the Point Reyes Peninsula.

PRNS is bounded to the north, west and southwest by the Pacific Ocean and to the east by the residential communities of Inverness, Inverness Park, Point Reyes Station, Olema, and Dogtown. The town of Bolinas is south of PRNS at the southern tip of the Peninsula (see Figure 11). An estimated 3,800 permanent residents live in the towns and communities close to the project area from the tip of Tomales Bay in the north to Stinson Beach in the south (US Census Bureau 2000). The census population figure does not count the many part-time residents of western Marin who maintain second homes in the project area.

Through a memorandum of agreement between the two national parks, PRNS manages the 19,265 acres of Bolinas Ridge for GGNRA. Bolinas Ridge is a northwest/southeast trending ridge paralleling the Olema Valley and the San Andreas fault zone. The northwest-facing slope of the Ridge is primarily grassland and shrub with east facing slopes forested with Douglas-fir and coast redwood.

East of the project area, land use is a mix of private residential and agricultural lands, publicly held watershed, and parks and open space. Adjacent to the park are areas managed by Audubon Canyon Ranch, Marin Municipal Water District, Tomales Bay and Samuel P. Taylor State Parks, and Marin County Open Space District (MCOSD) lands. Marine boundaries are shared with the Gulf of the Farallones and the Cordell Banks National Marine Sanctuaries, and Tomales Bay State Park. Some agricultural parcels are part of the Marin Agricultural Land Trust to which the owners have deeded development rights to protect rural agriculture from development pressures.

Park Management Zoning

PRNS and GGNRA share a general management plan (NPS, 1980), which uses the following zoning designations (see Figure 12) to guide park management. Prescribed fire and other fuel management strategies could be used to help achieve the desired future conditions described for some or all of these zones.

Project area lands fall under one of two management zones: Natural Resource Zone or Historic Resource Zone. The Natural Resource Zone covers pastoral lands, natural landscape areas, sensitive resources, designated wilderness and marine reserves. Historic ranches, the Point Reyes lighthouse and the lifesaving station are included in the Historic Resource Zone. A third zone called Special Use Zone exists within the boundaries of PRNS and GGNRA, but is not applicable to fire management. These lands are managed by another entity such as Mt. Tamalpais State Park and Audubon Canyon Ranch.

Natural Resource Zones

Pastoral Landscape Management Zone (northern Olema Valley and northern Point Reyes peninsula). Approximately 19,000 acres of PRNS have been retained in agricultural production within the pastoral zone that supports beef and dairy production. The Northern District of GGNRA contains an additional 10,500 acres leased for cattle grazing. Pastoral operations presently include seven dairy and ten beef cattle ranches. The GMP indicates that, at a minimum, agricultural buildings and open grasslands will be retained in these areas, and where feasible, livestock grazing will continue within the limits of carefully monitored range capacities (NPS, 1980, p. 18), and that future resource management studies could significantly alter the configuration of this zone. To help in carrying out these policies, the FMP may include small pilot projects within the pastoral lands geared towards techniques for the control of invasive exotic plant species such as Scotch and French broom and the maintenance of high-quality pasture for cattle grazing. The Estero and Headlands FMUs, the northern end of the Bolinas Ridge FMU and the southern end of the Palomarin FMU are in the Pastoral Landscape Management Zone.

Natural Landscape Management Zone (southern Olema Valley and Bolinas Ridge, Limantour Road corridor and Limantour Beach, Tomales Bay shoreline north of the State Park, Bear Valley, recreational beaches, road corridors and select trail corridors). The Natural Landscape Management Zone applies to those lands containing important natural resources that are not within the designated wilderness of PRNS. The largest track is the southern half of the Bolinas Ridge, lands buffering Limantour Road and Limantour Beach and the Marshall Beach area north of Tomales Bay State Park. GMP direction for these areas is that natural resources and processes remain as undisturbed as possible given a relatively high level of park use (NPS, 1980, p. 18). The Olema Valley is to be managed to maintain the visual contrast between woodland and open grassland. (NPS, 1980, p. 96). Fire management strategies such as selective thinning, burning and mowing would be cautiously pursued in this zone with the objective of protecting scenic, ecological and recreational values. The Inverness Ridge, Limantour and Palomarin FMUs are within this zone as are the road corridors of the Wilderness North and South FMUs.

Special Protection Zone (Philip Burton Wilderness Area, Gulf of the Farallones National Marine Sanctuary, State of California Marine Reserves, shorelines and riparian corridors). Special Protection Zones includes lands that have received legislative or special administrative recognition of exceptional natural qualities requiring strict protection measures.

Wilderness Subzone. Public Law 94-567 designated more than half of PRNS as the 32,373-acre Philip Burton Wilderness Area, part of the National Wilderness Preservation System. As directed in NPS 2001 Management Policies (2000), fire management activities in wilderness areas must:

- Conform to the basic purposes of wilderness,
- Provide for the identification and reconciliation of the natural and historic roles of fire in the wilderness, and
- Identify a prescription for response to natural and human-caused wildfires in the wilderness area. (NPS, 2000, section 6.3.9)

The Management Policies also state that suppression strategies for wildland fire in wilderness areas must use the “minimum requirement” concept, a process of identifying the least damaging tools or activities, to protect natural and cultural resources and minimize any lasting impacts of the suppression actions. The Tomales Point, North Wilderness, South Wilderness, Limantour, Highway One, Palomarin and Inverness Ridge FMUs contain designated wilderness lands.

Marine Reserves Subzone. Marine reserves were established at the Point Reyes Headlands, Limantour Estero (Estero de Limantour) and Duxbury Reef Reserve (adjacent to PRNS’s southern boundary) in 1972 by the California Department of Fish and Game under Title 14 of the California Code. The purpose of the reserves is to preserve them in a natural condition and to protect the aquatic organisms and wildlife found thereon for public observation and scientific study. Management of the Headlands Reserve prohibits recreational fishing and places restrictions on commercial fishing. Commercial and recreational fishing and collecting are prohibited in the Estero de Limantour Reserve. The NPS maintains a standing proposal to the State to grant Research Natural Area status to the Double Point and Bird Rock areas of Point Reyes. The FMP must provide adequate protections for the marine reserve subzone areas from direct and indirect effects of plan implementation. The Headlands FMU, Limantour Road FMU, Tomales Point FMU, and Estero FMU border these marine reserves.

Biotic Sensitivity Subzone. This subzone includes natural resources in the park that are particularly sensitive to human use or are especially valuable from an ecological or scientific point of view. Most of the areas covered by this subzone are watercourses or bodies of water recognized for their importance in sustaining wildlife and vegetation. The GMP states that use and development in these areas will be either discouraged or mitigated sufficiently to avoid significant levels of deterioration. The FMP must provide sufficient safeguards during implementation to protect this resource subzone from degradation and provide enhancement wherever possible. Potential beneficial and adverse effects on riparian areas and water resources are addressed in this EIS under the headings of water quality and vegetation in the Environmental Consequences Chapter. The Estero, Highway One and Palomarin FMUs contain lands with this designation.

Historic Resource Zones

Preservation Zone (including the Point Reyes Lighthouses and Lifeboat Station). Spaces and objects in this category primarily are managed and used for facilitating public enjoyment, understanding, and appreciation of their historic values. Since the adoption of the 1980 GMP, many of the historic structures in the park have been adaptively re-used under the agricultural leases. Others house visitor activities and associations, park administrative offices or provide housing for park employees. The GMP indicates these historic resources be protected from damage and deterioration, and the FMP includes actions such as roadside mowing and maintenance of defensible space around them to provide protection should an unplanned ignition occur.

Geology and Topography

The character of the Point Reyes Peninsula has been shaped and remains defined by its association with the San Andreas Fault System. The San Andreas Fault Zone (SAFZ) forms the active tectonic boundary between the Pacific plate and the continental North American plate.

Clark and Brabb (1997) describe similarities between Eocene and Miocene depositional sequences of the Point Reyes and Monterey peninsulas suggesting displacement of the Point Reyes Peninsula along the San Gregorio Fault of as much as 150 km (94 mi) in the last 11 million years. Recent research on the San Andreas Fault has allowed researchers to document the occurrence of 10 additional large-scale land movement events in the past 2,500 year, with a recurrence interval on the order of one major event every 250 years (Zhang et al., 2003). Due to different rock types, the geomorphology, hydrology, weather, soils, and plant communities east of the fault differ in many ways from that of the peninsula.

Salinian granite underlies nearly the entire peninsula, and is exposed in the areas of Inverness Ridge, Tomales Point, and the Point Reyes Headlands (see Figure 13). The granite is unconformably overlain by the Monterey Shale in the southern part of the peninsula which is exposed along the coastline from Drakes Bay south to Bolinas (Konigsmark, 1998). Coastal wavecut benches and flooded valleys are the result of sea level fluctuations during the Pleistocene and Quaternary tectonic uplift (Scherer and Grove, 2003). The Point Reyes plain, extending from Inverness Ridge west to the headlands is underlain by siltstone and mudstone of the Purisima Formation (Clark & Brabb, 1997), which also occurs in the Santa Cruz Mountains. The headlands present the most unique exposed formation within the park, the Point Reyes Conglomerate, a sandstone conglomerate with rounded chert, volcanic, and granitic cobbles. It is best exposed along the Lighthouse steps and is most similar to a conglomerate that occurs on Point Lobos, 100 miles to the south (Evens, 1993).

The Olema Valley, extending from Bolinas Lagoon to Tomales Bay is representative of the SAFZ. The Valley ranges in width from 1,500 to 7,000 feet. The Olema Valley includes a variety of fault-associated topographic features including linear ridges and drainage patterns, parallel stream systems, offset rows of trees and fences, and a series of sag ponds. The surface rupture caused by the 1906 earthquake extended from Bolinas Lagoon to Tomales Bay, with lateral displacement ranging from 14 to 20 feet in the Olema Valley (Gilbert, 1908).

Bedrock east of the fault (generally east of Highway 1) is the Franciscan Complex that makes up much of California's Coast Range. The Franciscan Complex is believed to be a fossil accretionary wedge of sediment that used to fill the trench of a subduction zone. It is mostly composed of greywacke, sandstone and shale with different grades of metamorphism. Some parts of the Franciscan Complex are a *mélange*, including highly metamorphosed, low-grade mudstone, siltstone, and sandstone with occasional inclusions of limestone, chert, serpentinite, eclogite, and amphibolite conglomerate (Galloway, 1977). The Franciscan Complex is highly unstable and is known for slope instability, thin soils, and high runoff rates.

The topography within the project area is controlled by Inverness and Bolinas Ridge and the dominant San Andreas Fault. Watersheds draining from Inverness Ridge are perennial while those draining from Bolinas Ridge are nearly always intermittent. Most of the watersheds within the Olema Valley have drastically altered and unusual drainage patterns associated with the combination of stream capture and alterations to the topography caused by the strike-slip movement of the San Andreas Fault. Near their headwaters, Olema Creek and Pine Gulch Creek run parallel, but in opposite directions for nearly two miles. Near the head of Tomales Bay, Bear Valley Creek drains at an acute angle from Inverness Ridge (likely stream capture) and makes an

abrupt turn to the north adjacent to the 1906 fault rupture, running parallel to Olema Creek until they discharge into the Lagunitas Creek estuary.

Inverness Ridge forms the backbone of the Point Reyes Peninsula, reaching a height of 1,407 feet at Mount Wittenberg. The ridge is characterized by relatively consistent upland elevation with overly steep headwater stream systems. The only interruption in the ridge between Bolinas and Tomales Point is the 400-foot pass at Divide Meadow. The soils of the Monterey Shale and Purisima Formation have high rates of infiltration, allowing Inverness Ridge to support most of the perennial streams within PRNS. South of Laguna Creek, Inverness Ridge merges with the Bolinas Mesa, a wave-cut bench into Monterey Shale. The terrace is intersected by a number of steep ravines formed by actively downcutting stream channels. Some of the most spectacular landmarks in PRNS, including Arch Rock and Alamere Falls are a result of this interaction between small streams and bedrock along the rocky coastline.

Bolinas Ridge to the east rises approximately 800 feet in elevations. The soil type, lithology, and climate combine resulting in far drier conditions on the west facing slopes. The ridge is primarily grassland with the steep, narrow ravines dominated by oak, bay laurel, and Douglas fir.

Inverness Ridge forms the backbone of the Point Reyes Peninsula, reaching a height of 1,407 feet at Mount Wittenberg. The ridge is characterized by relatively consistent upland elevation with sharp precipices dropping down into the river valleys. The only interruption in the ridge, between Bolinas and Tomales Point is the 400-foot pass between Bear Valley and Coast Creek drainages. Most of the perennial streams within PRNS originate from the ridge. South of Laguna Creek, the ridge merges with the Bolinas Mesa, an uplifted, wave-cut Monterey Shale bench. This terrace is intersected by a number of steep ravines caused by drainages cut down to current sea level. Some of the most spectacular landmarks in PRNS, including Arch Rock and Alamere Falls, are on this terrace.

Bolinas Ridge to the east rises to approximately 800 feet in elevation. Due to soil type and climate, conditions are far drier on these west-facing slopes. Ridges are primarily grasslands with the steep tributary valleys dominated by oak and bay laurel.

Fire Regime

The term “fire regime” refers to a simplified description of characteristics of the fires that typically occur at a given site. Present fire regimes often differ from historic fire regimes. Descriptions of fire regimes are general and broad because of the enormous variability of fire over time and space (Whalen, 1995). The factors that are often used to determine and describe fire regimes in an area include fire type, intensity, extent or size, frequency, and/or season (Whalen, 1995, Brown, 2000).

It is likely that prior to Euro-American settlement of the project area in the mid-1800s, forest and woodland plant communities were subject to a mixed severity fire regime, which can arise in one of three ways (Brown, 2000):

Many trees are killed by mostly surface fire but many survive, usually survivors include fire-resistant species of relatively large size.

Severity within individual fires varies between understory burning and stand-replacement, which creates a fine-grained pattern of young and older trees. This type of regime probably is due to fluctuations in weather during fires, diurnal changes in burning conditions, and variation in topography, fuels, and stand structure within burns. Highly dissected terrain is conducive to this fire regime.

Fire severity varies over time with individual fires alternating between understory burns and stand-replacement. This regime has also been termed “variable” and has been applied to redwood forests.

Prior to Euro-American settlement, shrub-dominated or grassland plant communities in the project area may have been influenced by a stand-replacing fire regime, as most fires likely killed or removed most of the aboveground vegetation. The variability in topography, fuels, and diurnal weather fluctuations, however, could have resulted in a mixed severity fire regime, as described above for forests and woodlands.

The current fire regime for the Point Reyes area has changed dramatically since the mid-1800s as a result of Euro-American settlement patterns and practices. Effective fire suppression has resulted in large accumulations of fuels in many forest, woodland, and shrub-dominated plant communities. Thus, when fires do burn, they often are stand-replacing, as evidenced by many areas within the perimeter of the 1995 Vision Fire.

Following the cessation of winter rains in mid-April, fuels dry rapidly and the light fuels of the annual grassland (2,000-7,000 lbs/acre) cure. During the summer months, live, dead and downed round wood material and duff in the understory of PRNS’s forest stands gradually lose moisture.

Fire season at Point Reyes begins in early June. At this time, high-pressure air masses frequently stagnate over the Great Basin. Strong foehn winds, referred to as Mono winds in central California, may develop if there is a low-pressure trough off the coast. These winds bring warm, dry air to Point Reyes and cause rapid drying of fuels. These episodes usually last 1-2 days and fire danger can be extreme. In typical years, a persistent coastal fog bank is formed by July 1, following the stabilization of the Pacific high over central California. From July through early September fog moves inland and back out to sea in a 3-4 day cycle in response to heating and cooling in California's Central Valley. Fine fuel moisture fluctuates in this cycle, while wood fuels and duff remain relatively wet. In mid-September the fog pattern changes and fuel moistures drop steadily. It is at this time that conditions contributing to Mono winds occur. The combination of prolonged drought, low relative humidity and a peak in fuel production often causes fire danger to be high through September and October. In addition, almost one fifth of the area's annual lightning storms occur during this period (Martin and Sugnet, 1984).

The late fall fire season is one of the primary constraints limiting the number of days available in the project area during which prescribed burns can be conducted each year. Other constraining factors are air quality and disruption of wildlife breeding periods.

In summary, the fire season at Point Reyes differs somewhat from most areas in the western United States. Bimodal peaks of fire danger occur in late spring and late summer/early fall. In most years, persistent fog keeps fire danger moderate in July and August when danger is highest in most of the western United States. The period from September 1 through October 31 can be considered the most critical time of fire danger for PRNS.

Fire History

Research into Historic Fire Cycles

There is evidence from dendrochronological (tree ring) records and from sediment core analyses that periodic fire has occurred in the project area for the past several thousand years, and ecosystems in the area have developed under the influence of these fires. Several native plant species in the project area (e.g., Bishop pine, Marin manzanita) reproduce abundantly following fire. For the past 100 years, however, fire frequency has decreased, and most fires have been suppressed. The lack of periodic fire during this period has resulted in changes in vegetation structure and species composition. For example, it is generally assumed that forest stand density in many areas has increased, and shrub and grassland habitats in many areas are being reduced in size due to encroachment by conifers. Populations of the Marin manzanita are becoming increasingly rare as a result of habitat loss due to shading from increasing forest stand density.

It has been well documented that fires in the Point Reyes area and within California coastal ranges were frequently set by Native Americans (Slaymaker, 1982; Keely, 2002) and European settlers. Fire history studies conducted in and around the peninsula show the northern coastal prairie was very important to the Coastal Miwok as a source of food. Seeds were harvested from the coastal prairie and other grasslands in late summer. Individual seed fields were the possession of specific families and were probably often burned after harvest to enhance growth the next year. Documentation of Coast Miwok culture indicates burning of grasslands for several purposes, but information on the extent and timing is minimal. Some sources indicate that fields were burned frequently, as often as once a year (Lewis, 1973; Slaymaker, 1982). Pre-contact burning along the coast may have focused on grasslands, while later burning during the Spanish and Anglo periods focused on shrublands to increase pasture acreage. The latter probably did not burn grasslands because of the need for winter livestock forage, leading to a very different fire regime (Greenlee and Langenheim, 1990).

Conditions conducive to lightning-caused wildfire do occur in Point Reyes, but they are rare (Martin and Sugnet, 1984). The Bay Area averages about 3 lightning days a year. An average of two lightning storms occur annually in the vicinity of Inverness with 18 percent of these storms occurring in September (Martin and Sugnet, 1984). Between 1970 and 1989, 13 lightning-ignited fires occurred in the following areas: Inverness Ridge, Mt. Tamalpais, and Stinson Beach. On September 27, 2001 a lightning fire occurred on Bolinas Ridge above Stinson Beach. During this same September storm, an observer saw about 60 lightning strikes from the Mount Barnabee

Lookout near Samuel P. Taylor State Park, adjacent to the National Seashore. In addition, Pacific Gas and Electric staff counted 4,600 lightning strikes in the Bay Area during this storm (Freed, 2001).

Regardless of the source of ignition, however, ecosystems of Point Reyes are not burning today with nearly the frequency they did in the past. This change in fire frequency can result in shifts from understory to overstory dominance, increases in fuel loads and changes in forest structure, including increases in ladder fuels, which may lead to increased incidence of overstory, stand-replacing fires (Covington et al., 1994).

The best records of Point Reyes fire history reside in fire-scarred tree rings in redwood, and to a lesser extent, in Douglas-fir trees. Bishop pines are relatively short-lived trees (100 to 120 years), and generally occur in single-aged stands which arise after a stand-replacing fires. While the age of a Bishop pine stand can give solid evidence of a single large fire, it yields little insight into longer-term fire history. Shrubs respond to burning by either sprouting back from their stumps, or by regenerating via seeds in the soil so little record of the physical evidence of fire is retained. The same is true of grassland species.

Due both to past logging and the relatively thin bark and low resistance to burning in Douglas-fir, Douglas-fir forests are a limited source of data on fire history. However, at least one research team (Brown et al., 1999) was able to extract data from fire scars on Douglas-fir and redwood trees at three locations in Point Reyes. The researchers found that fire scars did not extend much beyond the late 1700s. The oldest Douglas-fir tree found in the park dated to 1680, but this individual had no fire scars. Within the approximately two hundred-year period of fire scars (roughly 1800 to the present), researchers calculated a mean fire interval ranging from 7.0 to 13.0 years for the Douglas-fir forests. They were unable to cross-date any pre-settlement redwood trees, although some post-settlement trees did contain fire scars that successfully cross-dated with the Douglas-firs. Researchers speculated these trees were likely basal sprouts that established after the original redwood stand was logged, or grew in response to fire. Using fire scar information for burns from the early 1800s to the early 1900s, the researchers calculated a mean fire return interval in the redwood groves of 7.7 to 8.5 years.

Adjacent to Point Reyes, Finney (1990) found mean fire intervals between 1850 and 1900 that ranged from 6 to 33 years, with a mean of 14 years in coast redwood stands on Bolinas Ridge. He was able to document high fire frequency in the grove studied dating from the middle 1400s. Jacobs et al. (1985) calculated mean fire intervals of 22 to 27 years from stumps containing fire scars on ridges surrounding Muir Woods National Monument.

Work at Humboldt Redwoods State Park revealed a larger range in fire intervals, although this area has higher precipitation levels than Point Reyes and so is not directly comparable. Stuart (1987) calculated mean pre-settlement fire intervals in Humboldt from fire scars and redwood sprouts varied between 11 and 44 years. In the same area, Fritz (1932) estimated that at least 45 severe fires had burned during the previous 1,100 years, with a mean fire interval of 25 years. At Salt Point State Park, Finney and Martin (1989) found fire return intervals of 20.6 to 29.0 years. The authors state that all of these studies probably overestimate the actual mean fire interval.

Sediment taken from the bottoms of the lakes at the south end of Point Reyes Peninsula provides further evidence of forest fires over the past several centuries (Russell, 1983). In an on-going charcoal stratigraphy study by Anderson (2001), sediment cores from Glenmire and Wildcat lakes are being analyzed with radiocarbon dating. The Glenmire sample within the Douglas-fir forest; the Wildcat Lake area is dominated by coastal scrub. Sediments from both lakes indicated a near absence of fire during the past 100 years. Ongoing research is examining additional sediment cores from wetland areas in Point Reyes through radiocarbon dating and pollen analysis with the goal of constructing a more complete fire history.

Recent Fire History

The Marin County Fire Department has historically maintained a list of the larger fires in the county in the 20th century. Several of these fires have occurred in the project area. A fire in October 1917 burned 2,000 acres on the ridge west of Inverness. The largest fire, in September 1923, burned 40,000 acres from Lucas Valley to Bolinas including 35 homes in Woodacre.

More recently, the Mount Vision Fire burned more than 12,000 acres in 1995. It was started by an unattended campfire on October 3 at approximately 1:00 pm within Tomales Bay State Park. Driven by 40- to 50-mile per hour winds in steep terrain and heavy forest fuels, the fire rapidly burned 700 acres and spread to PRNS and the residential community of Paradise Ranch Estates where 48 structures were destroyed. By October 6, up to 1,200 firefighters had participated in suppressing the fire. The next night, October 7, 1995, the fire was declared contained after burning a total of 12,354 acres (11,598 acres NPS lands, 386 acres State Park lands, 370 acres of private lands). The fire was declared controlled 9 days later.

Since 1997 an average of three wildland fires have occurred each year in the project area. In all cases, the burned area was less than ten acres and most were kept to less than one acre. Most of the fires occurred in the Olema Valley, and all but one was human-caused.

AFFECTED ENVIRONMENT

Soils

The Marin County Soils Survey provides generalized baseline information on soils within the project area (SCS, 1985). Soils are classified into broad associations comprised of one or two major soil types, from which the name of the association is taken, and several minor soil types. As the FMUs share geologic substrate, they also share many of the same soil types. Generally, FMUs involve 3 general landscape types – alluvial fans and tidal flats, coastal dunes and uplands. However, the presence of the San Andreas fault zone and the opposing bedrock formations present on each side of the fault leads to a more complex mix of soil types.

When considering potential impacts to soils from fire and fire management actions, the important indices include soil permeability, topsoil infiltration, degree of slope, soil texture, compositional stability, plant cover and rainfall intensity. These factors can contribute to an understanding of the erosion potential of disturbed soils and are used in the Natural Resources Conservation Service Erosion Hazard Rating (EHR). The EHR, the general text rating given in the 1979 Soils Survey and first hand observations of NPS staff are combined to describe potential erosion

hazard of Point Reyes soil types. Another important factor to consider is the potential for a soil type to develop hydrophobic (water-repellent) properties due to intense fires. Figure 14 shows soil types in the project area; they are described in more detail below.

Tomales Point FMU. The principal soil type in the Tomales Point FMU, Kehoe Variant coarse sandy loam, is derived from the quartz diorite of the underlying granite bedrock. Soil formed from granitic bedrock or coarse-grained bedrock, such as the Kehoe Variant and Sheridan Variant (see discussion below - Inverness Ridge FMU) soils appear prone to developing surface or subsurface hydrophobic properties during intense fires. If the vegetation cover of Kehoe soils is disturbed, the potential for erosion is slight in areas of gentle slopes and high in the drainages and steeper slopes above Tomales Bay. Erosion is currently controlled by overlying vegetation, primarily grasses and coastal scrub.

Headlands FMU has a complex soils map. Rock outcrops along the western and southern coast comprise nearly 1/3 of the land surface of the FMU. Found primarily west of Sir Francis Drake Highway, Sirdrak sand soils formed by wind-born (eolian) sands make up roughly 25% of the FMU. Kehoe Variant soils (described above for Tomales Point FMU) and Tocaloma McMullin complex soils make up much of the FMU east of Sir Francis Drake Highway. These two soil types have a high erosion potential when surface soils are disturbed. As previously noted, Kehoe Variant soils have potential to form a surface or subsurface hydrophobic layer under an intense fire.

Estero FMU. Approximately 72% of the Estero FMU soils are Tomales fine sandy loam, derived from underlying sandstone. Tomales loam tends to seasonal saturation due to very slow permeability. Slow permeability leads to more rapid runoff and a high potential for erosion on slopes than 15%. Principal drainages flowing to the Drakes Estero are Rodeo clay loam, a deep, alluvial soil formed in narrow valleys.

Inverness Ridge FMU. The northern half of the Inverness Ridge FMU is comprised primarily of Sheridan Variant soils, a coarse sandy loam derived from underlying quartz diorite bedrock. The soil type supports the bishop pine forests, grasslands and scrub. The erosion potential of these soils is high where slopes are greater than 50%. Sheridan Variant, supporting tanoak, Bishop pine and coastal scrub, often have a dense duff layer on the soil surface and a high percent of organic matter within the soil. Loss of the duff layer during a fire can exacerbate erosion potential of this soil.

During the 1995 Vision Fire, Sheridan Variant soils were subject to intense heating and most organic material was burned away. Post-fire monitoring noted a crust-like hydrophobic layer had formed in patchy areas on the surface soil. This layer was water repellent for the first winter season (1995-1996) but was largely broken up by the second winter season, primarily by the force of vegetation pushing through the surface layer. Since this area was subject to the most intense burn during the Vision Fire, it was surprising how much of the seedbed survived in the surface soils. The area is now densely vegetated with dense stands of bishop pine, grassland and coastal scrub.

Compared to other Point Reyes soils, Sheridan Variant soils have high percent of organic matter in the upper surface soils and could be prone to nutrient volatilization (vaporization) or changes in soil chemistry that reduce nutrient capacity during an intense fire.

The dominant soil type in the southern half of the FMU is the Inverness loam soils, another granite derived soil, which predominates throughout the central portion of the Inverness Ridge. Inverness loam soils were the major soil series in the area burned in the 1995 Vision Fire. Like the Sheridan Variant soils, they are of particular concern for potential high rates of surface runoff and very high potential for erosion where the vegetation cover is removed or burned away (BAER Team, 1996).

Limantour FMU. The northern section and eastern sections of this FMU, extending from Inverness Ridge east to Bear Valley Road, share the Sheridan Variant Inverness loam soils that support the Bishop pine forest. The southern portion of the FMU has Palomarin-Wittenberg complex soils, supporting Douglas-fir forest, that predominate on the southern half of the Inverness Ridge. Both soil types have a very high potential for erosion on steeper slopes and have an organic content in the upper soil horizon making the soil susceptible to nutrient loss if exposed to intense heat from fire. Tomales fine sandy loam predominates on the uplands between the principal drainages and soils within the Muddy Hollow and Laguna Creek drainages are alluvial Rodeo Clay loam.

The Vision Fire burned all of this FMU in the 1995. Post-fire monitoring noted pervasive hydrophobicity in soils in the upper drainage of Muddy Hollow extending from 2 to 8 inches in depth (Collins and Ketcham 2001). Hydrophobic properties broke down and nearly disappeared by the end of a second winter's rains. Post-fire monitoring recorded accelerated upstream channel cutting and hillside rilling in the upper drainages of the Muddy Hollow Creek system during the first year after the fire. In the first two years following the fire, soils in the middle drainage of the Creek eroded primarily from exposed areas such as old roadbeds and channel banks. Eroded sediments were deposited in a wide channeled alluvial fan at the base of the drainage especially during the second rainy season after the fire. Soil erosion was largely controlled by the third year post-fire as eroded areas in the watershed revegetated (B. Ketcham, pers. com.).

Wilderness North FMU is primarily Palomarin-Wittenberg complex soils supporting Douglas-fir forests on southern portion of the Inverness Ridge. The soils are derived from the underlying sandstone and shale and are deep and well drained with a 2 to 4 inch covering of Douglas-fir needles. The erosion hazard is very high on slopes greater than 50%. As noted previously, the high percent of organic content in the upper soil layer points to a potential for changes in soil chemistry in the event of a high intensity fire. The northern portion of the FMU burned in 1995.

Wilderness South FMU is also dominated by the Palomarin-Wittenberg complex soils though slopes are generally less steep than in the Wilderness North FMU. Like the Limantour FMU to the north, the west-facing slopes are thin, erodible Pablo Bayview soils. Less than 10% of the FMU on the steepest eastern slopes of Inverness Ridge is Dipsea Barnabe gravelly loam soil supporting Douglas-fir and redwoods. These soils are considered highly erosion-prone due to

the high gravel content (SCS, 1979). The Dipsea soils have the highest average percent of organic matter in the upper soil layer of all the Point Reyes soil types.

Highway One FMU. The Highway One FMU runs northwest to southeast along Highway 1 overlying the San Andreas fault zone and the floodplain of Olema Creek. It extends west to the lower slopes of Inverness Ridge and east to the top of Bolinas Ridge. Bedrock type differs distinctly on each side of the San Andreas fault leading to distinct soil types on each ridge. The slopes of Inverness Ridge are primarily highly erodible Tomales or Tomales-Steinbeck fine sandy loams derived from the underlying sandstone. The Olema Creek floodplain is comprised of alluvial soils, mainly clay loams and silt loams (Blucher-Cole complex and Rodeo clay loam) that have high water capacity tending to become saturated with very low rates of erosion. Soils on the west-facing slope of Bolinas Ridge are primarily highly erosive Centissima Barnabe soils supporting Douglas-fir and Redwood forest and grasslands and Cronkhite-Barnabe soils supporting primarily grasslands.

Bolinas Ridge FMU. The northern half of the Bolinas Ridge FMU shares the characteristics of the eastern portion of the Highway One FMU. Centissima Barnabe and Dipsea-Barnabe soils, both highly erosive, are on the ridgetops and steep side slopes of the Ridge and support Douglas-fir and Redwood forests. More gently sloped areas of Cronkhite-Barnabe soils exist on the ridgetop. The southern half of the FMU has shallow Maymen-Maymen Variant gravelly loam soils on the long uplands side slopes which have a high hazard of erosion and siltation.

Palomarin FMU. Similar to the Wilderness South FMU to the north, the spine of the Inverness Ridge in this FMU has Palomarin-Wittenberg soils and the rounded, west-facing slopes is composed of Pablo Bayview soils. Much of the southern half of the FMU consists of moderately sloped uplands. Side slopes in this region are covered with thick but erodible Cronkhite Barnabe soils supporting grasslands, and steeply sloped areas of Palomarin Wittenberg soils supporting Douglas-fir forest.

Table 7A. Erosion Hazard Potential Per FMU

FMU	Total Acres in FMU	Low erosion potential		Moderate erosion potential		High erosion potential		Very high erosion potential	
		Acres per FMU	% of each FMU	Acres per FMU	% of each FMU	Acres per FMU	% of each FMU	Acres per FMU	% of each FMU
Tomales Point	2,783	717	26%	245	9%	1,821	65%	--	--
Headlands	881	290	33%	347	39%	215	24%	--	--
Estero	1,639	200	12%	528	32%	911	56%	--	--
Inverness	1,250	225	18%	388	31%	466	37%	171	14%
Limantour	4,144	828	20%	543	13%	1924	46%	824	20%
Wilderness North	1,591	27	2%	224	14%	313	20%	1027	64%
Wilderness South	2,298	179	8%	654	28%	777	34%	683	30%
Highway 1	2,868	285	10%	246	9%	1798	63%	539	19%
Bolinas	2,382	9	>1%	764	32%	1,054	44%	555	23%
Palomarin	2,022	161	8%	420	21%	1082	53%	324	16%
ALL FMUs	21,858	2,921	13%	4,359	20%	10,361	47%	4,123	19%

Air Quality

PRNS is classified as a mandatory Class I area under the Federal Clean Air Act and Amendments. Title I of the Clean Air Act Amendments of 1990, Part C, “Prevention of Significant Deterioration of Air Quality,” Section 162, defines Class I areas as including all national parks greater than 6,000 acres. The areas must have been in existence on the date of enactment of the Clean Air Act Amendments in 1977.

The NPS, as the Federal Land Manager (FLM) of PRNS, is responsible for the protection of the park from ambient air quality impacts, including air quality-related values (AQRVs) such as visibility and the protection of plants, animals, soils, water quality, cultural and historic structures from the effects of contaminants. The northern lands of the GGNRA, comprising Bolinas Ridge directly east of Highway One is administered by PRNS and included in the scope of this FMP, are a federal Class II area.

PRNS is located in the San Francisco Air Basin and is under the jurisdiction of the Bay Area Air Quality Management District (BAAQMD). The BAAQMD is the agency that is directly responsible for the protection of air quality and implementation of local and State Implementation Plan (SIP) measures within the Bay Area region. The BAAQMD regulates air quality under the auspices of the California Air Resources Board (CARB) and the U.S. Environmental Protection Agency (EPA), Region 9. Both CARB and the EPA have general oversight responsibilities for the purpose of making sure local rules and regulations and stationary source permits issued are consistent towards attainment and maintenance of the California and National Ambient Air Quality Standards (AAQS). The AAQS are discussed later in this section. Mobile sources are not regulated at the local level except in certain instances where they are strongly associated with a stationary source project, such as a power plant. Otherwise, under the mandated authority of the EPA, mobile source emissions are regulated by CARB.

In the 2000 Census, Marin County had a total population of 247,289 (U.S. Census Bureau, 2000). Most of the population of Marin County lives to the south and east of the project area; other populated areas (including Petaluma, in Sonoma County) are located in a more easterly direction inland from Point Reyes. In the vicinity of PRNS, a scattered population lives in the small towns of Inverness, Inverness Park, Olema, and Bolinas, Point Reyes Station and along Highway 1. Private development on and/or west of Highway 1, especially near Bolinas and western Inverness, occurs in or near high fuel densities in and beyond the project area representing public/private land interfaces across which the propagation of fire and/or smoke can be a serious threat.

Protecting public and firefighter health and safety, and protecting private and public property are primary goals of the FMP. In each of the alternatives, strategies to offer this protection include the use of prescribed burns and mechanical treatment, including firebreaks to limit the potential expansion of a future wildland fire. In addition to offering protection of property, this strategy would result in several smaller episodes of smoke, rather than a severe fire with severe smoke and pollutant emissions.

In 1993, the EPA adopted conformity regulations implementing Section 176 of the Clean Air Act, as amended. Section 176 requires that federal actions conform to state implementation plans for achieving and maintaining the national standards. Federal actions must not:

- Cause or contribute to new violations of any standard,
- Increase the frequency or severity of any existing violation,
- Interfere with timely attainment or maintenance of any standard,
- Delay emission reduction milestones, or
- Contradict State Implementation Plan requirements.

The conformity rule applies only in federal non-attainment areas. PRNS has historically ensured conformity by ensuring that all prescribed burning is planned and performed within the auspices of the BAAQMD Smoke Management Program.

Regional Climate

PRNS receives an average of 38.2 inches of rain annually. This amount is higher than much of the San Francisco Bay area due to the somewhat more elevated terrain along the coast. Most annual rainfall in Marin County occurs from November through March. The following general climate description is from “Climate, Physiography, and Air Pollution Potential – Bay Area and its Subregions (BAAQMD, 2003a)”:

“Areas along the West Coast of Marin County are usually subject to cool marine air. In the summer months, the marine air is cooled as it passes over the offshore upwelling region, and forms a fog layer along the coast. In the winter, proximity to the ocean keeps the coastal regions relatively warm. Temperatures do not vary much over the year at these coastal areas: high 50s in the winter and low 60s in the summer. The warmest months are September and October, which are in the mid to high 60s.”

“. . . Wind speeds are highest along the west coast of Marin, about 8 to 10 mph. Although most of the terrain throughout central Marin County is not high enough to act as a barrier to the marine airflow, the complex terrain creates sufficient friction to slow the airflow. Downwind, at Hamilton Air Force Base in eastern Marin County, the annual average wind speeds are only 5 mph. The prevailing wind directions throughout Marin County show less variation, and are generally from the NW.”

Figure 15 illustrates predominant wind patterns occurring in California (Bell, 1958). The predominant regional surface winds during winter flow from the north-northeast. During spring and summer, stronger north-northwest winds dominate. These northwesterly winds are primarily caused and/or strengthened by the combination of high pressure offshore and the warmer air inland. During the fall transition, when warm easterly winds break through to the coast while inland conditions remain hot and dry, the coastal region faces its most significant fire threat.

Project Area

Long-term average temperature and precipitation data have been collected at Bear Valley at the eastern part of the Point Reyes National Seashore (NPS, 2003). The Bear Valley monitoring station is the closest surface meteorological station to the project site. Surface climate data are presented in Table 8. Average temperatures (°F) during the summer vary from the high 40s to the low-to-middle 70s. Summer precipitation is low, averaging less than 0.2 inches per month, due to the strong stationary high-pressure system located off the coast and preventing weather systems from moving through the area. During the winter, average temperatures (°F) vary from the mid-to-upper 30s to the upper 50s-low 60s. About 84% of the precipitation in the area occur during November through March, generally in association with storm systems that move through the region.

Table 8. Temperature and Precipitation Data for Bear Valley- Point Reyes National Seashore, California

Month	Average Daily Temperature (°F) ^a			Average Precipitation
	Minimum	Maximum	Daily	(inches)
January	36.5	58.6	47.7	8.65
February	39.5	62.1	50.8	6.69
March	39.7	63.0	51.4	5.64
April	39.5	65.4	52.4	2.42
May	44.0	68.0	56.7	1.07
June	46.6	71.1	58.9	0.20
July	48.6	73.9	61.2	0.09
August	49.4	74.4	61.9	0.14
September	48.0	75.7	61.9	0.34
October	44.1	72.3	58.2	2.10
November	39.7	64.9	53.1	5.68
December	35.9	59.0	47.5	6.27
Annual Average	42.0	66.2	54.2	39.57 (total)

Source: Pt. Reyes National Seashore, 2003.

^aAverage temperature and precipitation data for 1964-1989.

Atmospheric stability and mixing heights are important parameters in determining pollutant dispersion. Atmospheric stability is a parameter that reflects the amount of atmospheric turbulence and mixing. In general, the less stable an atmosphere, the greater the turbulence, resulting in more mixing and better dispersion. Good ventilation results from deep vertical mixing and at least moderate wind speeds within the mixing layer.

The frequent occurrence of temperature inversions over the project area and its surroundings limits the air mixing height and, consequently, could concentrate air pollution levels near the ground. Mixing heights generally increase as the air temperatures increase, so that more dilution occurs during hot weather or the heat of the day. Enhanced vertical mixing typically accompanies the warm easterly fall winds that lead to the most significant fire threats in the project area. Pollutants are comparatively more concentrated near the ground during colder weather or after sunset. The marine dominated cool spring and summer conditions feature limited vertical mixing, but the cool moist conditions are not conducive to fire generation or

propagation. The air pollution potential in the region is moderated by the strong westerly winds most of the year.

The climate of the project area, along with much of the West Coast of the country, is controlled by a semi-permanent high-pressure system centered over the northeastern Pacific Ocean. The copious late fall through spring precipitation provides significant moisture. In the summer, the relatively northern location of this strong high-pressure system results in clear skies further inland and coastal fog. Very little precipitation occurs during the summer months because storm systems are blocked by the high-pressure system. Fog, humidity, and cool temperatures, though, help vegetation in the project area dry more slowly. Beginning in the fall, high pressure forming over the warmer inland areas breaks the summer pattern, introducing warm, dry winds from the northeast and east. These conditions lower vegetation moisture levels and significantly increase fire threat. Through the winter, the high-pressure system weakens and moves south, allowing storm systems to move through the area, replenishing the vegetation moisture levels and restarting the annual cycle.

Regional Air Quality

The project area lies within the Bay Area Airshed managed by the BAAQMD. Within California, compliance with federal and state AAQSs is determined by airshed. The BAAQMD encompasses urban, rural, coastal and inland settings. As would be expected, areas with high population density also tend to have higher ambient air quality impacts from stationary and mobile sources.

California AAQS standards are values that are generally not to be exceeded. Federal standards are not to be exceeded more than once per year. The attainment status of the BAAQMD with regard to the federal and state AAQSs is shown in Table 9.

Table 9. Ambient Air Quality Standards & Bay Area Attainment Status

Pollutant	Averaging Time	California Standards		National Standards	
		Conc.	Attainment Status	Conc.	Attainment Status
Ozone	8 Hour			0.08 ppm	<u>U</u>
	1 Hour	0.09 ppm (180 µg/m ³)	N	0.08 ppm (235µg/m ³)	<u>N</u>
Carbon Monoxide	8 Hour	9.0 ppm (10 mg/m ³)	A	9 ppm (10 mg/m ³)	<u>A</u>
	1 Hour	20 ppm (23 mg/m ³)	A	35 ppm (40 mg/m ³)	A
Nitrogen Dioxide	Annual Average			0.053 ppm (100 µg/m ³)	A
	1 Hour	0.25 ppm (470 µg/m ³)	A		
Sulfur Dioxide	Annual Average			80 µg/m ³ (0.03 ppm)	A
	24 Hour	0.04 ppm (105 µg/m ³)	A	365 µg/m ³ (0.14 ppm)	A
	1 Hour	0.25 ppm (655 µg/m ³)	A		

Pollutant	Averaging Time	California Standards		National Standards	
		Conc.	Attainment Status	Conc.	Attainment Status
Particulate Matter (PM10)	Annual Arithmetic Mean			50 µg/m3	A
	Annual Geometric Mean	30 µg/m3	N		
	24 Hour	50 µg/m3	N	150 µg/m3	U
Particulate Matter - Fine (PM2.5)	Annual Arithmetic Mean			15 µg/m3	U
	24 Hour			65 µg/m3	U
Sulfates	24 Hour	25 µg/m3	A		
Lead	Calendar Quarter			1.5 µg/m3	A
	30 Day Average	1.5 µg/m3	A		
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m3)	U		
Vinyl Chloride (chloroethene)	24 Hour	0.010 ppm (26 µg/m3)	No information available		
Visibility Reducing particles	8 Hour (1000 to 1800 PST)	(See note 7)	U		

NOTES

A=Attainment N=Nonattainment U=Unclassified

ppm=parts per million mg/m3=milligrams per cubic meter µg/m3=micrograms per cubic meter

Western Marin County Air Quality

BAAQMD, describing air pollution trends in Marin County in 2000, does not address western Marin but focuses on the principal traffic corridors.

“Air pollution potential is highest on the eastern side of Marin County. This is where the semi-sheltered valleys and largest population centers are located. Currently, most of the development has been along the bay, particularly in southern Marin. In the south, where distances to the ocean are short, the influence of the marine air keeps the pollution levels low. As development moves further north where the valleys are more sheltered from the sea breeze, it would encounter greater pollution potential (BAAQMD, 2003a).”

The only air pollution currently measured at Point Reyes is PM_{2.5}, small particulate aerosols that affect acid deposition and regional haze. Since no other ambient air pollutant is measured locally, air quality data were obtained from other BAAQMD monitoring stations within the Marin County Air Basin. The closest ambient air monitoring station to the project area is in San Rafael. However, as San Rafael is heavily urbanized, the data from that site would not be representative of the project area. Instead, data from the city of Santa Rosa (approximately 25 miles to the northwest) is used to represent background concentrations of particulate matter of 10 microns or less diameter (PM₁₀), carbon monoxide (CO), ozone (O₃), and nitrogen oxides (NO_x) for the project area. Data from the Vallejo station (approximately 30 miles to the east) is used for background sulfur dioxide (SO₂) (BAAQMD, 2003b). It is anticipated that actual ambient pollutant concentrations at the PRNS are lower than the background concentrations at Santa Rosa and Vallejo because the project area and surroundings feature less human and commercial activity and more steady onshore winds. However, the Santa Rosa and Vallejo monitoring station concentrations are used as conservative estimates.

In summary, the maximum 3-year average from the three most recent years (during 1999-2001) of $74 \mu\text{g}/\text{m}^3$ in Santa Rosa complies with the federal standard for ambient particulates smaller than 10 microns of $150 \mu\text{g}/\text{m}^3$, but does not meet the stricter California standard of $50 \mu\text{g}/\text{m}^3$. It is well below both the maximum one-hour and eight-hour average federal and state standards for carbon monoxide, and the state and federal one-hour (state) and annual average (federal) standards for nitrogen dioxide. Vallejo is also well below the federal and California maximum 24-hour and annual average standards for sulfur dioxide. Results for ozone are presented in Table 10 below.

Table 10. Ambient Ozone Standards and Levels at Santa Rosa: 1999-2001

	Federal Ambient Air Quality Standard	California Ambient Air Quality Standard	Maximum 3-Year Average 1999-2001	Compliant with Ambient Air Quality Stds
Maximum 1-Hour Average	0.12 ppm ($235 \mu\text{g}/\text{m}^3$)	0.09 ppm ($180 \mu\text{g}/\text{m}^3$)	0.10 ppm	---
Number of Days Exceeding California Standard (0.09 ppm; 1-hour avg.)	---	---	1	Federal: Yes California: No
Number of Days Exceeding Federal Standard (0.12 ppm; 1-hour avg.)	---	---	0	---
Maximum 8-Hour Average	0.08 ppm ($157 \mu\text{g}/\text{m}^3$)	---	0.08 ppm	Yes
Number of Days Exceeding Federal Standard Concentration	---	---	0	---

Note: The maximum ambient air quality average concentrations occurred in 1999.

Santa Rosa has exceeded the state's maximum 24-hour average of $50 \mu\text{g}/\text{m}^3$ twice over the three year period measured, and the California one-hour ozone standard once. The PM_{10} data in Table 10 reflects two exceedances of the California 24-hour AAQS. The area is in compliance with all other ambient air quality standards.

The annual ambient air quality standard for particulate matter in California is about to become more stringent, upon approval by the Office of Administrative Law. (Refer to Table 9, footnotes.) The affect this may have on future compliance status of the region remains to be seen. Further, the federal and California standards for particulate matter of $2.5 \mu\text{g}/\text{m}^3$ or less would be enforced pending sufficient baseline monitoring data collection, as determined by the U.S. Environmental Protection Agency. Currently, the $\text{PM}_{2.5}$ standard is not enforced. Project activities are expected to be minimally affected since all prescribed burning would continue to occur under the auspices of the BAAQMD Smoke Management Program, which would be planned and managed to ensure conformity with all applicable rules and regulations.

Project Area Air Quality

The federal and state $\text{PM}_{2.5}$ ambient air quality standards shown in Table 9 are proposed, but not yet in place. When fully implemented, the federal 24-hour standard will be attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard.

The NPS has been collecting PM_{2.5} data at the PRNS for several years. The most recent available years of data (1999 through 2001) indicate a daily average concentration of 8.330 µg/m³ or less averaged over these three years of data, well below the state and federal AAQs of 12 and 15 µg/m³ respectively. PRNS data available to date indicates 24-hour averages well below the proposed federal PM_{2.5} AAQS of 65 µg/m³.

Water Resources

The water resources within the project area include a significant number of perennial and intermittent streams, human-made impoundments, wetlands, natural lakes and sag ponds. The water resources support a variety of threatened and endangered species including coho salmon, steelhead trout, California freshwater shrimp, and California red-legged frog. Beginning in 2000, the NPS began surface water quality monitoring at 23 stream locations and three recreational ponds within 12 watersheds. Implemented in conjunction with fisheries monitoring efforts, the water quality program is focused on identifying water quality impacts to the aquatic ecosystems on NPS managed lands. Results indicated distinct differences in monitored water quality parameters between watersheds that supported dairying, ranching or wilderness. Of the water quality parameters measured, two in particular – Total Suspended Solids (TSS) and nitrogen - could be exacerbated by fire management activities, so data that has been gathered on the water quality of creeks in the project area will be important when considering potential affect.

Ash generated by fires is rich in nitrogen, a nutrient essential to biotic reproduction. Excess nitrogen in a water body can increase production of algae and aquatic plants. Decay of this excessive biomass can deplete a water body of oxygen and lead to fish kills. Ash is rich in nitrogen and could contribute to higher nutrients levels in stormwater runoff following burning. Following one year of water quality sampling, it was clear that at most of the 23 sites, current nitrogen levels, measured as nitrate and nitrite, were below detectable limits (>0.2 mg/l) (Ketcham, 2001). The exception was in one watershed supporting dairying operations.

The activities in the FMP could also result in increases in erosion. Localized compaction, removal of vegetation and burning all cause changes in the proportion of water infiltrating into soil to that which is surface runoff. Increases in rates and velocity of runoff can increase erosion, which in turn can lead to elevated levels of TSS flowing to wetlands, ponds, and creeks in the project area. TSS is made up of sediments and other materials suspended in the water column. High TSS is common during storms and flooding. Extremely high level of sediments can also injure fish by clogging their gills, obscuring the presence of food, or covering the gravel surface of spawning areas. All watersheds sampled for the Point Reyes National Seashore Water Quality Monitoring Report (Ketcham, 2001) had TSS that exceeds the recommended standard. Sampled watersheds were Lagunitas Creek, Olema Creek, Drakes Estero, Drakes Bay, and Pacific Drainages. Sediment data was not collected from the Bolinas Drainages, Pine Gulch Creek or Tomales Bay watersheds.

In addition to water quality, fire management activities can affect characteristics of a watershed. Individual watersheds are defined as the total area of land surface from which a body of water,

an aquifer or a river system collects its water. There are many scales of size by which watersheds can be defined; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

For purposes of planning for the management of NPS water resources, NPS staff scientists consider watersheds in relation to the extent of NPS resource management responsibility and the presence of sensitive biological resources. Overall, the NPS has management responsibility for portions of the Tomales Bay Watershed, the Lagunitas Creek watershed, the Pine Gulch Creek watershed, Bolinas Drainages, Olema Creek watershed, all of the Pacific Drainages (Kehoe, Abbotts Lagoon, etc.), Drakes Bay, and Drakes Estero watersheds. Study area watersheds are shown in relation to the 10 FMUs in Figure 16 and 6. Table 11 lists FMUs that either fully or partially within each watershed. This information is important in understanding how projects planned for distinct FMUs could potentially impact the same watershed.

Table 11. Percent of Project Area in Project Watersheds

Watershed	FMU	% of the Watershed in an FMU	Percent of FMU in Watershed
Tomales Bay	Inverness Ridge	1%	26%
	Limantour Road	3%	18%
	Tomales Point	6%	67%
	Wilderness North	4%	75%
		14% of watershed w/in FMUs	
Lagunitas Creek	Bolinas Ridge	3%	56%
		3% of watershed w/in FMUs	
Olema Creek	Bolinas Ridge	6%	25.446
	Highway One	14%	25%
	Wilderness South	8%	34%
		28% of watershed w/in FMUs	
Drakes Bay Drainages	Headlands	4%	52%
	Limantour Road	6%	20%
	Palomarin	0%	2%
	Wilderness North	3%	21%
	Wilderness South	11%	63%
		24% of watershed w/in FMUs	
Drakes Estero	Estero	9%	100%
	Inverness Ridge	5%	74%
	Limantour Road	14%	61%
	Wilderness North	0%	0%
		29% of watershed w/in FMUs	
Pacific Drainages	Headlands	4%	48%
	Tomales Point	9%	33%
		13% of watershed w/in FMUs	
Bolinas Drainages	Bolinas Ridge	3%	11%
	Highway One	7%	18%

Watershed	FMU	% of the Watershed in an FMU	Percent of FMU in Watershed
	Palomarin	23%	90%
		33% of watershed w/in FMUs	
Pine Gulch Creek	Bolinas Ridge	3%	7%
	Highway One	20%	35%
		23% of watershed w/in FMUs	

Roughly 200 square miles of western Marin County drains to Tomales Bay, including Olema and Bear Valley creeks. For the FMP, this large drainage basin is split into its constituent subwatersheds to allow for a more detailed scrutiny of potential effects to sensitive resources located in distinct parts of the greater drainage area. Olema Creek and Lagunitas Creek are addressed as separate watersheds and the Tomales Bay Watershed itself is limited to the 45 square miles of land encircling the Bay (see Figure 16). The following descriptions characterize water quality in each FMP watershed in the study area.

Tomales Bay Watershed. The NPS manages approximately 28% or 13 square miles (8,266 acres) of the 45 square mile (29,219 acres) Tomales Bay Watershed shown on Figure 16. The remainder of the watershed lands is privately managed by either the Marin Municipal Water District or California State Parks, or privately held land. Tomales Bay and Drakes Estero are home to a number of oyster production operations accounting for nearly 35% of the oyster production in the state of California. The San Francisco Bay Regional Water Quality Control Board (RWQCB) has listed Tomales Bay and its major watersheds, Lagunitas Creek and Walker Creek, as impacted by sediment, nutrients, and pathogens under Section 303 (d) of the Clean Water Act. In addition, the RWQCB has also listed Tomales Bay and Walker Creek as impaired by mercury. The RWQCB is required by the EPA to develop and implement TMDLs for each pollutant parameter by 2010. FMP actions that could increase erosion have the potential to affect sediments and nutrients levels of Bay waters. Portions of the Inverness Ridge, Limantour, Tomales Point and Wilderness North FMUs are located in the Tomales Bay Watershed.

Lagunitas Creek Watershed. The northern portion of the Bolinas Ridge FMU is in the northwestern portion of the Lagunitas Creek watershed. The 83-square mile watershed that drains to the head of Tomales Bay provides much of Marin County's drinking water through the Marin Municipal Water District. Four dams with storage in excess of 60,000 acre-feet on Lagunitas and Nicasio creeks have significantly altered the hydrology and ecology of these creeks. The dams have also eliminated nearly two thirds of the spawning habitat of populations of the coho salmon and steelhead trout, listed as threatened species under the Endangered Species Act. Other federal threatened and endangered species in the watershed include the California red-legged frog and California freshwater shrimp.

Olema Creek Watershed. The 14.5 square mile (37.5 square kilometers) Olema Creek watershed supports viable populations of coho salmon and steelhead trout. The Creek also supports California red-legged frogs. Approximately 90% of the lands in the Olema Creek Watershed are managed by the NPS. Olema Creek has been the subject of extensive monitoring to determine

the effectiveness of various stream protection measures – including riparian exclusion fencing and habitat restoration. Water quality sampling by the NPS found elevated levels of TSS in this watershed. The source of the elevated sediment levels may be soils disturbed by instability along the San Andreas fault zone, due to past logging, and a result of past and current agricultural land uses within the watershed.

Drakes Bay Watersheds. Drakes Estero and the Estero de Limantour comprise a complex estuarine system capturing flow from more than 13.5 square miles (35 square kilometers) and draining through the Estero inlet. Steelhead trout are found in several of the contributing creeks draining to this watershed including Laguna, Muddy Hollow, Glenbrook, Home Ranch, East and North Schooner Creek. Several smaller creeks are characterized as rather small, steep drainages that discharge directly to the beach. The Estero is susceptible to nutrient and other inputs from grazed lands within the watershed and increased sediments from areas burned during the Vision Fire. Water quality monitoring by the NPS found the indicators for these potential pollutants currently within acceptable levels.

Pacific Ocean Watersheds. The primary watersheds draining to the open ocean are from the north, and include McClures, Kehoe North, Kehoe South, E Ranch and Lighthouse. There are a significant number of smaller drainages north of Kehoe Beach that empty into the ocean such as Elk Fence, and others. There are a number of intermittent dune watersheds that are not included in this list but occasionally drain to the ocean across the ten-mile beach. North and South Kehoe Creeks converge approximately ¼ mile upstream of Kehoe Lagoon.

The Abbott's Lagoon watershed drains across gently sloping terrain and into a unique lagoon environment. A human-made pond and a dual chambered lagoon separated by a bedrock sill provide a unique combination of brackish and freshwater environments in a system that often has the same surface water elevation. The lagoon does not breach regularly remaining closed for years at a time.

Water quality monitoring, as part of a focused study by the USGS in partnership with the NPS, is underway in Abbott's Lagoon to address pollutants flowing and develop prevention or reduction strategies. Current approximately 6.1% (or 188 acres) of the lands within the Abbotts Lagoon watershed is responsible for contributing most of the increased nutrient levels to the lagoon. Plans are proposed to construct facilities at a dairy within these lands that would reduce the levels of nutrients, sediments and pathogens flowing to the lagoon.

Bolinas Drainages. The Bolinas drainages include Double Point, Arroyo Hondo, and RCA. Following the major drought (1976-77) the NPS allowed the Bolinas Community Public Utilities District to enact their appropriated water right from Arroyo Hondo, in order to protect stream flow and habitat in the Pine Gulch Creek Watershed. The upper watershed of Arroyo Hondo Creek are located within the Philip Burton Wilderness and are managed as a Public Water Supply Watershed.

Pine Gulch Creek Watershed. Pine Gulch Creek is the largest watershed draining to Bolinas Lagoon. The Creek supports coho salmon, steelhead trout, and the California red-legged frog. Approximately 85% of the lands in this watershed are managed by the NPS. Of all the project

watersheds, Pine Gulch Creek was historically the most heavily logged and erosion from the past logging activities has been contributing sediment to Bolinas Lagoon for roughly 100 years. The lagoon is now the subject of an intensive restoration plan process coordinated through Marin County and the US Army Corps of Engineers exploring dredging to restore tidal prism. Important watershed management issues in the study are the protection of the stream and lagoon from additional sedimentation and deposition.

Impoundments, Natural Lakes, and Sag Ponds

The project area contains more than 75 impoundments and many are known to support the California red-legged frog. Most of these facilities were constructed by former landowners for stock watering or development. The condition of these many of these ponds is not well known and the stability of many is likely compromised by the presence of brush and trees on the dam structure. Activities conducted near pond facilities would protect pond edges and dam structures when planning specific prescription burns or mechanical fuel reduction projects.

Within the Olema Valley, a number of naturally occurring sag ponds associated with the San Andreas Fault provide unique aquatic habitat. The southwestern part of the project area, from Palomarin to Double Point is dotted with ponds and lakes derived from massive slope failure events. These water bodies, such as Bass, Pelican, and Crystal Lake are naturally occurring.

Vegetation

PRNS owes much of its distinctive character to the assemblage of plants that occur on the Peninsula. Plant communities create patterns that reflect the underlying geologic formations and soils and the influence of a moist, maritime climate. PRNS is known to support over 910 plant species. Fifty-five of these are of management concern (see Table 12 and 13) in Special Status Species) and include the federally-listed endangered beach layia (*Layia carnosa*), Tidestrom's lupine (*Lupinus tidestromii*), Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*), Sonoma spineflower (*Chorizanthe valida*) and robust spineflower (*Chorizanthe robusta*). Of the 910 plant species, roughly one third are not native to the area.

Vegetation in the project area has been subject to human activities for 7,000 - 10,000 years, a time evidence suggests is concomitant with the first occupation of the area by the Coast Miwok. Although data are not available on the effects of Miwok activities on vegetation, it is assumed that they gathered plants for food and for shelter materials, and probably used fire to manipulate the growth of plant species. Beginning in the mid-nineteenth century and continuing into the present, activities such as land clearing, timbering, cultivation, cropping, road building, commercial development and livestock grazing have markedly affected the vegetation.

For purposes of analysis, the 90,311-acre project area has been divided into 9 broad vegetation types. Acreage estimated for each type in the project area and brief descriptions are presented below. Acreage was estimated from the Point Reyes vegetation map and is rounded to the nearest 100 acres. Vegetation types correspond most closely to the community level in the vegetation map classification hierarchy.

Table 12. Acres Within Each General Vegetation Class Within Each Fire Management Unit

Vegetation Class	Bishop Pine Forest	Douglas-fir/Coast Redwood Forest	Hardwood Forest	Monterey Pine/Monterey Cypress	Riparian Woodland	Coastal Scrub	Grass-land	Pasture	Coastal Dune	TOTAL
Tomales Point	0	0	24.9	5.6	64.3	1518.9	1006.7	0	12.5	2632.9
Headlands	0	0	0	0	1.8	400.7	299.4	38.1	51.3	91.3
Estero	2.2	0	5.3	37.0	37.9	520.2	913.1	16.9	0	1532.6
Inverness Ridge	646.3	55.7	12.5	0	46.2	245.6	143.8	84.4	0	1234.5
Limantour Road	140.9	748.4	216.9	12.1	371.5	2,040.3	462.2	13.6	0.2	4006.1
Wilderness North	0	1,262.3	103.5	0	4.0	130.6	88.4	0	0	1588.8
Wilderness South	0	1,673.3	128.0	0	54.0	303.6	85.5	0	0	2244.4
Highway One	0	719.3	771.1	0	112.4	421.6	797.4	8.8	0	2830.6
Bolinas Ridge	0	755.4	570.0	0	5.9	203.4	846.7	0	0	2381.4
Palomarin	0	624.3	92.2	0.08	58.4	889.0	190.2	0.1	0	1854.3
TOTAL	789.4	5,838.7	1924.4	54.78	756.4	6,673.9	4,833.4	161.9	64	21096.9

Bishop Pine Forest (3,700 acres). Bishop pine (*Pinus muricata*) is the dominant tree species in the forest/woodland community found on the northern portions of Inverness Ridge. Madrone (*Arbutus menziesii*), tanoak (*Lithocarpus densiflorus*), coast live oak (*Quercus agrifolia*) and California bay (*Umbellularia californica*) are often present in significant cover. Huckleberry (*Vaccinium ovatum*) is important to dominant in the shrub layer. Other species common in the understory include salal (*Gaultheria shallon*) and swordfern (*Polystichum munitum*). Stands of Bishop pine tend to be even-aged, usually originating after a stand-destroying fire. In the project area, approximately 65% of the Bishop pine forest is mature; the remaining 35% of the total forest area burned in the Vision Fire. The areas burned in 1995 are characterized by a patchwork of extremely dense stands of 12 to 15 foot tall, regenerating pines alternating with extremely dense stands of blue blossom (*Ceanothus thrysiflorus*) and Marin manzanita (*Arctostaphylos virgata*).

This vegetation type also includes a small amount of non-native Monterey pine (*Pinus radiata*) and Monterey cypress (*Cupressus macrocarpa*) stands, amounting to less than 5% of the total forest/woodland acreage. These stands are characterized by planted groves dominated by either

tree species, invasive in some areas, usually with sparse to low shrub and herbaceous cover. The understory species in these stands are often non-native.

Bishop pines are limited in distribution, and occur only in relict stands in California, from Humboldt to Santa Barbara counties, on Santa Cruz and Santa Rosa islands, and in isolated populations south to central Baja. Vegetation mapping in the park indicates approximately 3,570 acres of Bishop pine forest occurring within Seashore boundaries. In 1995, approximately 35% (1,250 acres) of this acreage was burned in the Vision Fire. Following the fire, most of the pines in the area were dead and the formerly deep litter layer had been burned away. The bare, charred soil was covered with extremely large numbers of Bishop pine seeds. Regeneration in the burned area has been prolific, with dense stands of young Bishop pine growing up to replace the burned forests. One year following the fire, large dense patches of Bishop pine had recolonized the burned area.

Fire plays an important ecological role in maintaining Bishop pine forests. Stands of Bishop pine are characteristically even-aged, originating after fires, and their cones persist for many years, usually opening as a result of fire. Bishop pine stands are often dense, and stand-replacing crown fire typically occurs in such stands. It is hypothesized that a fire-free period of 80+ years would allow trees to succumb to diseases and die without reproducing. Bishop pine is susceptible to rust gall infection and to secondary fungal infections.

Douglas-fir/Coast Redwood Forest. The Douglas-fir (*Pseudotsuga menziesii*) and Coast redwood (*Sequoia sempervirens*) forest is the most common forest type in the project area. The forests reach a maximum height of 165 to 230 feet (50-70 meters) in the project area. Approximately 90% of this type of forest in the park is dominated by Douglas-fir while the other 10% is primarily redwoods.

In the project area, the Douglas-fir-dominated forest is characterized by a strong component of hardwood trees, usually California bay (*Umbellularia californica*), but tanoak (*Lithocarpus densiflorus*) or individual coast live oaks (*Quercus agrifolia*) may be present. The shrub understory is highly variable, but is usually moderate to very dense. Coffeberry (*Rhamnus californica*), huckleberry (*Vaccinium ovatum*), California hazel (*Corylus cornuta*), poison oak (*Toxicodendron diversilobum*) and coyote brush (*Baccharis pilularis*). Swordfern (*Polystichum munitum*) often dominates the herbaceous layer.

In those areas where redwood is the dominant tree in the forest canopy, tanoak is often a significant component, sometimes co-dominating with redwood. California bay or Pacific madrone (*Arbutus menziesii*) are also often present in significant cover. California hazel and huckleberry are the most common understory shrubs, with shrub cover usually sparse to moderate. Sword fern may dominate the herbaceous layer.

Because this vegetation type is typified by its two dominant species, each is described in more detail below.

Douglas-fir (*Pseudotsuga menziesii*)

Coast Douglas-fir is a large, coniferous, evergreen tree. Trees 5 to 6 feet in diameter and 250 feet or more in height are common in old-growth stands. Trees often live more than 500 years and occasionally more than 1,000 years. Douglas-fir is shade intolerant and requires stand-destroying disturbance (e.g., wildfire, logging, extensive windthrow) to initiate a new cohort of seedlings. This species is extremely long-lived. Stands 350 to 750 years old are subclimax and may contain a significant component of Douglas-fir for several more centuries. Without disturbance, these stands will give way to shade-tolerant associates such as western hemlock, western red cedar, and Pacific silver fir, but it may take 1,000 or more years for Douglas-fir to be fully replaced. This longevity allows Douglas-fir to persist until the next disturbance, ensuring a seed supply for postdisturbance establishment.

Coast Douglas-fir can survive moderately intense fires. Thick, corky bark on the lower bole and roots protects the cambium from heat damage. In addition, tall trees have their foliage concentrated on the upper bole, which makes it difficult for fire to reach the crown; however, it should be noted that trees are typically not free of lower branches up to a height of 33 feet until they are more than 100 years old. Additionally, many stands in the project area have substantial ladder fuel accumulations, which could result in crown fire.

Crown fires will commonly kill Douglas-fir trees over extensive areas. Rapidly spreading crown fires inflict damage to crowns, while slow spreading ground fires damage the boles and kill trees through cambial heating. Early or mid-summer fires are more damaging than late summer or fall fires because more buds are killed through crown scorching. During late summer buds are set and subsequent year needles are well-protected. Seedlings and saplings may be killed by even low intensity ground fires. Most seeds on the forest floor are killed by fire, but green cones are relatively well insulated and are not highly flammable. If cones are just scorched in a fire, seeds can mature in the cones and disperse onto the burned area.

Coast Redwood (*Sequoia sempervirens*)

Coast redwood is endemic to northern California and southwestern Oregon coastal areas. The trees occur on a narrow strip of land approximately 450 miles long and 5 to 35 miles wide. Coast redwood is a native, evergreen, long-lived (greater than 2,200 years) tree. Redwoods are among the world's tallest trees; trees over 200 feet are common, and many are over 300 feet. The largest tree measured to date was 364 feet tall and 20 feet in dbh. The tree's root system is composed of deep, widespreading lateral roots with no taproot. The bark is up to 12 inches thick and quite fibrous. Redwood self-prunes well in dense stands, and the base of the bole is strongly buttressed.

Hardwood Forest. This type of forest is comprised of hardwood species such as California bay (*Umbellularia californica*), coast live oak (*Quercus agrifolia*), eucalyptus (*Eucalyptus globulus*), tanoak (*Lithocarpus densiflorus*), madrone (*Arbutus menziesii*), and giant chinquapin (*Chrysolepis chrysophylla*). California bay is by far the most abundant, comprising roughly 75% of trees in this type of forest. Coast live oak makes up about 20%; these two species often associating with each other. Of the remaining forest, less than 5% is eucalyptus, and tanoak, madrone and giant chinquapin each comprise less than 1% of tree densities

California bay forest canopy is dominated by California bay or co-dominated by bay and coast live oak with each species comprising 30-60% relative canopy cover. Tanoak, Douglas-fir (*Pseudotsuga menziesii*) and California buckeye (*Aesculus californica*) may also have a significant presence. The understory is variable; it can be a moderately dense shrub understory often dominated by hazel (*Corylus cornuta*), coffeeberry (*Rhamnus californica*), elderberry (*Sambucus racemosa*) and/or poison oak (*Toxicodendron diversilobum*). If there is no significant shrub cover, swordfern (*Polystichum munitum*) usually dominates understory.

Coast live oak woodlands are dominated by coast live oak usually with a significant component of California bay, sometimes co-dominating with bay. Individual Douglas-firs may be present. Understory is usually open to moderate with poison oak being the most commonly found shrub, often fairly high in cover. Coffeeberry, coyote brush (*Baccharis pilularis*), toyon (*Heteromeles arbutifolia*) and hazel can be present. Herbaceous cover is usually low.

California Bay (*Umbellularia californica*)

California bay occurs in the Klamath, Siskiyou, and Coast Ranges from Douglas County, Oregon south to San Diego County, California, and on the western slope of the Sierra Nevada from Shasta County south to Kern County. It grows along drainages in California's Central Valley. It occurs from sea level to 4,000 feet in northern California and Oregon and from 2,000 to 5,000 feet in southern California.

A highly branched native evergreen tree, California bay grows from 40 to 80 feet tall. It grows in scrub form on poor sites. California bay begins reproducing by seed at 30 to 40 years. Seed crops are abundant in most years. Germination and establishment are favored in riparian areas where seed is buried by silt deposition or high water. Seedlings are good competitors against other species and grow under moderately dense canopies. Seedling recruitment, however, is poor under other California bay trees. California bay sprouts from the root crown, bole, or stump.

Coast Live Oak (*Quercus agrifolia*)

Coast live oak occurs along the Coast, Transverse, Peninsular, and Sierra de Juarez ranges from Mendocino County, California, south to Baja California. Limited inland populations occur along watercourses in California's Central Valley. Coast live oak also is found on the Channel Islands of Santa Rosa and Santa Cruz.

Coast live oak is a frequent dominant or codominant in mixed evergreen forests in the project area where it grows with tanoak, Pacific madrone, California bay, and coast Douglas-fir. Elevations of coast live oak populations range from sea level to 3,000 feet in central and northern California.

Coast live oak is a drought-resistant, evergreen tree, ranging from 19 to 82 feet tall and from 1 to 4 feet in diameter. The bark of young trees is smooth, and it develops deep furrows and ridges with age. The inner bark and cork layers are thick. Open-grown crowns are broad and dense, with foliage often reaching the ground. In open areas trunks are usually 4 to 8 feet tall; at this height, primary branches originate and grow horizontally. Coast live oak stands are typically

from 40 to 110 years old, and individual trees may live over 250 years. Coast live oak may grow where it can access groundwater, but most individuals have extensive shallow root networks.

Ecologists refer to changes in the grassland, chaparral, and oak woodland mosaic of California as “non-directional fluctuations” rather than succession. Coast live oak may be considered seral or climax depending on habitat, but it is tolerant of shade throughout its life. Because deer and cattle prefer coast live oak, it is gradually replaced by California bay in some areas of coastal northern California where the two species codominate.

In burned or logged mixed evergreen forest, a coast live oak phase is seral to the climax forest. However, on steep slopes or poor sites within this habitat type, coast live oak represents a topographic or edaphic climax. In the San Francisco Bay area coyote brush invades grasslands, and coyote brush subsequently facilitates coast live oak woodland development. In the absence of disturbance, coyote brush scrubland almost always gives way to coast live oak and California bay, as coyote brush seedlings do not develop beneath their own canopies.

Coast live oak is exceptionally fire resistant. Adaptations include evergreen leaves, thick bark, and sprouting ability. Evergreen leaves allow this species to allocate greater amounts of energy to recovery from fire than to replacing the entire crown annually. Evergreens are often better able to conserve nutrients than deciduous species, and are favored in fire-prone environments. Coast live oak bark is the thickest among California oaks. Oaks are more likely to be damaged by fall fire than earlier fires. Because of mortality among small-diameter trees, frequent fire limits coast live oak invasion of grasslands.

Eucalyptus (Eucalyptus spp.)

Eucalyptus is notable because it is an invasive non-native hardwood species in the park, and would be treated in some alternatives by thinning and herbicide application to prevent stump resprouting. Eucalyptus forests are dominated by the non-native Blue gum eucalyptus which have been planted in or have invaded native plant communities. Eucalyptus is usually highly dominant in the canopy. Monterey pine (*Pinus radiata*)/Monterey cypress (*Cupressus macrocarpa*) or individuals of Douglas-fir, California bay or coast live oak may be present. Understory is usually sparse often including remnants of the native community. Poison oak and non-native or native berries (*Rubus spp.*) are common shrubs. Other non-native shrubs and herbs are often present in low cover. The floor of the eucalyptus forests is characterized by a thick layer of litter made up of bark, seedpods, leaves and branches.

Monterey Pine/Monterey Cypress (Pinus radiata/Cupressus macrocarpa)

Monterey pine is an evergreen conifer. The typical variety of Monterey pine occurs along the California coast in three disjunct populations in San Mateo, Santa Cruz, Monterey, and San Luis Obispo counties. The Monterey pine trees in the project area were introduced.

Monterey pine is cultivated for timber in numerous countries. Much of the Monterey pine planted as ornamentals comes from New Zealand stock. This stock originated from native California populations several generations ago. In Cambria and Monterey, California, this imported stock is crossbreeding with native individuals. Monterey pine also hybridizes with

knobcone pine and Bishop pine. The genetic effect of this crossbreeding on native trees is unknown, and preserving genotypes of native individuals is of management concern.

Monterey pine attains a height of 49.5 to 115.5 feet and a dbh of 24 to 36 inches. The tree's outer bark is narrowly ridged and the inner bark is resinous. The needles occur in clusters of three and are 4 to 6 inches long. They persist for approximately three years. Cones are 3 to 5.5 inches long and occur in one or more clusters of three to five around the branch. Monterey pine lives a maximum of 80 to 90 years.

The minimum seed-bearing age for Monterey pine is between 5 and 10 years. Maximum seed production begins at 15 or 20 years of age if trees are open-grown, and later if stands are dense. Cones are produced annually, with good cone crops produced every other year. Mature cones remain attached to the branch. They may remain closed for several years, depending on temperature and humidity. Cones open and release seed during warm, dry periods and close rapidly when temperature drops and relative humidity increases. Seedfall is heaviest in warm, dry years. Unreleased seed remains viable for decades. Seeds from cones up to 24 years old have germinated; but germination appears to fall off with progressing years. Seedling recruitment is best on mineral soil. Monterey pine does not reproduce by sprouting.

Monterey pine cones are serotinous; seeds are released when cones are exposed to heat such as fire or high air temperature. Fire is particularly effective for opening cones and releasing seeds and it creates a favorable seedbed. Reproduction rates are greatest after surface fire in which the parent trees survive. Monterey pine is killed by severe surface or crown fire. Trees survive crown scorch, however, unless it is extensive. Young, thin-barked Monterey pine are often killed by fire, particularly when stands are dense and crown fire occurs.

Monterey cypress (*Cupressus macrocarpa*) occurs in two natural stands in Monterey County, California. One stand is between Point Cypress and Pescadero Point on the north side of Carmel Bay, Monterey Peninsula. A smaller one is near Point Lobos on the south side of Carmel Bay. Monterey cypress is widely planted and naturalized on the California coast. The Monterey cypress in the project area were introduced.

Monterey cypress is an evergreen tree that grows to 82 feet tall. The bark is thick and fibrous, becoming furrowed with age. A well-defined taproot and numerous laterals are formed the first year. Naturalists at the Point Lobos State Reserve have estimated the maximum age of Monterey cypress at 200 to 300 years.

Riparian Woodland. These streamside forests and shrublands are dominated by broad-leaved deciduous trees or shrubs such as red alder (*Alnus rubra*), mixed willows, and arroyo willows (*Salix lasiolepis*). Red alder forest is the most abundant of this type comprising approximately 70% of riparian areas. Understory is usually moderate to dense. Berry species (salmonberry- *Rubus spectabilis*, thimbleberry- *R. parviflorus*, California blackberry- *R. ursinus*) and red elderberry (*Sambucus racemosa*) are the common shrubs. Hedgenettle (*Stachys ajugoides*), sedges (*Carex spp.*), rushes (*Juncus spp.*), small-fruited bulrush (*Scirpus microcarusp*) and ferns (sword fern- *Polystichum munitum*, lady fern- *Athyrium felix-femina*) dominate the herbaceous layer.

Other forested riparian areas are dominated by mixed willow forest, represented in the project area by yellow willow (*Salix lucida*), often associating with other willows. Mixed willow forest makes up less than 5% of riparian areas.

Arroyo willow shrublands make up approximately 25% of the riparian type. Arroyo willow in its shrub form stands between 16 and 23 feet high (5 to 7 meters), and strongly dominates the canopy. Other taller willows or alder may be present in small quantities. The understory is usually extremely dense because of the thicket-forming growth habit of this species. Shrubs such as berry species (*Rubus parviflorus*, *R. spectabilis*, *R. ursinus*) are most commonly found woven through the understory. Wax myrtle (*Myrica californica*) or poison oak (*Toxicodendron diversilobum*) may be present. Sedges, rushes, small-fruited bulrush along with hedgenettle, beeplant (*Scrophularia californica*) and the ferns (Lady fern, bracken fern- *Pteridium aquilinum*) dominate the herbaceous layer. Because they are dominant species in PRNS riparian woodlands and shrublands, red alder and arroyo willow are described in more detail below:

Red Alder (*Alnus rubra*)

Red alder occurs from southeast Alaska to southern California. Red alder communities were primarily restricted to streams and wet areas during presettlement times. Since then, disturbances such as logging have provided an abundance of open sites with bare mineral soil, which favor red alder colonization.

Red alder grows in humid coastal climates characterized by cool wet winters and warm dry summers. Trees need more than 25 inches of precipitation annually, and most stands receive over 40 inches. Red alder is a rapidly growing, short-lived, medium-sized, deciduous tree, generally with one straight distinct trunk. It reaches a maximum height of about 120 feet, with a maximum trunk diameter of about 32 inches. Mature trees are typically from 80 to 100 feet tall and 14 to 18 inches in diameter. Maximum age is one hundred years.

Red alder regenerates primarily by seed. Plants are monoecious and primarily are wind pollinated. Flowering generally occurs from late February to early May depending on latitude and climate.

Seed dispersal begins soon after ripening in late summer, but most seeds are shed during fall and winter. The seeds are very lightweight and are normally carried up to several hundred yards in the direction of the prevailing winds. Seed production begins at about 10 years (but sometimes sooner), and continues throughout maturity, with optimum production at about 25 years of age. A prolific seeder, red alder produces peak crops about every four years, with moderate to light crops produced in between. Total seed crop failure is very rare.

Germination is best on moist mineral soil in full sunlight. Seed also germinates well on rotten wood and duff, and to a lesser extent on soil organic horizons and on rock-surfaced logging roads, but the roots must quickly reach a moist nutritious substrate if seedlings are to survive. Sunlight is required for germination. Seeds under thick vegetation or buried deeply in the soil, will not germinate until the site is disturbed, exposing the seeds to sunlight. Germination percentages range from 59 to 84 percent. Seeds remain viable in storage for about three years.

Red alder is an early seral species. It quickly invades forest openings, such as those created from fires, logging, wind throws, or road cuts, and it also pioneers volcanic mud flows. Plants often reach 6 to 18 inches in 1 year and may reach 18 feet in 5 years. This rapid juvenile growth gives the shade-intolerant red alder a competitive edge over conifers, as it quickly overtops them.

Red alder and Douglas-fir are reported as the principal pioneer tree species of lower and middle elevation forests from southwestern British Columbia to northwestern California. Thus they often dominate the first postfire community. Disturbed areas are naturally seeded, resulting in stands that start out with several thousand alder trees per acre. Due to red alder's shade intolerance, stands are self-thinning; trees that do not maintain their height in the canopy die, resulting in even-aged stands. Conifers such as Douglas-fir that become established at the same time are quickly overtopped by this extremely fast growing species. These early seral red alder communities suppress competing conifers, but after about 25 years, conifers equal red alder height and begin to overtop them. After about 40 years, Douglas-fir becomes dominant. Few red alder trees remain in stands past 60 years. As stands develop and trees mature, they prevent other red alder seedlings from becoming established, due to the seedlings' shade intolerance.

Information regarding the effects of fire on red alder generally is lacking. Red alder's bark, although thin, is sufficiently fire resistant to protect trees from light surface fires. The foliage and leaf litter do not carry fires well. Red alder stands often lack flammable understory debris and are often on moist sites which burn infrequently. Red alder revegetates burned areas via seed from off-site plants.

Red alder quickly invades burned areas. Off-site plants inhabiting fire resistant draws and streambeds provide an abundance of seed, which reportedly can travel several hundred yards via wind. Thus red alder quickly colonizes soils exposed after forest fires. Information regarding the sprouting response of red alder after above-ground plant parts have been killed by fire is lacking. However, response after cutting shows that red alder tends to sprout at the root collar or along the lower stem no matter where the stem is cut. Fire hazard is generally low in red alder stands and stands may be used as natural firebreaks.

Arroyo Willow (*Salix lasiolepis*)

Arroyo willow is a common shrub or small tree (<10 m tall) that occurs in streambeds and on riverbanks below 7000 feet. It occurs in the western United States, from Washington and Idaho south to Texas and Mexico. This species is abundant along shorelines, marshes, meadows, and springs. Flowers are produced from February to April.

Most willows resprout from the root crown or stem base following fire. Severe fires can completely remove organic soil layers, however, leaving willow roots exposed and charred, thus eliminating basal sprouting. Severe fires probably occur infrequently in the moist habitats occupied by arroyo willow. Generally, willows tend to be prolific seeders, and off-site plants are important as a seed source for revegetating burned areas.

Coastal scrub is a highly variable vegetation type including all of the shrublands of the study area and a small amount of chaparral. Coastal scrub is one of the most widespread plant community

types in the project area and is present to some degree in all FMUs. Approximately 90% of coastal scrub is dominated by coyote brush (*Baccharis pilularis*), a small-leaved evergreen shrub. Because it is dominant, it is discussed in more detail below. Coyote brush scrub is highly diverse and variable, ranging from fairly low open areas where coyote brush associates with grasses, to tall dense multi-species scrubs. Coyote brush scrub can be roughly equally divided in the project area between these open and dense variations. In its more open variation, coyote brush commonly associates with non-native and native grasses and California blackberry (*Rubus ursinus*). It may also be found in association with sedges (*Carex spp.*) and rushes (*Juncus spp.*). In its taller, denser variation, poison oak (*Toxicodendron diversilobum*) is the most commonly associating shrub, often in fairly high cover. Coffeeberry (*Rhamnus californica*), thimbleberry (*Rubus parviflorus*), California blackberry and California sagebrush (*Artemisia californica*) are common associates in dense coyote brush scrub.

An additional 5% or so of coastal scrub is dominated by a diverse list of shrub species that includes coffeeberry, yellow bush lupine (*Lupinus arboreus*), hazel (*Corylus cornuta*), and blue blossom (*Ceanothus thrysiflorus*).

Chaparral accounts for less than 5% of the coastal scrub type. The manzanitas (*Arctostaphylos spp.*), primarily Eastwood manzanita (*Arctostaphylos glandulosa*) and chamise, (*Adenostoma fasciculatum*) are the dominant shrubs here. These evergreen species tend to be in the hotter, drier areas with the largest occurrences in the project area found on the western slope of Bolinas Ridge and within the Vision Fire burn area on Inverness Ridge.

Coastal sage and coastal scrub community types are fire-dependent, with prominent shrubs establishing by seed and sprouting. They are flammable vegetation types that may burn again 1 to 2 years after fire if dry conditions exist. With fire in less than 5-year intervals, or with overgrazing, coastal scrub generally reverts to annual non-native grassland. Fire exclusion in coastal sage scrub and mesic chaparral communities allows coast live oak, California bay, and other shade tolerant species to increase in density and reduce understory diversity and abundance. In the absence of fire, coast live oak recruitment in chaparral and grassland is commensurate with their aerial extents; in coastal sage scrub, however, coast live oak recruitment exceeds that expected by chance alone. This is primarily because coyote brush is a nurse shrub for shade-tolerant tree seedlings, particularly coast live oak and California bay. With tree development, coyote brush is reduced or excluded.

Coyote brush (*Baccharis pilularis*)

Coyote brush occurs in the outer Coast Ranges from northern Baja California, Mexico, and San Diego County, California, north to Tillamook County, Oregon. The species occurs in the Channel Islands and as isolated populations in the Cascade and Sierra Nevada foothills from Butte County to Tuolumne County, California. It is a dominant shrub in northern coastal scrub communities and a minor component of coastal beach communities, coastal sage scrub, chaparral, foothill woodlands, closed-cone pine forests, and mixed-evergreen forests.

Coyote brush grows a taproot up to 10.5 feet long; lateral roots are also well developed. Individuals live 10 to 15 years, but basal sprouting and layering may extend this lifespan. Seeds germinate well on mineral soil and have no stratification or temperature requirement. Most

germination occurs within about 15 to 30 days. Coyote brush sprouts from the root crown and roots. It may also grow roots where branch nodes contact soil.

Coyote brush is shade-intolerant. Along with other small-seeded coastal sage shrubs, it colonizes actively eroding or alluviating areas such as dunes and gravel bars. Exposed mineral soil gives coyote brush an advantage over perennial grasses and chaparral shrubs. Coyote brush's successional status varies with habitat type. In California grasslands, it is a late seral species that invades and increases in the absence of fire or grazing. Coyote brush invasion of grasslands is of structural importance because it facilitates the establishment of other coastal sage species. Shrub cover subsequently increases numbers of rabbits and small mammals that reduce herbaceous vegetation and favor shrub development. Thus, well-established coyote brush stands generally have depauperate understories. Coyote brush is a common dominant in coastal sage scrub, but because seedling growth is poor in shade, coyote brush does not regenerate under a closed shrub canopy. Coast live oak, California bay, or other shade tolerant species replace coastal sage scrub and other coyote brush-dominated areas, particularly when fire and grazing are excluded. Generally the transition from coyote brush-dominated scrub to mixed evergreen forest takes place in about 50 years and is reversible with periodic fire.

Coyote brush is moderately fire tolerant. In areas of high shrub density, heat at root crowns is often too low to cause mortality, and coyote brush is able to resprout. Fires in such communities reduce crown cover but are not likely to reduce shrub density. Fires that occur in areas with low shrub density and high herbaceous biomass create enough heat at the root crown to girdle and kill plants. In oak woodlands and chaparral, most postfire recovery of coyote brush and other dominants is by sprouting. In coastal sage scrub, fire creates canopy gaps with exposed mineral soil that allow coyote brush and other coastal sage scrub species (most of which also have small, light seeds) to establish from seed and outcompete herbaceous vegetation.

Fire frequency largely determines the extent of grasslands, coastal sage scrub, chaparral, and oak woodlands and whether or not coyote brush is present in each of these types. In grasslands, low fire frequency permits establishment of coyote brush and the gradual exclusion of herbaceous species. In coastal sage scrub, chaparral, and oak woodland, decreasing fire frequency allows coyote brush to be replaced by more shade-tolerant species. In mixed evergreen forests, closed-cone pine stands, and coast Douglas-fir stands, coyote brush is only important in early seral vegetation after fire or logging. Transition from coyote brush scrub to mixed evergreen forest can occur in 50 years without fire. In some cases, however, tree recruitment is limited by crown closure, and fire exclusion does not result in type conversion but rather maintenance of a dynamic mosaic wherein reversion and succession allow both vegetation types to persist.

Fire exclusion in coastal prairie allows coyote brush establishment, with best establishment in wet years. Prescribed burning has been used in coastal prairie to reduce invasion of coyote brush and other shrubs.

In coastal sage scrub, prescribed fire reduces fuel loading, risk of property-damaging wildfire, and the establishment of coast live oak and other trees. Mature coyote brush stands in coastal sage scrub are generally replaced by shade-tolerant species, and maintenance of coastal scrub, if

desired, requires periodic disturbance. Grazing and/or prescribed fire have been recommended where the management objective is grassland maintenance.

Grassland. Pristine coastal prairie in the study area is dominated by perennial bunchgrasses, but roughly 80% of the grasslands in the Seashore are dominated by non-native grasses. Most common is the invasive perennial purple velvet grass (*Holcus lanatus*), although annual Italian wild rye (*Lolium multiflorum*), farmer's foxtail (*Hordeum murinum*) and rattail fescue spp. (*Vulpia spp.*) also cover large acreage.

Pacific reedgrass (*Calamagrostis nutkaensis*) is the most common native grass in the project area, along with tufted hairgrass (*Deschampsia cespitosa*), California oatgrass (*Danthonia californica*), meadow barley (*Hordeum brachyantherum*), and California brome (*Bromus carinatus*). Where Pacific reedgrass is in association with rushes (*Juncus spp.*) and sedges (*Carex spp.*), it is included in the wetland vegetation type. Native grasses are often found in association with annual non-native grasses, coyote brush, California blackberry and a variety of native and weedy herbs.

Pasture is distinguished from grazed grasslands and other grazed naturally occurring vegetation types in the project area as it is used to graze cattle or horses, or managed to produce silage for cattle, or used for other agricultural purposes. The Minimal Management FMU is predominately pasture.

Coastal Dunes - The majority of dune habitat is dominated by non-native species. The western portion of the Linamtour FMU has the most extensive areas of coastal dunes; smaller patches are present in the Headlands and Tomales Point FMU. Non-native European beachgrass (*Ammophila arenaria*) represents roughly 50% of the coastal dune vegetation, and non-native iceplant (*Carpobrotus edulis*), roughly 25%. In areas where these two species dominate, they form dense monocultures, with few or no other species present.

The remaining 25% of this vegetation type are remnant patches of native plant community comprised primarily of dune sagebrush (*Artemisia pycnocephala*), coast buckwheat (*Eriogonum latifolium*), dune lupine (*Lupinus chamissonis*), or goldenbush (*Ericameria ericoides*), often with significant cover of the two invasive species - European beach grass and/ or iceplant. Total vegetation cover is often low and interspersed with bare sand.

Wetlands

This vegetation class includes moist herbaceous wetlands, salt marshes and freshwater marshes. Moist herbaceous wetlands, dominated by rushes (*Juncus spp.*), sedges (*Carex spp.*), small-fruited bulrush (*Sirpus microcarpus*) and Pacific reedgrass (*Calamagrostis nutkaensis*) in association with these wetland species, make up approximately 70% of this type. Any of these species may dominate and may often be found in swales in a patchwork pattern. Other associating species include purple velvet grass (*Holcus lanatus*) and California blackberry (*Rubus ursinus*) in the drier areas, potentilla (*Potentilla anserina*), hedgenettle (*Stachys ajugoides*), lady fern (*Athyrium felix- femina*), and horsetail (*Equisetum spp.*) in the moister areas.

Table 13. Marsh and Other Wetland Acreage in each FMU Where Management Would Take Place

FMU	Acreage
Tomales Point	74.3
Headlands	7.7
Estero	94.2
Inverness Ridge	13.4
Limantour Road	69.7
Wilderness North	2.6
Wilderness South	22.4
Highway One	13.4
Bolinas Ridge	0
Palomarin	25.2
<hr/>	
TOTAL	322.9

Salt marshes make up roughly 30% of wetlands in the project area. Pickleweed (*Salicornia virginica*) is the most common dominant, as well as saltgrass (*Distichlis spicata*); these species often co-dominate. Jaumea (*Jaumea carnosa*) is the most common associate. Sea lavender (*Limonium californicum*), arrow-grass (*Triglochin concinna*), alkali heath (*Frankenia salina*) and bird's beak (*Cordylanthus maritimus*) are often associates as well.

Freshwater marshes account for less than 5% of this type. Dominant species are the tall California bulrush (*Scirpus californicus*) and cattails (*Typha* spp.). These species are found in the wettest areas in or at the edge of standing water such as marshes or stock ponds. Bur-reed (*Sparganium* spp.) and water parsley (*Oenanthe sarmentosa*) are common associates.

Wildlife

The project area supports a wide diversity of wildlife species, including 28 species of reptiles and amphibians, 65 species of mammals, and breeding habitat for 130 species of birds. Nearly 490 bird species (representing 45% of the avian fauna documented in the United States) have been sighted on land and over near shore waters at Point Reyes. PRNS is also home to innumerable invertebrates. The waters of the Pacific Ocean and Tomales Bay support rich and diverse fisheries. Many of the wildlife species present in the study area are listed by the federal or state endangered species acts as threatened or endangered by extinction from all or part of their range.

Mammals

A rich diversity of terrestrial mammals occupies the many habitats presented in the 10 Fire Management Units. More common mammalian species include dusky-footed woodrat (*Neotoma fuscipes monochroua*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), black-tailed deer (*Odocoileus hemionus columbianus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), black-tailed hare (*Lepus californicus californicus*), brush rabbit (*Sylvilagus bachmani ubericolor*) and many species of bats, shrews, mice and moles. Mountain lion (*Felis concolor*)

are present though rarely seen and coyotes (*Canis latrans*) are widespread. Tule elk (*Cervus elaphus nannodes*), once extirpated from the Peninsula, have been successfully reintroduced. They are a regular presence in several of the FMUs and are especially numerous in the Tomales Point FMU.

The many marine mammals that inhabit or transit in the waters off of Point Reyes would not be affected by actions proposed in the Fire Management Plan and are therefore not described as part of the Affected Environment. FMP actions in each alternative have been developed to ensure marine mammal areas are not impacted by smoke produced from a prescribed fire.

Amphibians and Reptiles

Large populations of the California red-legged frog (*Rana aurora draytonii*) occur within the project area (see below). More common amphibians in the project area include bullfrogs (*Rana caesbeiana*), California newts (*Taricha torosa*), Pacific treefrog (*Hyla regilla*) and rough-skinned newts (*Taricha granulosa*). It is not uncommon to find the Pacific giant salamander (*Dicamptodon enstatius*) near streams.

Common reptiles include the Western fence lizard (*Sceloporus occidentalis*), Northern alligator lizard (*Gerrhonotus coeruleus*), Pacific gopher snake (*Pituophis melanoleucus*), Western terrestrial garter snake (*Thamnophis elegans*) and Western pond turtle (*Clemmys marmorata*).

Birds

Located along the Pacific Flyway and prominently jutting from the coast, the Point Reyes Peninsula supports a large number of resident and migratory birds. Though nearly 490 bird species have been documented at PRNS over half of the sightings were considered rare or extremely rare occurrences (i.e., unusual for this area). The project area provides breeding habitat for over 100 bird species. The park is recognized as a site of global significance for birds because of the great diversity and abundance of species. Some of the species of particular note that are resident and nesting include northern spotted owls, osprey, various raptors and owls, Neotropical migrant songbirds, several species of seabirds such as ash storm-petrel, and western snowy plovers. Examples of significant migratory species include the Neotropical migrant songbirds, raptors, and brown pelicans.

Fish

Several important anadromous fish species are present in the creeks and watersheds within the study area. Anadromous species are those that migrate from the ocean to brackish or fresh water habitat to breed. Species present within the study area include coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Oncorhynchus mykiss*), an anadromous rainbow trout. Both species are listed as threatened under the federal Endangered Species Act (see below). The coho returns to the stream in which it was born to breed after spending two years in the open ocean. The Lagunitas Creek watershed population is host to one of the largest remaining populations in the central coast of California. Steelhead trout occur in most perennial watersheds in the study area (Ketcham, 2001). Other anadromous fish species include herring, the Pacific lamprey (*Lampertra tridentata*), a federal Species of Concern, the green sturgeon (*Acipenser medirostris*), a federal Candidate Species, the California roach (*Hesperoleucus symmetricus*), a state Species of Concern.

Non-native wildlife

Several species of non-native wild and feral animals also occur in the project area. Axis deer (*Axis axis*) and fallow deer (*Dama dama*) were released in the 1940s and 1950s by a local landowner for hunting. Non-native and feral predators, such as red fox (*Vulpes vulpes*), Norway rat, possum and house cats (*Felis domesticus*) are present, as well as several non-native bird species including house sparrows, European starlings, wild turkeys (*Meleagris gallopavo*), and common peafowl (*Pavo cristatus*).

Special Status Species

The study area supports 47 listed animal species - 14 are federally listed as endangered, 8 as threatened and 24 as Species of Concern. Among these are the endangered Brown Pelican (*Pelecanus occidentalis*) and Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*). Federally threatened species include Northern spotted owl (*Strix occidentalis*), Western snowy plover (*Charadrius alexandrinus*), and the California red-legged frog (*Rana aurora draytoni*). Nineteen federally listed plant species (seven of which also are state listed) and an additional 25 listed or proposed for listing by the California Native Plant Society (CNPS) have been documented in the study area (Table 3).

Many of the plant and wildlife species present in the project area are regulated or monitored by the US Fish and Wildlife Service (USFWS), National Marine Fisheries Service and/or the State of California. Regulatory protection is afforded to species listed or proposed as threatened or endangered under the federal and state endangered species acts, the Marine Mammal Protection Act and the Migratory Bird Treaty Act. Species listed as Species of Concern by the US Fish and Wildlife Service, and Species of Special Concern by the California Department of Fish and Game, do not have legal protection under Endangered Species Act but are considered as species with potential to require future listing. Rather, the listing as species of concern brings these species to the attention of the public and appropriate agency with the aim of obviating the need for future listing through wise management practices.

This section is divided into a discussion of plants that are listed under the Endangered Species Act (Federally listed species), plants that are listed as Species of Concern by the USFWS or on California state lists only (Other Special Status plant species). Tables 3, 15, 21, and 22 list all plant special status species, and Tables 24 and 33 animals species with special status.

Federally Listed Plant Species

Federally listed plants in the study area that may be affected by fire management activities include Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*), Sonoma spineflower (*Chorizanthe valida*), robust spineflower (*Chorizanthe robusta*), Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*), Marin dwarf flax (*Hesperolinon congestum*), beach layia (*Layia carnosa*) and Tidestrom's lupine (*Lupinus tidestromii* [var. *layneae*]). These species are described below.

Sonoma alopecurus (Alopecurus aequalis var. sonomensis) – Endangered

Sonoma alopecurus is a perennial grass 9-47 cm tall that has spike-like flowers. It is a variety of the species found in wet meadows and shorelines in California, the eastern U.S., and Eurasia.

Because *alopecurus* individuals flower at different times throughout late spring and early summer within a given site, it is difficult to accurately estimate numbers of plants.

Four occurrences of this species are currently known on the Point Reyes peninsula, all occurring within pastures on agricultural permit lands (Table 14). Two occur in the vicinity of Abbott's Lagoon, on the G and H ranches, another on the F Ranch, and the fourth on a private in-holding within the PRNS owned by American Telephone and Telegraph (AT&T).

All occurrences are within the low-lying coastal plain that occupies most of the west-central Point Reyes peninsula. Soils in these areas are of the highly sandy Sirdrak and Sirdrak variant series, the latter characterized by a weakly cemented discontinuous hardpan producing a seasonal high water table, which can support robust growth of wetland species such as small-fruited bulrush (*Scirpus microcarpus*) and bog rush (*Juncus effusus*). While the present range of this taxon within PRNS is restricted to sandy soils, the distribution of the taxa as a whole suggests that it could occur, or could have occurred in the past, in wetland sites dispersed over much of PRNS.

Table 14. *Sonoma alopecurus* Occurrences and Numbers of Plants from 2000-2003

	2000	2001	2002	2003
G Ranch	1,572	3,405	7,530	8,386
H Ranch	60-328	648	129	661
F Ranch	53	336	340	1,042
AT&T				
Sub- occurrence 1	470	289	400	1,843
Sub- occurrence 2	1,696	243	800	1,774

Table 15. Federal Threatened, Endangered, Candidate, and Proposed Plant Species that may occur in Areas Affected by PRNS's Fire Management Plan (per USFWS Letter, May 24, 2001).

Common Name	Scientific Name	Listing Status ^a	Known to Occur	Potentially Subject to Adverse Impacts
Sonoma alopecurus	<i>Alopecurus aequalis</i> var. <i>sonomensis</i>	E	yes	yes, but unlikely ^b
Tiburon paintbrush	<i>Castilleja affinis</i> ssp. <i>neglecta</i>	E	yes	yes, but unlikely ^b
Robust spineflower	<i>Chorizanthe robusta</i> var. <i>robusta</i>	E	yes	no
Sonoma spineflower	<i>Chorizanthe valida</i>	E	yes	yes, but unlikely ^b
Baker's larkspur	<i>Delphinium bakeri</i>	E	no	no
Marin dwarf flax	<i>Hesperolinon congestum</i>	T	yes	yes, but unlikely ^b
beach layia	<i>Layia carnosa</i>	E	yes	no ^c
Tidestrom's lupine	<i>Lupinus tidestromii</i> (var. <i>layneae</i>)	E	yes	no ^c

showy Indian clover	<i>Trifolium amoenum</i>	E	extirpated	no
a	Listing status: E: Endangered T: Threatened			
b	These species do not occur within any of the FMUs except the Minimum Management Unit (where prescribed fire and mechanical treatments would not occur). The grazed grassland and wetland (<i>Alopecurus</i>) habitats supporting these species are unlikely to be affected by unplanned wildfire.			
c	These species occur in coastal dunes, which is part of the Minimum Management Unit (where prescribed fire and mechanical treatments would not occur). The dune habitats supporting these species are very unlikely to be affected by unplanned wildfire			

The G Ranch occurrence is located in a back dune area near the southwest corner of Abbott's Lagoon, in a swale that supports freshwater marsh vegetation. The swale is located along a fence built in 1989 to exclude cattle from the shores of the lagoon and from the dunes west of Abbott's Lagoon. The occurrence numbered 33 plants in 1994, 38 plants in 1995, and 40+ plants in 1998. In June, 2000, a more thorough and systematic survey than previously conducted documented a peak population size of 1,572 individuals.

The H Ranch occurrence is in a freshwater marsh/swale along a fence that borders an ungrazed area south of Abbott's Lagoon. The fence was built in 1983 to keep cattle away from the eastern, freshwater lobe of Abbott's Lagoon and from a trail running from Pierce Point Road to the beach. *Alopecurus* was sown in a part of the swale excluded from grazing after the fence was constructed. This fenced location is now overgrown with dense native wetland vegetation and no *alopecurus* is present. The site that does presently support plants, within the pasture, is immediately above a small berm carrying the trail across the swale. The berm may have altered the hydrology above it, making it wetter and more favorable for *alopecurus*, while cattle may remove competing taller wetland plant species. This occurrence was most recently surveyed several times over the summer of 2000, with plant numbers varying from 60 to 328 individuals.

The third occurrence was newly discovered on F Ranch in 2000, in a wetland swale between semi-stabilized dunes. This occurrence supported 53 individuals when a census was conducted in July, 2000. This survey, however, was done late in the blooming season and may not have included all of the *alopecurus* present.

This *alopecurus* occurrence is located on land that was recently purchased by the NPS from AT&T. This 521-acre tract previously served as a base for telecommunications transmission and reception, and has limited development of facilities. Poles bearing transmission wires are scattered over part of the parcel, and only minimal ground disturbance for maintaining poles takes place. The land is leased to one of the PRNS ranchers for cattle grazing. The two sub-occurrences located on this tract supported a total of over 2,100 plants when last surveyed in May and July, 2000.

One historic colony of Sonoma *alopecurus*, located in a pasture near Mesa Road north of Bolinas, has been extirpated since rare plant monitoring began in the park in 1983. Following exclusion of cattle from the site by fencing in 1985, it became overgrown with wetland and weedy vegetation. *Alopecurus* was last seen there in July, 1991.

Efforts to establish new occurrences of *Sonoma alopecurus* in several locations in PRNS took place in the late 1980's at five sites. By 1990, no *alopecurus* were found in any of these sites.

Results of monitoring of *Sonoma alopecurus* described above suggest that *alopecurus* thrives in wetlands that are grazed just enough to reduce competing vegetation. New occurrences of *alopecurus* may be found in areas of seasonally saturated soils as rare plant surveys continue. Such areas are most common in, but not exclusive to, the relatively gentle topography of the west-central Point Reyes peninsula. In 2002, four new introduction sites were established and are being monitored annually by park staff and volunteers.

Sonoma spineflower (Chorizanthe valida) – Endangered

Sonoma spineflower is an annual, growing 10-30 cm tall on sandy soils. A member of the Buckwheat family, it is named for its stiff involucral awns. It is thought to have originally been widespread in Marin and Sonoma counties, and was believed to have gone extinct during the mid-1900s due to agricultural and urban development. In 1976, the species was rediscovered in PRNS south of Abbott's Lagoon in the same pasture on G Ranch in which *Sonoma alopecurus* is located. This population has been monitored by CNPS since 1983. These surveys provide only coarse estimates of plant numbers. Survey data show population size ranging from several hundred plants in 1983 to 30,000 plants in 1993 (Table 16). The Marin chapter of CNPS has actively searched other areas for this plant since its 1980 rediscovery without success, and it is considered unlikely that other populations of spineflower will be found. The closely related San Francisco Bay spineflower (*C. cuspidata var. villosa*) is also found at Point Reyes in greater numbers and over a larger area, primarily in dune habitat.

Table 16. Population Estimates for *Sonoma Spineflower* on G Ranch 1980-2002 (intermittent)

Year	Estimated Numbers	Year	Estimated Numbers	Year	Estimated Numbers
1980	100	1990	2,000	1998	5,400
1984	1,000	1991	25,000	1999	23,000
1986	2,500	1992	27,000	2000	6,200a
1988	2,500	1993	30,000	2001	16,800a
1989	3,000	1994	7,570	2002	25,300a

a/ Survey of sub-population only.

Monitoring conducted since the mid-1980's has shown that the *Sonoma spineflower* can experience large variations in numbers from year to year, and estimated plant numbers have ranged from as low as several thousand individuals occupying less than 0.4 acres (0.85 ha) to as high as 30,000.

One of the requirements for downlisting *Sonoma spineflower* is to establish and maintain two new populations (USFWS, 1998). Several efforts have been made to establish new occurrences from seed within grazed pastures at PRNS. In 1988 seeds were planted in three 2x2 meter plots within 100-200 meters of the existing population. Although reproducing spineflowers initially

grew in all three plots, two of the plots eventually failed. The third, however, has expanded outside the original seeded plot and had 690 individuals in 2000. Two smaller seed plots planted near the successful plot had 122 plants between them in 2000.

In 1999, Sonoma spineflower was seeded at F Ranch, in the vicinity of an occurrence last observed in 1903. The site chosen for planting is regularly frequented by cattle to the extent that the soil is disturbed and competing vegetation is well grazed down. Although it is too early to know if the population will persist, 34 plants were counted there in 2000. In 2001, the original seeding had 182 plants, while a second and third seeding made in 2000 had 26 and 0 plants respectively. In 2002 the original seeding had 80 plants, the second and third seeding had 201 and 4 plants respectively. In 2002 an additional three seed plots were installed.

Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*) – *Endangered*, *Marin dwarf flax* (*Hesperolinon congestum*) – *Threatened*, and *Robust spineflower* (*Chorizanthe robusta* var. *robusta*) – *Endangered*

Approximately 300 acres at the crest of Nicasio Ridge at the northern border of GGNRA’s North District contains serpentine soils and rocky outcrops that support a number of serpentine endemic plant species. Serpentine soils are found on a relatively flat ridgetop, most of which is on private land outside of GGNRA, and on smaller rocky outcrops within GGNRA.

Tiburon paintbrush is a semi-woody perennial, with erect, branched stems 30 to 60 cm (1 to 2 ft) tall. It is known from six locations - one each in Napa and Santa Clara counties, three on Ring Mountain in eastern Marin County, and one on Nicasio Ridge. The Nicasio Ridge occurrence covers approximately 11 acres on the McIssac Ranch in GGNRA and adjoining private ranchland. Tiburon paintbrush grows in association with an evergreen, spiny-leafed ceanothus taxa that may be previously not described. The number of Tiburon paintbrush on Nicasio Ridge was 100 individuals in 1998, 41 in 1999, 84 in 2000, and 68 in 2001. A survey was not conducted in 2002.

Table 17. Monitoring for Tiburon paintbrush (Nicasio Ridge)

Year	Number of Individuals
1998	100
1999	41
2000	84
2001	68
2002	No survey

Marin dwarf flax is an annual species growing 5-15 cm tall on serpentine grassland from Marin to San Mateo counties. It is known from six locations on Nicasio Ridge, with the largest occurrence overlapping with the Tiburon paintbrush area extending along the ridgetop from the McIssac Ranch into private land. The other five occurrences are located on small rocky outcrops on the Cheda, McIssac, and Zanardi ranches. Abundance of Marin dwarf flax on Nicasio Ridge

appears to vary widely from year to year (Table 18). Survey efforts in 1998-2000 were the same but the number of occurrences and estimates of individual plants differed substantially, with new occurrences found in 1999 and 2000. This suggests the distribution of Marin dwarf flax on Nicasio Ridge is not fully known, and it may appear in other sites in the future due to seed dispersal, weather, or localized disturbances.

Table 18. Occurrences and Estimated Numbers of Marin Dwarf Flax on Nicasio Ridge.

Occurrence	1998	1999	2000	2001	2002
#1	157	87	2,000	178	No survey
#2	56	0	350 ^b	0	No survey
#3	a	2	740	No survey	No survey
#4	a	a	285	No survey	No survey
#5	a	a	350 ^b	130	No survey
#6	a	a	350 ^b	182	No survey

a/ Occurrence not found.

b/ Observers stopped counting at 350 plants.

Beach layia (*Layia carnosa*) – *Endangered*; and *Tidestrom’s lupine* (*Lupinus tidestromii*) – *Endangered*

These two plant species occur in coastal dunes on the western edge of the PRNS peninsula. Both have been monitored by CNPS volunteers and PRNS staff since the 1980s. Monitoring reports include an estimate of plant numbers, a description of site characteristics, and apparent threats to each occurrence. These reports have been assembled in the PRNS Rare Plant Database (NPS, 2001c).

Beach layia is an annual, usually prostrate member of the Asteraceae family found in 19 dune sites on the northern and central California coast from Humboldt to Santa Barbara counties. It has been recorded at 14 sites within the dunes at PRNS, with estimated numbers of individual plants varying widely among occurrences (Table 19). Its habitat is the central foredune community characterized by some drifting sand and low growing herbaceous and perennial species. *Beach layia* can experience large fluctuations in plant numbers and local distribution associated with dune blowouts and restabilization. Such fluctuations have been observed in four of the five PRNS occurrences for which counts have been made over multiple years. Five of the thirteen *beach layia* occurrences at PRNS are located in pastures, but plant monitors did not consider cattle to be a threat to them. Twelve of the occurrences were considered to be threatened by the presence of the non-native European beachgrass (*Ammophila arenaria*), sea fig (*Carpobrotus chilensis*), and/or Hottentot fig (*Carpobrotus edulis*) nearby. These perennial, rhizomatous non-native species form monotypic stands that virtually exclude less competitive native species.

Table 19. Beach layia Occurrences and Estimated Numbers of Plants, 2000-2003.

Population Number	2000	2001	2002	2003
1	2,140	289	>100	3,129
2	250	>1,000	no count	no survey
3	667	no survey	no survey	7,167
4	36a	0	481	687
5	<10	788	no survey	5,199
6	792	>1,000	no count	no surveys
7	632	no survey	>100	no surveys
8	8	no survey	175	583
9	1,879	>1,000	no survey	no surveys
10	350	no survey	>1,000	9,029
11	15,000	349	no survey	no surveys
12	15	no survey	no survey	1,152
no # 13	--	--	--	--
14	664	no survey	no survey	4,427
15b	--	--	no count	8,070
Total	22,433	>4,000	>2,000	39,444

a/ Surveyed in 1988.

b/ New occurrence in 2002.

Tidestrom's lupine is a small (10-30 cm) decumbent shrub found in 11 areas in dunes from southern Sonoma County to Monterey County. It is known from seven occurrences at PRNS, of which four have been monitored since the 1980s by CNPS.

The largest Tidestrom's lupine occurrence is in the large stable plain behind dunes southwest of Abbotts Lagoon, where the taxa is found on an estimated 383 acres. This area was once part of G Ranch, but was fenced off from cattle in 1989. This occurrence has been monitored from 1983 to the present and appears to be stable. Other occurrences are located north of Abbotts Lagoon and further south, near the North Beach parking area and the Old Lifesaving Station. Three of the seven occurrences are within pastures but grazing was not considered a threat by plant monitors. Six of the occurrences are considered threatened by European beachgrass and ice plant.

A project to remove non-native species near Abbotts Lagoon will be carried out from 2001-2003. The project is focused on areas where native vegetation is still relatively intact and may provide an effective means of protecting beach layia, Tidestrom's lupine, and other native dune species from invading non-natives.

Table 20. Tidestrom's lupine Occurrences and Estimated Numbers, 2000-2002.

	2000	2001	2002
1	2,000	128,528	157,651
2	79	12	34
3	13	33	217
4	7	35	28

5	0	0	no survey
6	5,940	11,181	32,748
7	64	151	214
Total	8,103	139,940	190,892

Robust spineflower (Chorizanthe robusta va. robusta) – Endangered

In January 2002, plant taxonomists at the Jepson Herbarium confirmed that an unidentified *Chorizanthe* species found in Point Reyes National Seashore was the federally endangered robust spineflower (*Chorizanthe robusta var. robusta*). This is the first time that this species has been documented within Seashore lands, and the first time it had been identified within Marin County. Prior to this find, robust spineflower was known to occur only in Santa Cruz and Monterey counties, in four populations. It is most likely that this species was not identified in Point Reyes until recently because of its very similar appearance to two other species of *Chorizanthe* that occur within the same habitat.

Between 2002 and 2004, surveys were conducted within Point Reyes to determine the species’ aerial extent, estimate the number of individuals, and to assess existing and/or potential threats to the species. Over 500 acres of potential habitat were surveyed and three robust spineflower populations were documented and mapped. In total, these populations were estimated to contain over 10,000 individuals. One population, located near Abbot’s Lagoon, occurs in a very popular visitor use area. The plants occur near a parking lot, along a roadside, and in a pasture grazed by cattle. The proximity of these plants to human activities may result in threats to the long-term survival of the population. A management plan, which includes a sampling strategy, is currently being developed in order to gather accurate estimates of individual numbers within each population. Surveys of potential habitat within the Seashore continue and it is anticipated that they will result in additional population locations.

As noted in Table 15, impacts to this endangered plant are not analyzed in the Environmental Consequences section because the FMP does not treat the area where the robust spineflower is located.

Other Plant Species of Concern

Tables 21 and 22 below shows several plant species in the affected area are listed as federal “species of concern.” Species of concern are species for which USFWS is collecting additional information to determine if they warrant consideration for future listing. In addition, two species (Point Reyes blennosperma and Mason’s ceanothus) are considered rare by the state of California, one species is state endangered (Point Reyes meadowfoam) and all plant species in the table are on California Native Plant Society lists. In Alternative A, although no federal or state listed species have been found in FMUs that would be treated with prescribed fire, one state rare species (Mason’s ceanothus) is present in the Bolinas Ridge FMU. Bolinas ceanothus does not occur in any FMUs slated for mechanical treatment in this alternative. Several federal species of concern are present in Estero and Limantour Road FMUs, which would be treated with both prescribed fire and mechanical thinning.

Although these species are not listed under the federal Endangered Species Act, NPS Management Policies (2000) state that the Service will inventory, monitor and manage state and locally listed species in a manner similar to its treatment of federally listed species, and will inventory other species that are of special management concern to parks (such as rare, declining, sensitive or unique species).

Table 21. Plant Species of Concern and California-listed Species that may Occur in Areas Affected by PRNS's Fire Management Plan (per USFWS Letter, May 24, 2001).

Common Name	Scientific Name	Known to Occur	Potentially Subject to Adverse Impacts	Comments
pink sand verbena	<i>Abronia umbellata</i> <i>ssp.breviflora</i>	yes	no	on coastal strand
Blasdale's bentgrass	<i>Agrostis blasdalei</i> var. <i>blasdalei</i> ^b	yes	yes	
Tamalpais manzanita	<i>Arctostaphylos hookeri</i> ssp. <i>Montana</i>	no	no	
Point Reyes stickyseed	<i>Blennosperma nanum</i> var. <i>robustum</i>	yes	yes	
Thurber's reedgrass	<i>Calamagrostis crassiglumis</i> ^c	yes	no	not in action FMUs
swamp harebell	<i>Campanula californica</i>	yes	yes	
Humboldt Bay owl's-clover	<i>Castilleja ambigua</i> ssp. <i>Humboldtensis</i>	yes	no	in wetlands
Mt. Vision ceanothus	<i>Ceanothus gloriosus</i> var. <i>porrectus</i>	yes	yes	
Mason's ceanothus	<i>Ceanothus masonii</i>	yes	yes	
San Francisco Bay spineflower	<i>Chorizanthe cuspidata</i> var. <i>cuspidata</i>	yes	no	in stabilizing dune habitats
Mt. Tamalpais thistle	<i>Cirsium hydrophilum</i> var. <i>vaseyi</i>	no	no	not in action FMUs
Tomales clarkia	<i>Clarkia concinna</i> ssp. <i>raichei</i>	no	no	
northcoast bird's-beak	<i>Cordylanthus maritimus</i> ssp. <i>Palustris</i>	yes	no	in salt marsh habitat
supple daisy	<i>Erigeron supplex</i>	extirpated	no	
San Francisco wallflower	<i>Erysimum franciscanum</i>	no	no	
fragrant fritillary	<i>Fritillaria liliacea</i>	yes	yes	
San Francisco gumplant	<i>Grindelia hirsutula</i> var. <i>maritima</i>	yes	yes	
Tiburon tarweed	<i>Hemizonia multicaulis</i> ssp. <i>Vernalis</i>	no	no	not in action FMUs
Kellogg's horkelia	<i>Horkelia cuneata</i> ssp. <i>sericea</i>	no	no	
Point Reyes horkelia	<i>Horkelia marinensis</i>	yes	no	in grazed pastures
Tamalpais lessingia	<i>Lessingia micradenia</i> var. <i>micradenia</i>	no	no	
coast lily	<i>Lilium maritimum</i>	yes	no	in grazed pastures
Pt. Reyes meadowfoam (CE) ^a	<i>Limnanthes douglasii</i> ssp. <i>Sulphurea</i>	yes	yes	
Gairdner's yampah	<i>Perideridia gairdneri</i> ssp. <i>Gairdneri</i>	yes	yes	
northcoast phacelia	<i>Phacelia insularis</i> var. <i>continentis</i>	yes	yes	
San Francisco popcornflower	<i>Plagiobothrys diffusus</i> ^d	yes	no	not in action FMUs

northcoast semaphore grass	<i>Pleuropogon hooverianus</i>	no	no	
Marin knotweed	<i>Polygonum marinense</i>	yes	no	in salt marsh
California beaked-rush	<i>Rhynchospora californica</i>	extirpated	no	
valley sagittaria	<i>Sagittaria sanfordii</i>	no	no	
Marin checkerbloom	<i>Sidalcea hickmanii</i> ssp. <i>Viridis</i>	no	no	
Santa Cruz microseris	<i>Stebbinoseris decipiens</i>	no	no	
Tamalpais streptanthus	<i>Streptanthus batrachopus</i>	no	no	
San Francisco owl's-clover	<i>Triphysaria floribunda</i>	yes	yes	

a/ CE: Listed as endangered under the California Endangered Species Act

b/ Recognized by The Jepson Manual (1993) as *A. densiflora*

c/ Recognized by The Jepson Manual (1993) as *C. stricta* ssp. *inexpansa*

d/ Recognized by The Jepson Manual (1993) as *P. reticulatus* var *rossianor*

Table 22. Additional Plant Species of NPS Management Concern that Occur in Areas Affected by PORE's Fire Management Plan

Common Name	Scientific Name	CNPS List	Potentially Subject to Adverse Impacts	Comments
coast rock cress	<i>Arabis blepharophylla</i>	4	yes	
Marin manzanita	<i>Arctostaphylos virgata</i>	1B	yes	
coastal marsh milk-vetch	<i>Astragalus pycnostachyus</i> var. <i>pycnostachyus</i>	1B	no	in coastal strand habitat
coastal bluff morning-glory	<i>Calystegia purpurata</i> ssp. <i>Saxicola</i>	1B	yes	
Buxbaum's sedge	<i>Carex buxbaumii</i>	4	no	in wetlands
glory brush	<i>Ceanothus gloriosus</i> var. <i>exaltatus</i>	4	yes	
Point Reyes ceanothus	<i>Ceanothus gloriosus</i> var. <i>gloriosus</i>	4	yes	
unnamed ceanothus	<i>Ceanothus</i> sp. nov.	-	no	in grazed pastures
woolly-headed spineflower	<i>Chorizanthe cuspidata</i> var. <i>villosa</i>	1B	no	in sandy dune habitat
Franciscan thistle	<i>Cirsium andrewsii</i>	1B	yes	
western leatherwood	<i>Dirca occidentalis</i>	1B	no	not in action FMUs
California bottlebrush grass	<i>Elymus californicus</i>	4	yes	
Marin checker lily	<i>F. affinis</i> var. <i>tristulis</i>	1B	yes	
dune gilia	<i>Gilia capitata</i> ssp. <i>chamissonis</i>	1B	no	in sandy dune habitat
dark-eyed gilia	<i>Gilia millefoliata</i>	1B	no	in sandy dune habitat
white hayfield tarplant	<i>Hemizonia congesta</i> ssp. <i>Leucocephala</i>	3	yes	
short-leaved evax	<i>Hesper-evax sparsiflora</i> var. <i>brevifolia</i>	2	no	in grazed grassland
perennial goldfields	<i>Lasthenia macrantha</i> ssp. <i>Macrantha</i>	1B	yes	
delta mudwort	<i>Limosella subulata</i>	2	no	in mud flats
large-flowered linanthus	<i>Linanthus grandiflorus</i>	4	yes	
rosy linanthus	<i>Linanthus rosaceus</i>	1B	yes	
marsh microseris	<i>Microseris paludosa</i>	1B	yes	
Point Reyes rein-orchid	<i>Piperia elegans</i> ssp. <i>decurtata</i>	1B	yes	

nodding semaphore grass	<i>Pleuropogon refractus</i>	4	yes	
Point Reyes checkerbloom	<i>Sidalcea calycosa ssp. rhizomata</i>	1B	no	in wet areas
beach starwort	<i>Stellaria littoralis</i>	4	yes	
Mt. Tamalpais jewelflower	<i>Streptanthus glandulosus ssp. Pulchellus</i>	1B	no	

NOTES: ¹ CNPS = California Native Plant Society (Skinner and Pavlik 1994)

Listing Significance:

List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere

List 2: Plants Rare, Threatened, or Endangered in California, but More Common Elsewhere

List 3: Plants About Which We Need More Information - A Review List

List 4: Plants of Limited Distribution - A Watch List

Special-Status Wildlife

The following threatened or endangered animal species are those listed under the Endangered Species Act and considered likely or possible to experience impacts from fire management activities: Northern spotted owl (*Strix occidentalis caurina*), California red-legged frog (*Rana aurora draytonii*), Central California coho salmon (*Oncorhynchus kisutch*), Central California Coast steelhead (*Oncorhynchus mykiss*), California freshwater shrimp (*Syncaris pacifica*), Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*), Western snowy plover (*Charadrius alexandrinus nivosus*). All listed, proposed, or candidate animal species in the study area are listed in Table 24. A section on animal species not listed under the Endangered Species Act, but of concern to federal or state agencies follows.

Federally listed animal species

Northern Spotted Owl (*Strix occidentalis caurina*) - Threatened

Habitat within the project area supports one of the densest populations of Northern spotted owl in the world. In Marin County, the owls live in second growth Douglas-fir (*Pseudotsuga menziesii*), Bishop pine (*Pinus muricata*), coast redwood (*Sequoia sempervirens*), mixed conifer-hardwood and evergreen hardwood forests as well as remnant old-growth stands of coast redwood and Douglas-fir. The habitat types for the Northern spotted owl are defined as multi-layered, multi-species with >60% total canopy cover for nesting/roosting with large overstory trees, large amounts of down woody debris, presence of trees with defects or signs of decadence in the stand. Small isolated pieces of habitat are not regarded as suitable. Northern spotted owls are residents throughout PRNS and GGNRA and occur in habitat types that are atypical when compared to other areas of the species range. For example, owls have been observed nesting in young bay (*Umbellularia californica*) trees in small stands. Nevertheless, most nesting and roosting sites do occur in older, decadent stands of conifer and hardwood trees with large overstory trees. Preliminary pellet analyses indicate that spotted owls in Marin forage primarily on dusky-footed woodrats (*Neotoma fuscipes*) as well as other small mammals and forest-dwelling birds (Chow and Allen, 1998). The Northern spotted owl is found in the Inverness Ridge FMU, eastern Limantour FMU, North and South Wilderness FMUs, Highway One and Bolinas FMUs.

The Northern spotted owl (*Strix occidentalis caurina*) was federally listed as threatened in 1992 (USFWS 1993). A ¼ mile radius buffer zone must be protected around active nest sites to protect the birds from the impacts of noise and smoke. A severe wildfire may alter the owl's

habitat, making it unsuitable for the species. The degree of habitat modification that can occur within a given radius of an owl activity site is regulated by the California Code of Regulations, Title 14, §919.9(g)(1) addressing Wildlife Protection Practices for the Northern Spotted Owl.

The parks contain approximately 35,000 acres of potential northern spotted owl habitat. Extensive surveys of habitat use, distribution and abundance have been conducted since 1993 by the NPS and these surveys will continue. A recent census estimated a population of approximately 49 owl activity centers (Chow and Allen, 1996, Chow and Allen, 1998, Fehring and Adams, 2001, NPS, 2002b). The parks initiated a demographic study of owls in 1998 and have been banding owls annually under permit from the USFWS (Permit # 842449). The overall population trend is unknown, but we believe the population is stable because the number of activity centers has been similar among years since 1998 when an inventory was completed of the park. Table 23 describes each of the occupied site's history to date.

While conducting an inventory of owls within the parks following USFWS protocols, biologists noted the habituation of owls to people, resulting in owls approaching people in campgrounds. Consequently, the parks developed a modified protocol from the USFWS protocol to reduce interactions with owls during surveys. The modified protocol was developed in collaboration with USFWS, and resulted in a reduction in the use of mice to confirm owl presence and productivity.

No critical habitat for the spotted owl has been designated within PRNS or the Northern District of GGNRA, although much of the parks contain high quality owl habitat. Critical habitat was not designated because the park habitat is protected from adverse effects due to its National Park status. The park is in the process of analyzing habitat associations of occupied sites and nest site descriptions. The Point Reyes Bird Observatory, in collaboration with the NPS, will have a final report completed on this analysis in 2003.

Table 23. Site History of Northern Spotted Owl Activity Centers within PRNS and the Northern District of GGNRA

Marin County Spotted Owl Activity Site Number	Landowner	Survey Purpose	Survey Years
MR001	TBSP	Demography	1997-2001
MR002	TBSP	Demography	1997-2002
MR003	PVT	Inv/Mgmt	1997-1998, 2002
MR004	PRNS	Demography	1997-2002
MR005	PRNS	Demography	1997-2002
MR006	PRNS	Inv/Mgmt	1997-1998, 2001-2002
MR007	PRNS	Demography	1997-2002
MR008	PRNS	Inv/Mgmt	1998, 2002
MR012	PVT	Demography	1997-2002
MR018	PRNS	Demography	1997-2002
MR021	PVT	Inv/Mgmt	1997-1998, 2001-2002
MR022	PRNS	Demography	1997-2002
MR023	PRNS	Inv/Mgmt	1998, 2002
MR024	PRNS	Inventory	1997-1998
MR026	PVT	Inventory	1997-1998

MR027	TBSP	Demography	1997-2002
MR028	PVT	Inv/Mgmt	1997-1998, 2002
MR029	PVT	Demography	1997-2002
MR030	PRNS	Demography	1997-2002
MR031	PVT	Demography	1997-2002
MR032	PVT	Inventory	1997-1998
MR033	PVT	Inventory	1997-1998
MR034	GGNRA	Demography	1997-2002
MR035	GGNRA	Demography	1997-2002
MR039	GGNRA	Demography	1997-2002
MR040	GGNRA	Demography	1997-2002
MR041	GGNRA	Demography	1997-2002
MR046	PVT	Demography	1997-2002
MR047	TBSP	Demography	1997-2002
MR048	TBSP	Inventory	1997-1998
MR049	PRNS	Demography	1997-2002
MR050	PRNS	Demography	1997-2002
MR051	PRNS	Demography	1997-2002
MR052	PRNS	Demography	1998-2002
MR053	PVT	Inventory	1997-1998
MR054	GGNRA	Demography	1997-2002
MR056	TBSP	Inv/Mgmt	1997-1998, 2001-2002
MR057	PRNS	Demography	1997-2002
MR058	GGNRA	Demography	1997-2002
MR059	PRNS	Demography	1997-2002
MR063	PVT	Inv/Mgmt	1998, 2002
MR064	GGNRA	Demography	1998-2002
MR067	PVT	Demography	1998-2002
MR068	GGNRA	Demography	1998-2002
MR069	GGNRA	Demography	1997-2002
MR070	PRNS	Inventory	1997
MR072	GGNRA	Demography	1998-2002

TBSP (Tomales Bay State Park), PVT (Private land adjacent to Seashore boundaries). Source: Marin County Spotted Owl Database, PRNS, CA.

Thirty-two sites in PRNS and North District GGNRA are included in a long-term demographic study. Other sites were included in an inventory of all spotted owl habitat on federal lands conducted in 1997 and 1998. A subset of these sites were monitored in 2001 and 2002 because of their proximity to Wildland-Urban Interface Hazardous Fuel Reduction Projects at PRNS.

Red-legged Frog (*Rana aurora draytonii*) – Threatened

PRNS and GGNRA support one of the largest known populations of California red-legged frogs. This frog frequents marshes, slow parts of streams, lakes, stock ponds, and other usually permanent waters. The frog is generally found near water but disperses during rain events and after breeding season to non-breeding habitat adjacent to water bodies. The non-breeding habitat is usually a moist area with some cover such as a willow or blackberry thicket.

The U.S. Geological Survey Biological Resources Division (USGS-BRD) has conducted surveys of aquatic habitats in PRNS and GGNRA since 1993 under the direction of Dr. Gary Fellers.

Survey protocol is adapted from USFWS practices and has been published as a NPS Technical Report (Fellers & Freel, 1995).

Surveys have been conducted on virtually all sites containing aquatic habitat that could support amphibians. Field data includes information on habitat type (permanent or seasonal, natural or created), water characteristics, (depth, flow, turbidity, etc.), vegetation (emergent, floating, and surrounding the site), disturbance, including current grazing, and the age classes and physical condition of amphibians found.

Field surveys have led to documentation of numerous sites used by the California red-legged frog; sites have been mapped in a geographically related database. Approximately 76 sites are located on ranch lands, with a large proportion located at stock ponds. A breakdown of sightings according to the type of habitat use observed (breeding vs. non-breeding, upland dispersal vs. other upland habitat use, etc.) has yet not been made, since survey work is ongoing and it is believed that new locations will be detected. It is likely that further surveys will document additional red-legged frog sites at PRNS/GGNRA. Several new breeding sites have recently been found along tributaries of Olema Creek. Several large bodies of water, such as Abbott's Lagoon, are expected to yield new sites during a planned boat survey, which will allow more thorough coverage than has been attained by foot surveys. In FY04, PRNS plans to survey the wilderness area of the park to determine additional breeding and non-breeding habitat.

Table 24. Federal Threatened, Endangered, Candidate, and Proposed Animal Species that May Occur in Areas Affected by PRNS's Fire Management Plan (per Attachment A in USFWS Letter, May 24, 2001).

Common Name	Scientific Name	Listing Status ^a	Known to Occur	Potentially Subject to Adverse Impacts ^b
Mammals				
blue whale	<i>Balaenoptera musculus</i>	E	rare	No ^b
finback (=fin) whale	<i>Balaenoptera physalus</i>	E	rare	No ^b
gray whale	<i>Eschrichtius robustus</i>	D	yes	No ^b
Guadalupe fur seal	<i>Arctocephalus townsendi</i>	T	yes	No ^b
humpback whale	<i>Megaptera novaeangliae</i>	E	yes	No ^b
right whale	<i>Eubalaena glacialis</i>	E	no	No
sei whale	<i>Balaenoptera borealis</i>	E	no	No
sperm whale	<i>Physeter catodon</i> (<i>macrocephalus</i>)	E	yes	No ^b
Steller (=northern) sea-lion	<i>Eumetopias jubatus</i>	T	yes	No ^c
Birds				
Aleutian Canada goose	<i>Branta canadensis</i>	E	rare	No ^b
American peregrine falcon	<i>Falco peregrinus anatum</i>	D	yes	No
bald eagle	<i>Haliaeetus leucocephalus</i>	T	rare	No
California brown pelican	<i>Pelecanus occidentalis californicus</i>	E	yes	No
California clapper rail	<i>Rallus longirostris obsoletus</i>	E	yes	No
greater sandhill crane	<i>Grus canadensis tubida</i>	T	rare	No
marbled murrelet	<i>Brachyramphus marmoratus</i>	T	yes	No
northern spotted owl	<i>Strix occidentalis caurina</i>	T	yes	Yes
short-tailed albatross	<i>Diomedea albatrus</i>	PE	rare	No ^b
western snowy plover	<i>Charadrius alexandrinus nivosus</i>	T	yes	No
Reptiles				
green turtle	<i>Chelonia mydas (incl. agassizi)</i>	T	rare	No ^c
leatherback turtle	<i>Dermochelys coriacea</i>	E	yes	No ^c
loggerhead turtle	<i>Caretta caretta</i>	T	rare	No ^c
olive (=Pacific) ridley sea turtle	<i>Lepidochelys olivacea</i>	T	rare	No ^c
Amphibians				
California red-legged frog	<i>Rana aurora draytonii</i>	T	yes	Yes
California tiger salamander	<i>Ambystoma californiense</i>	C	no	No
Fish				
central California coho salmon	<i>Oncorhynchus kisutch</i>	T	yes	Yes
central California coast steelhead	<i>Oncorhynchus mykiss</i>	T	yes	Yes
delta smelt	<i>Hypomesus transpacificus</i>	T	unknown	No
Sacramento splittail	<i>Pogonichthys macrolepidotus</i>	T	unknown	No

So. OR/CA coastal chinook salmon	<i>Oncorhynchus tshawytscha</i>	T	no	No
threespine stickleback	<i>Gasterosteus aculeatus williamsonii</i>	E	no	No
tidewater goby	<i>Eucyclogobius newberryi</i>	E	no	No
Invertebrates				
black abalone	<i>Haliotes cracherodii</i>	C	yes	No ^b
California freshwater shrimp	<i>Syncaris pacifica</i>	E	yes	Yes
Myrtle's silverspot butterfly	<i>Speyeria zerene myrtleae</i>	E	yes	Yes
white abalone	<i>Haliotes sorenseni</i>	PE	no	No

a. Listing status: E: Endangered T: Threatened C: Candidate PE: Proposed Endangered D: Delisted

b. Offshore marine species (e.g., whales, pelagic birds) are expected to receive little to no impact from fire management activities. Fire management activities such as prescribed fires and mechanical treatments are not planned to occur adjacent to coastal bluffs, beaches, or dunes and smoke will be directed away from any marine mammal sites. Unplanned wildfire and associated suppression activities could occur in these areas and very minor impacts could occur if wildland fire reduces vegetation cover near coastal bluffs, and sediments are removed from the bluffs and deposited in coastal waters. These sediments would be quickly diluted when they reach the ocean, and impacts to marine species are expected to be insignificant.

c. Species that use beaches as haulouts may be disrupted by unplanned wildfire and the associated suppression activities. Impacts could be caused by smoke or by sedimentation as mentioned in the previous paragraph. Among Threatened and Endangered species, however, such habitat use is restricted to marine turtles, which are unlikely to occur at PRNS. Steller's sea-lions are more likely to use rocky shorelines as haulouts.

Creation of stock ponds and other small impoundments on ranches over the past 100 years has likely resulted in increased numbers and an expansion in range for red-legged frogs in the PRNS area (G. Fellers, pers. comm.). Frogs appear to move readily between these ponds during periods when the ground is moist, which is prolonged on the foggy PRNS peninsula. Numerous wet swales, seasonal springs, and ephemeral pools provide dispersed travel and feeding habitats. In GGNRA, riparian habitat along creeks provides corridors for travel along the Olema Valley and its tributaries.

PRNS, GGNRA, and adjoining areas of Marin County comprise one of the 57 core areas for focused recovery of red-legged frogs established in the Final Recovery Plan for the species. Much of the project area falls within the recently established criteria for red-legged frog critical habitat. The central peninsula has roughly 75 stock ponds in an area extending from the Kehoe Ranch near Pierce Point south to Point Reyes itself and east to Tomales Bay, Mt. Vision, and the Laguna Ranch (now the Clem Miller Environmental Education Center). Approximately 50 of these ponds are located on land currently used for ranching, with most of the remaining 25 on former ranch lands on Inverness Ridge and above Limantour Estero. Most of these ponds retain water at least 20" deep well into the summer, and a number are perennial in typical rainfall years. Evidence of breeding red-legged frogs has been observed in many of these ponds. Pond habitat and several perennial creeks are densely clustered on the Point. Distances of under 1.25 miles separate one or more adjacent aquatic habitats, and the ground between them is suitable for red-legged frog overland movement. Traffic along Sir Francis Drake Boulevard, the only major potential barrier to movement, is less than 30 cars per hour on late fall and winter nights, when adult red-legged frogs are most likely to be traveling overland. The habitat area for red-legged frogs on central Point Reyes encompasses all of the grazing land there.

A second interconnected habitat area extends along the Olema Valley, where the perennial segment of Olema Creek links scattered off-stream aquatic habitats from the vicinity of Point Reyes Station south approximately 13.5 km. Stock ponds are less common in the Olema Valley than on the peninsula, numbering less than 20. Red-legged frogs have been observed in most of the tributaries on the eastern side of Olema Creek, where ranching occurs.

Suitable habitat along Olema Creek and its tributaries may have been adversely affected by geomorphologic instability associated with historic logging of parts of Inverness Ridge, channel alterations in the lower 2.8 km of Olema Creek, and the effects of highway culverting. Areas of downcutting, bank cutting, and sedimentation are present along the mainstem and its tributaries, resulting in a probable reduction in numbers of backwaters and pools.

Red-legged frogs have also been found on Bolinas Mesa and at several ponds on top of Bolinas Ridge. Since frogs could be present in unsurveyed locations on Inverness Ridge, and could travel along seasonally wet riparian corridors over the ridge, all the red-legged frog sighting locations have been linked into one metapopulation.

Potential impacts of projects on red-legged frog aquatic habitats is summarized in Table 25, which is based on pages 31-34 of the Draft Recovery Plan.

Table 25. Potential Impacts on Red-legged Frog Aquatic Habitats

Impact	Potential Effect on CRLF Habitat
Emergent vegetation removed	Emergent vegetation necessary for amplexus and anchoring egg masses. Excessive levels may reduce sunlight needed for growth of algae, which is chief larvae food.
Shading vegetation removed (emergent and bank side)	Chiefly harmful to adults, for whom shaded refugia may be critical in drier inland areas during the summer.
Insect habitat vegetation removal	Harmful to adults and juveniles that mainly feed on invertebrates for which bank side vegetation is prime habitat.
Excess water drawdown in ponds	Leave egg masses stranded on vegetation
Change hydrological regime by accelerating runoff	Pools may dry before metamorphosis completed

Riparian Areas

Based on survey data, the most important riparian areas for red-legged frogs in PRNS/GGNRA are those with relatively low gradient that have late season water flow or water retention in pools. On Point Reyes itself, such creeks support relatively few of the documented occurrences of the frogs, but they may serve as connector and refuge habitats. The most important of these are Kehoe Creek and Abbotts Lagoon Creek on the north end of the peninsula, and Schooner Creek, which drains into Drakes Estero.

In GGNRA and PRNS, Olema Creek is the most significant habitat for red-legged frogs. Approximately one-third of its length is outside of the ranching zone, while the remainder is fenced off from direct access by cattle along its entire length. The character of Olema Creek changes near the town of Olema, where it develops a substantial floodplain that extends to Sir

Francis Drake Blvd., just before the confluence with Lagunitas Creek. Several slough-like channels occur in the floodplain, fed either by Olema Creek or several tributaries that empty onto it. Since the mid 1990s, Olema Creek has recaptured its historic floodplain, to the north of the Olema Ranch Campground. This 9 acre floodplain is permanently excluded from livestock access and supports a diverse recovering riparian floodplain and willow flat. While these sloughs appear to be suitable as breeding habitat for red-legged frogs, there are no records from this area. Egg masses may be washed out by high flows or juveniles eaten by herons and other predators.

A Biological Opinion regarding agricultural operations within the Seashore, completed by the USFWS in 2002, addresses all issues related to ongoing ranch operations within lands known to support the California red-legged frogs.

Stock Ponds

Red-legged frogs have been detected in over 40 of the stock ponds scattered over PRNS and another 10 in GGNRA. Many of the ponds have minimal shading vegetation, although this may be a characteristic of the pond site rather than cattle presence. This is especially true on the Point, where trees are relatively sparse in the grassland and dune areas. Emergent vegetation also varies by pond, but overall is considered to be enough for red-legged frog reproduction but not excessive, which would reduce open water needed by larvae and the algal growth they feed on (G. Fellers, pers. comm.).

Observations on vegetation surrounding ponds, and on percent cover of pond surfaces by emergent and floating vegetation is part of the data collected in amphibian survey work. The extent to which presence of such vegetation beyond minimal levels is important to red-legged frog reproduction is not clear. In an effort to identify the optimal level of emergent and submerged vegetation for red-legged frogs, biologists at the East Bay Regional Park District used data from 265 ponds located in their parks, which together support an estimated 500-600 breeding adult frogs. Presence of frogs was compared at ponds with three levels of vegetation cover: no cover, cover less than 15%, and cover more than 15%. No significant differences in the presence of red-legged frog larvae, juveniles, and adults were found (S. Bobzien, pers. comm.).

Central California Coast Coho Salmon (*Oncorhynchus kisutch*) – Threatened and Central California Steelhead (*Oncorhynchus mykiss*) - Threatened

Central California coast coho salmon and Central California steelhead (hereafter referred to as coho and steelhead) occur in several creeks on the Point Reyes peninsula and in the Lagunitas Creek watershed that drains portions of PRNS and GGNRA. Coho salmon and steelhead trout are found in the Olema, Lagunitas and Pine Gulch Creek watersheds. Steelhead trout are also found in the Tomales Bay, Drakes Estero, and Bolinas watersheds.

Designated critical habitat for coho in PRNS includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding, naturally impassable barriers or above Peters Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NOAA Fisheries, 1996). Although critical habitat has not been established for central California steelhead, it is likely to be the same as that for coho in Marin County.

Dating back to the late 1800s, West Marin County was a popular destination for salmon fishing. Records of salmon hatchery releases to Lagunitas Creek and even Bear Valley Creek occurred even in the 1890s. Lagunitas Creek (then known as Papermill Creek) still holds the distinction as having produced the state record, 22 pound, coho salmon (caught by Milton T. Hain, January 3, 1959). Interviews with long time residents and fisheries managers suggest that coho and steelhead in the project area have been declining since the turn of the century, with significant declines occurring as late as the mid-1950's. Most historic information on salmonid numbers is anecdotal, while quantified data are lacking. Accounts by local residents of "excellent trout fishing" along Lagunitas and Olema creeks may refer to young steelhead, which are indistinguishable from rainbow trout during the three year period they typically spend in fresh water. Similarly, early accounts of "salmon runs" may refer to both coho and steelhead, which may not have been distinguished by fishermen. Such anecdotal information suggests that salmonids were abundant in the Lagunitas/Olema Creek drainage before extensive alteration by dam-construction, logging, and channelization. On its 1996 federal listing, the Lagunitas watershed, including Olema Creek, was documented to support 10% of the Central California Coast coho population (Brown et al., 1994, NOAA Fisheries, 1996).

NOAA Fisheries designated critical habitat for coho salmon to include all accessible reaches of rivers (including estuarine areas and their tributaries) (NOAA Fisheries, 1999). Through this designation, NOAA Fisheries identified ten essential features of critical habitat including: substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (PL 104-267), established new requirements for Essential Fish Habitat (EFH). Coho salmon and Chinook salmon are managed under Federal Fishery Management Plans, steelhead are not. Therefore, EFH conservation recommendations address only coho salmon, and not steelhead trout. Watersheds supporting coho salmon associated with the project are also protected under EFH regulations.

Reliable quantitative survey data for coho salmon dates from 1948, when the California Department of Fish and Game (CDFG) began annual surveys of coho numbers and spawning activity on Devil's Gulch, a tributary of Lagunitas Creek. Survey work on the Lagunitas mainstem began in the winter of 1982-83 by consultants to the MMWD. Beginning in the mid 1980s, biologists began collecting juvenile information and some smolt trapping was conducted on Lagunitas Creek.

Historic and current data on coho and steelhead populations for Lagunitas, Olema, and Pine Gulch Creek watersheds have been gathered as part of the Coho salmon and Steelhead trout Restoration Program (CSRP) and the Marin Municipal Water District. Through the CSRP, the NPS has established a detailed fisheries monitoring program that is carried on through support from the Natural Resource Challenge Inventory and Monitoring Program, as well as monitoring support through California Department of Fish and Game managed grant programs.

For most drainages, monitoring has focused on coho salmon, but includes equivalent information for steelhead trout. Differences between steelhead trout and coho salmon life cycles are pertinent to conservation efforts. While virtually all coho in project area watersheds have an 18 month freshwater life cycle, steelhead juveniles may migrate to the ocean after 18 months or extend freshwater residence for up to three years. Most coho return to spawn after 18 months, but steelhead may spend several years in the ocean before returning to spawn. Additionally, steelhead may make several spawning migrations while all coho spawn once and die. The variable life cycle of steelhead makes population analysis more difficult, but also makes them more resilient to adverse environmental conditions. In general, if the habitat requirements for coho are met, steelhead habitat requirements will also be met.

Estimates for adult coho escapement (numbers of spawning coho), were derived using the Peak Live plus accumulated Dead (PLD) index method, in which the highest count of living fish found in a single survey is added to the cumulative number of dead fish counted up to that time. The PLD index provides a minimum count of spawning fish in a season, based upon actual field observation. While the PLD index is best when peak numbers are counted, visibility and flow conditions are highly variable and can affect the quality of a field survey. The PLD is interpreted as an indication of spawning success, along with other monitoring parameters including redd counts, summer juvenile densities, and smolt outmigration, it can be used to as an indicator of population condition.

In conjunction with adult escapement surveys, the NPS staff and volunteers document redds, or egg nests. Because redds are often visible long after fish have spawned, and they can be marked to avoid double counting, it has been used in the watershed as an indices of the spawning run. However, since coho and steelhead may construct false redds, and redds may be washed over or difficult to distinguish, these data are best used to indicate spawning activity between years and watersheds. In the last five years, adult escapement monitoring efforts by the MMWD, PRNS, and other local organizations have included detailed redd counts.

Review of historical spawner abundance data supports anecdotal evidence of declining numbers of coho over the last 50 years. This corresponds to a similar trend region-wide. Since the mid-1990s, current monitoring effort shows that populations of both coho salmon and steelhead trout, while fluctuating, within the project area, remain persistent, and are considered stable.

Fisheries information are summarized by watershed areas as described in the Water Resources section.

Tomales Bay Watershed. The Tomales Bay watershed includes all of the small watersheds draining from Inverness Ridge and Bolinas Ridge directly to the Bay. The largest of these

watersheds, Bear Valley Creek is included within the Limantour Road FMU. In addition, the watershed includes small portions of the Tomales Point, Wilderness North, and Inverness Ridge FMUs. The watersheds within the each of these FMUs, with the exception of Tomales Point, support habitat for steelhead trout. No quantitative fisheries monitoring beyond presence/absence surveys have been conducted in these systems.

Lagunitas Creek Watershed. Lagunitas Creek and its tributaries (Nicasio Creek, San Geronimo Creek, Devil’s Gulch, Cheda Creek, Bear Valley Creek, and Olema Creek) drain more than 230 square kilometers of western Marin County. The headwaters of the Lagunitas Creek mainstem lie within the 53,000 ha watershed lands administered by MMWD. The mainstem originally totaled about 40 km of perennial stream draining the northern slope of Mt. Tamalpais, but was reduced by more than 50% by construction of Alpine Dam in 1918 and Peters Dam in 1953. Because neither dam has provision for fish passage, their construction resulted in permanent loss of the upper portion of the drainage to anadromous fish.

The portions of the Lagunitas drainage most significant for salmonids are under a number of ownerships. Approximately 12 km of the mainstem is bordered by lands within GGNRA. A major tributary, San Geronimo Creek, flows through privately held land in San Geronimo Valley. Devil’s Gulch lies almost entirely within Samuel P. Taylor State Park with its headwaters in GGNRA. Only one smaller tributary of Lagunitas Creek, Cheda Creek, lies entirely within GGNRA lands. Within the Lagunitas Creek watershed, the Bolinas Ridge FMU is the only active unit.

Lagunitas Creek has long supported populations of coho salmon and steelhead trout. Recent monitoring efforts within Lagunitas Creek have identified the presence of Chinook salmon for the past four years (MMWD, 2003) with less frequent occurrences of chum and even pink salmon.

Coho numbers for the Lagunitas watershed taken as a whole based on surveys of 36 km of the mainstem and its tributaries, including Olema Creek, Devil’s Gulch, and San Geronimo Creek, are shown in Table 26. Surveys were conducted during three periods between 1982-2003. Surveys differed in coverage and data gathered, but show an increasing trend in number of redds located. Total numbers of spawning coho using the drainage are suggested by PLD Index value high counts of 525 fish in 1996/97.

Table 26. Coho Salmon Spawning Survey Data for Overall Lagunitas Creek Watershed

Year	Number of Surveys	Survey Area (km)	PL Index ^c	Total Carcasses	Total New Redds	Source
1982/83 ^a	6	22.4	n.a.	n.a.	139	Bratovich & Kelly 1988
1983/84 ^a	6	22.4	n.a.	n.a.	44	Bratovich & Kelly 1988
1991/92 ^a	1	20.0	n.a.	n.a.	41	Wise 1992
1995/96 ^b	10	36	290	n.a.	86	Trihey & Assoc. 1996
1996/97 ^b	8	36	525	92	254	Trihey & Assoc. 1997
1997/98 ^b	10	36	241	112	360	MMWD, PRNS
1998/99 ^b	10	36	147 ^d	34	227	MMWD, PRNS
1999/00 ^b	14	36	496 ^d	65	220	MMWD, PRNS
2000/01 ^b	14	36	380 ^d	130	338	MMWD, PRNS

2001/02 ^b	15	36	463 ^d	146	375	MMWD, PRNS
2002/03 ^b	13	36	463 ^d	60	175	MMWD, PRNS

a/ Does not include Olema Creek and its tributaries.

b/ Includes Olema Creek and its tributaries.

c/ PLD Index = Peak Live and Cumulative Dead Index; n.a. = not available.

d/ Mainstem Lagunitas estimate based on total live coho observations and may include repeat sightings of same fish
MMWD = Marin Municipal Water District data; PRNS = Point Reyes National Seashore data

As discussed earlier, PL index data have not been consistently gathered for all creeks in the project area and can vary in quality depending on the number of surveys conducted and other factors. Data on the number of new redds provides a good overview of recent spawning activity in PRNS watersheds (Table 27). These data indicate the high annual variability in coho spawning activity and the relative importance of Olema Creek to spawning in the Lagunitas Creek drainage.

Table 27. Total Coho Redds in Lagunitas Creek Watershed, 1995-2003 (MMWD & PRNS)

Year	Lagunitas Creek mainstem	San Geronimo Creek (mainstem+tribs)	Devil's Gulch (+ Cheda)	Olema Creek (mainstem+tribs)	Total new redds
1995/96	70	6	10	n.a.	86
1996/97	98	115	42	n.a.	255
1997/98	80	107 + 14	46	126 + 7	380
1998/99	92	46 + 14	31	42 + 1	226
1999/00	139	58 + 3	3	10 + 7	220
2000/01	119	56 + 18	11	86 + 48	338
2001/02	79	102 + 43	59 + 3	58 + 31	375
2002/03	71	39 + 22	24 + 2	5 + 12	175

n.a. = not available.

The contribution of the Lagunitas Creek mainstem to overall spawning activity in that drainage is indicated by data collected by MMWD since 1982 (Table 27). Coho spawner counts and redd data show that much spawning activity takes place on Lagunitas Creek tributaries. Spawning on the mainstem takes place largely in Samuel P. Taylor State Park, upstream of PRNS-administered grazing lands.

Table 28. Coho Salmon Spawning Survey Data for Lagunitas Creek Mainstem

Year	Number of Surveys	PDL Index	Total Carcasses	Total New Redds	Source
1982/83	6	n.a	n.a	65	Bratovich & Kelly 1988
1983/84	6	n.a.	n.a.	26	Bratovich & Kelly 1988
1991/92	1	n.a.	n.a.	34	Wise 1992
1995/96	10	129 ^a	n.a.	70	Trihey & Assoc. 1996
1996/97	8	170 ^a	23	98	Trihey & Assoc. 1997
1997/98	10	46	27	80	MMWD
1998/99	8	56 ^b	6	92	MMWD
1999/00	14	371 ^b	37	139	MMWD
2000/01	14	181 ^b	18	119	MMWD
2001/02	15	214 ^b	25	79	MMWD
2002/03	13	283 ^b	18	71	MMWD

a/ Peak live fish counts only, no cumulative dead.

b/ Total live fish observations, may include repeat sightings of same fish

n.a. = not available.

MMWD = Marin Municipal Water District data

The mouth of Lagunitas Creek and adjacent floodplain supports activities associated with the Waldo Giacomini dairy. This 563-acre property, once tidal wetlands, was diked and drained in the early 1940s to create pastures. For many years, a gravel dam was constructed annually just below the confluence of Lagunitas and Olema creeks for irrigation and stock watering. The dam created an abrupt transition from fresh to saline water for smolts and spawning adults, eliminating the transition zone found in an unimpaired estuarine system. The transition zone allows smolting fish time to adjust to saline conditions and provides productive feeding zones where both freshwater and saltwater invertebrates are available.

The dam and the levees concentrated the area where spawning fish could hold and smolts could feed, and increased the potential for predation. While the annual construction of the dam has been discontinued, the levees are still in place. PRNS is currently acquiring these lands and developing a floodplain restoration plan. A phased restoration project requiring from five to ten years is planned to begin after final acquisition in 2007. Such restoration is expected to improve estuarine smolt and adult emigration habitat for both coho and steelhead.

Devil's Gulch has the longest period of spawner survey records for the Lagunitas Creek watershed. CDFG biologist Eric Gerstung and warden Al Giddings noted live coho and steelhead observations from 1948 to 1977. Consultants for MMWD conducted surveys from 1982-84 and 1995-97. PRNS expanded the sampling area further upstream in 1996-97 (Table 29). Prior to 1982/83, no more than two surveys were conducted in a single season and carcasses and redd data were not consistently collected. During a single survey in 1948, 174 coho and steelhead were counted in a 2.6 km reach. Between 1957/58 and 1976/77, peak counts of live coho ranged between 70 and 130 fish. Coho numbers had dropped by the 1990s, with PL index values between 1995/96 and 2002/03 ranging from 10 to 78 fish.

Table 29. Coho Salmon Spawning Survey Data for Devil's Gulch

Year	Number of Surveys	Survey Area (km)	PDL Index	Total Carcasses	Total New Redds	Source
1948	1	2.6	174 ^a	n.a.	n.a.	Gerstung & Giddings
1957/58	2	2.4	100 ^b	n.a.	74	Gerstung & Giddings
1960/61	1	2.6	77 ^b	n.a.	n.a.	Gerstung & Giddings
1961/62	1	2.6	70 ^b	n.a.	n.a.	Gerstung & Giddings
1964/65	1	1.6	91	76	n.a.	Gerstung & Giddings
1965/66	2	2.6	130 ^b	n.a.	n.a.	Gerstung & Giddings
1976/77	1	2.4	100	90	n.a.	Gerstung & Giddings
1982/83	6	2.4	n.a.	n.a.	23	Bratovich & Kelly 1988
1983/84	6	2.4	n.a.	n.a.	11	Bratovich & Kelly 1988
1995/96	6	2.4	19 ^b	n.a.	10	Trihey & Assoc. 1996
1996/97	3	3.2	47	20	42	Trihey & Assoc. 1997; PRNS
1997/98	8	3.2	27	9	46	PRNS
1998/99	6	3.2	26	6	31	PRNS
1999/00	2	3.2	10	1	3	PRNS
2000/01	4	3.2	14	2	11	MMWD
2001/02	11	3.2	46	12	59	MMWD
2002/03	5	3.6	78	1	24	MMWD

a/ Peak live fish count includes both coho and steelhead, does not include carcass data.

b/ Peak live fish counts without accumulated carcass data.

n.a. = not available.

MMWD = Marin Municipal Water District data; PRNS = Point Reyes National Seashore data

Cheda Creek, a Lagunitas Creek tributary, has been surveyed since 1996/97 by PRNS to detect the presence or absence of coho. Surveys were during peak migrations of coho in nearby drainages, when passage and attraction flows were sufficient and water clarity was not limiting. Coho presence in this creek appears to be sporadic, with no spawning activity detected during the winters of 98/99 and 00/01. However, coho spawning may be increasing, with four live fish and three redds seen in '01/02 and two fish and two redds in 02/03.

Until recently, much of the creek's potential spawning area was blocked by a failed sediment control structure. Construction of a fish passage structure consisting of a series of stepped pools was completed in 2000. Fencing to exclude cattle from 2.5 km of the creek above and below this structure has been completed. During fall, 2000, juvenile coho were observed in the project area. In anticipation of future spawning activity resulting from greater access to suitable habitat, monitoring of coho and steelhead juveniles on Cheda Creek will continue to be implemented.

Olema Creek Watershed. Olema Creek flows through the rift valley created by the San Andreas fault and joins Lagunitas Creek within the estuarine area, roughly three kilometers south of Tomales Bay. It is the largest drainage within the PRNS administrative area, providing the greatest habitat area and diversity. Most of Olema Creek's watershed is contained within the boundaries of GGNRA and PRNS, with only small pockets of private lands concentrated around the town of Olema. The Vedanta Society owns and manages 2,143 acres on the west side of the stream, but the land-use intensity on most of the property is very low.

The 37 km² Olema Creek watershed consists of a linear drainage basin that is approximately 14.5 km long and 3.2 km across at its widest point. The creek consists of 17.4 km of stream channel, which has several distinct sections. From its mouth to 11.9 km, it has continuous perennial flow, while above this section the creek becomes a series of isolated pools during the summer. Above 15.0 km, the creek usually dries up entirely in the summer. Numerous short tributaries enter Olema Creek from the east and west.

Olema Creek crosses the San Andreas Fault near Five Brooks, and again about 1 km downstream. At this location there are substantial natural landslides occurring on both sides of the creek. The west side of the drainage is largely covered by Douglas-fir forest. Extensive logging in this area prior to 1964 resulted in further instability of the channel. The hydrology of Olema Creek also has been altered by the straightening of the lower 3 km of its channel in the 1920s, and by construction of levees on Lagunitas Creek below the confluence with Olema Creek. Channel instability caused by these factors continues to cause bank cutting and failure, which is dramatic in several locations. The east side of Olema Valley consists of deep canyons dissecting the extensive grasslands of Bolinas Ridge. These grasslands have been grazed by cattle for 150 years.

Like Lagunitas Creek, Olema and its tributaries support both coho salmon and steelhead trout. Three FMUs, Bolinas Ridge, Highway One, and Wilderness South include portions of the Olema Creek watershed. These FMUs encompass 28% of the total watershed area (see Table 11).

The perennial section of Olema Creek has been systematically surveyed for live adult coho, carcasses, and redds since the winter of 1994/95 (Table 30). Results have shown considerable variability from year to year. As in other creeks in the Lagunitas drainage, Olema Creek had a high count for coho salmon in the winter of 1996-97, with a PL Index value of 174. Numbers fell considerably below this level for the following three years, but in 2000/01 they rebounded, with a PL index value of 103 fish, total carcasses numbering 65, and a total redd count of 86.

Table 30. Coho Salmon Spawning Survey Data for Olema Creek Mainstem

Year	Number of Surveys	Survey Area (km)	PDL Index	Total Carcasses	Total New Redds	Source
1994/95	3	13.4	53	1	9	Tomales Bay Association (TBA)
1995/96	2	13.4	106	37	n.a.	PRNS; TBA
1996/97	2	15.6	174	16	n.a.	PRNS; TBA
1997/98	8	13.4	88	39	126	PRNS
1998/99	6	15.0	42 ^a	13	42	PRNS
1999/00 ^b	2	7.2	9	9	10	PRNS
2000/01	4	11.8	103	65	86	PRNS
2001/02	4	11.8	90 ^c	28	58	PRNS
2002/03	4	11.9	20	17	5	PRNS

a/ Includes two peaks, 7 weeks apart.

b/ Surveys missed peak numbers.

c/ Includes two peaks, 4 weeks apart

n.a. = not available.

Surveys have also been conducted on tributaries of Olema Creek and its headwaters, which is the section of creek above 17.4 km from its mouth. These surveys have confirmed spawning activity in five of the tributaries and in the Olema Creek headwaters. Except for the John West Fork and Quarry Gulch, coho observed have been within a few hundred meters of the mainstem confluence.

The John West Fork (aka Blueline Creek) is the most significant of the Olema Creek tributaries, having a greater average flow and more potentially suitable spawning habitat (2.2 km) than any other. A sharp drop below a culvert under Highway 1 previously limited access to most of the spawning habitat; during the two winters from 1997 to 1999 only 9% (3 of 33) of the total coho observations in the creek were above the culvert. In 1999, a structure was constructed to aid fish passage through the culvert. In the following four winters, 75% the total coho observations (146 of 194) were above the culvert. As part of this project, fencing to exclude cattle from 1 km of the creek was installed.

Table 31. Coho Salmon Spawning Survey Data for the John West Fork

Year	Number of Surveys	Survey Area (km)	PDL Index	Total Carcasses	Total New Redds	Source
1995/96	?	?	8 ^a	n.a.	n.a.	PRNS
1996/97	n.a.	n.a.	n.a.	n.a.	n.a.	PRNS
1997/98	5	1.3	12	0	7	PRNS
1998/99	2	?	9	0	1	PRNS
1999/00 ^b	3	1.1	18	0	7	PRNS
2000/01	4	1.9	58	30	48	PRNS
2001/02	6	1.8	20	5	31	PRNS
2002/03	7	1.3	27 ^c	0	12	PRNS

a/ Includes live fish only, no carcass data.

b/ Surveys missed peak numbers.

c/ Includes two peaks, 4 weeks apart

n.a. = not available.

Starting in 1997, the CSRP has undertaken intensive survey work on Olema Creek to assess salmonid habitat condition and reproductive success. The focus of the CSRP is to correlate salmonid abundance at three life stages with habitat conditions to ascertain limiting factors on overall abundance. Index sites have been established along stream reaches representative of fish habitats and electrofishing is being used to determine juvenile coho and steelhead numbers. Results will be used to prioritize habitat restoration efforts and buffer threatened salmonid populations against potentially detrimental environmental conditions.

Data indicate that a high proportion of juvenile salmonids found in Olema Creek are located in the upstream, intermittent section above 11.9 km. A special study of the intermittent section of Olema Creek was conducted in 1999. Results indicate a significant loss of juveniles stranded in drying pools, which could be an important factor in reducing overall reproductive success in Olema Creek. Repeating this study, together with outmigrant trapping the following spring, could provide valuable information on the adequacy of Olema Creek juvenile salmonid habitat.

The CSRP also conducted a survey of in-stream salmonid habitat conditions on upper section Olema Creek (11.8-15.0 km). The survey found that much of the Olema Creek salmonid habitat may be sub-optimal due to high sediment loads that fill interstitial spaces in spawning gravel, fill pools, and reduce the overall stream volume.

The CSRP survey work to date shows that Olema Creek and its tributaries contain viable habitat for salmonids but there is not yet enough information to determine whether coho and steelhead populations are stable, increasing, or decreasing.

Drakes Bay Watersheds. The Drakes Bay watersheds include all those draining directly to the Bay from Double Point, north and west to Chimney Rock, with the exception of the watersheds within Drakes Estero (described as separate watershed unit). Watersheds south of Drakes Estero, such as Coast Camp Creek, Coast Creek, and Santa Maria Creek, are perennial systems known to support steelhead trout. In some watersheds, including Alamere Creek, rainbow trout (also *Oncorhynchus mykiss*) occur above the natural migratory barriers. The watersheds to the west of Drakes Estero do not support either of the salmonid species within the park. The Drakes Bay watersheds include portions of five FMUs, including Headlands, Limantour Road, Palomarin, Wilderness North, and Wilderness South (see Table 11). Steelhead trout occur within all of the FMU areas with the exception of the Headlands.

Drakes Estero Watersheds. Watersheds draining to Drakes Estero including East and North Schooner, Glenbrook, Muddy Hollow, Home Ranch, and Laguna Creeks are known to support steelhead trout. Many sites within the Drakes Estero watershed are identified for restoration of fish passage as part of the Coastal Watershed Restoration Project. The Drakes Estero watershed includes portions of four FMUs, including Estero, Inverness Ridge, Limantour Road, and Wilderness North (see Table 11). Steelhead trout occur within each of these management units.

Pacific Drainages. While the Pacific drainages include portions of two FMUs, Headlands and Tomales Point, these watersheds do not support threatened salmonid species.

Bolinas Drainages. The Bolinas drainages include Arroyo Hondo Creek draining to the ocean, as well as Lewis Gulch and McKinnon Gulch draining to Bolinas Lagoon. Many of the Bolinas watersheds support perennial stream flow and steelhead trout. The Bolinas Drainage area includes the Bolinas Ridge, Highway One, and Palomarin FMUs. These management units represent 33% of the total drainage area (see Table 11). Each of the FMUs includes areas known to support steelhead trout.

The unique flow and fish habitat characteristics observed within Pine Gulch Creek. Approximately 75% of the watershed drains from Inverness Ridge, west of the San Andreas Fault. These perennial tributaries provide water to the mainstem, but climb immediately from the valley bottom, providing little to no salmonid habitat. The geologic formations west of the San Andreas Fault include the Santa Cruz Mudstone and Merced Formation (Clark et. al, 1984), which support deep soils with high infiltration capacity. The remaining 25% of the watershed drains from Bolinas Ridge east of the SAF. The Franciscan Complex, which supports very thin soils with very low capacity for infiltration, makes up Bolinas Ridge. Tributaries draining from Bolinas Ridge have topography and stream profiles appropriate to support salmonids. Except for

McCurdy Creek, all eastern tributaries are intermittent. The Pine Gulch Creek watershed includes two FMUs, Bolinas Ridge and Highway One, representing 23% of the total watershed area (see Table 11).

The watershed supports a population of steelhead and it is generally accepted that it supported a native self-sustaining population of coho salmon into the 1970s. The last observation of coho salmon documented in July of 1968 reads, “coho salmon, 20 fish per 100 foot length of stream” (CDFG, 1968). The reasons for extirpation of coho salmon in Pine Gulch are uncertain. It is likely that the drought of the late 1970s coupled with in-stream damming during the same period severely depleted multiple year classes and led to unsuitable conditions for continued survival of the species within the Pine Gulch watershed.

Following thirty years without documented coho sightings, recent NPS monitoring activities have detected the presence of three consecutive cohort year classes in Pine Gulch Creek. Beginning in winter 2000-2001, coho salmon spawners have been observed in low numbers (<5 per year) within the watershed. Modified Hankin-Reeves surveys yielded estimates of 589 (\pm 329) juvenile coho salmon in September 2001 and 1205 (\pm 337) juvenile coho salmon in September 2002. The 2002 survey results indicate higher abundance and wider distribution of coho than the 2001 survey. In response to juvenile presence in 2001, a smolt trap was operated in the spring of 2002 capturing 249 coho smolts (Ketcham & Brown, 2003). Evaluation of genetic samples indicate that coho salmon captured during summer 2001 in Pine Gulch Creek have a strong genetic affinity to coho in the Redwood Creek watershed, Marin County (Garza, personal communication), six miles to the south.

California Freshwater Shrimp (*Syncaris pacifica*)- Endangered

The California freshwater shrimp is the only extant member of the genus and is listed by the U.S. Fish and Wildlife Service as endangered (55 FR 43884). The shrimp is endemic to 16 coastal streams in Marin, Sonoma, and Napa counties north of San Francisco Bay, California. The shrimp is found in low elevation (<116 meters), low gradient (generally <1 percent), perennial freshwater streams with structural diversity, including undercut banks, exposed roots, overhanging woody debris, or overhanging vegetation. Existing populations are threatened by introduced fish; deterioration or loss of habitat resulting from water diversion and impoundment; livestock, dairy, and other agricultural activities and developments; flood control activities; gravel mining; timber harvesting; migration barriers; and water pollution. A study was recently conducted in PRNS and GGNRA to determine the distribution of California freshwater shrimp within streams in the parks, to evaluate the effectiveness of three survey methods for the shrimp, and to provide recommendations for survey techniques for long-term monitoring.

These shrimp reside in the Lagunitas and Olema Watersheds and depend on overhanging vegetation along the creek’s banks for habitat. The shade provided by this vegetation is also important to the protection of rare fish species. Prescribed burning would incorporate a fixed setback from water resources to protect the water quality, the sensitive plant community and the listed fish species. The setback would also avoid adverse effects to the creek bank habitat important to the California freshwater shrimp.

The current range of the shrimp within Lagunitas Creek extends from Shafter Bridge in Samuel P. Taylor State Park to roughly 1.6 km below the confluence with Nicasio Creek (Serpa, 1991). Shrimp habitat along the main stem of Lagunitas Creek within the Parks is generally protected from agricultural activities occurring within the watershed. Small numbers of shrimp were collected in 1996 and 1997 near the confluence of Olema and Lagunitas creeks (Fong, 1999).

California Freshwater shrimp surveys detected small numbers of CA freshwater shrimp in lower Olema Creek in 2001. The USGS–BRD Dixon Field Station is conducting investigations of California freshwater shrimp habitat, survival, and predation within lower Olema and Lagunitas Creeks. This three-year investigation is looking at habitat and flow characteristics supporting the species and has found that native sculpin are a significant predator of the shrimp. Shrimp have not been found in the lower Olema Creek sections during this USGS investigation (LoBianco and Fong, 2002).

Myrtle's Silverspot Butterfly (*Speyeria zerene myrtleae*) – Endangered

Myrtle's silverspot butterflies inhabit coastal dune, coastal prairie, and coastal scrub habitats at elevations ranging from sea level to 300 meters, and as far as 5 kilometers inland (Launer et al., 1992). It was federally listed as endangered in 1992. Its historic distribution is believed to have extended from near Fort Ross south to Punta Ano Nuevo. By the 1970s populations south of the Golden Gate were believed to be extinct and extant; populations of the butterfly were believed to exist only within PRNS. Reasons for this decline include urban and agricultural development, changes in natural fire patterns, successional changes in plant communities have reduced availability of host plants, invasive non-native plants, livestock grazing, overcollecting, and other human impacts.

Following discovery of a population near the Estero de San Antonio in the early 1990s, field surveys were conducted by the Center for Conservation Biology at Stanford University. Two additional, apparently separate populations in PRNS were located and fieldwork was done to estimate populations' sizes. One population, centered on North Beach, extended from Abbotts Lagoon to South Beach and east to Drakes Estero and Drakes Beach. The highest numbers were found along the dune-scrub interface in the back dune area of the central peninsula on F and G ranches and the AT&T property, and on the bluffs on either side of the Drakes Beach visitor center. The population was estimated to number in the low thousands in 1993. Survey work in 1998 put the population estimate at 50-200 individuals, with no silverspots being found in portions of the 1993 range. The other population was found on the Tule Elk Reserve, with small numbers on the adjacent J Ranch. In 1993, the number of individuals in this population was estimated to be in the mid-hundreds. The 1997 survey of this northern Point Reyes population gave a population estimate of 250-500 (Launer et al., 1998).

Silverspot numbers in the area outside of parklands around the Estero de San Antonio were estimated at 2,000-5,000 individuals in 1991. Other nearby areas with potentially suitable habitat was not surveyed. Together with those found at Point Reyes, estimated numbers for the three known populations of the species total less than 10,000 individuals (USFWS, 1998).

Known Myrtle's silverspot nectar plants include curly-leaved monardella (*Monardella undulata*), yellow sand verbena (*Abronia latifolia*), seaside daisy (*Erigeron glaucus*), bull thistle (*Cirsium*

vulgare), gum plant (*Grindelia* spp.), and mule ears (*Wyethia* spp.). Brownie thistle (*Cirsium quercetorum*) and groundsel (*Senecio* spp.) are also fed upon. Many of these species are commonly found at Point Reyes. Oregon silverspot (*Speyeria zerene hippolyta*) feeds on other common plant species that may also be used by Myrtle's silverspot.

Myrtle's silverspot larvae are known to use only one species as a host plant, western dog violet (*Viola adunca*). It is possible that, like other subspecies of *Speyeria zerene* and other species of silverspots, Myrtle's silverspot use other violet species as larval hosts, although this has not been observed. The perennial, rhizomatous western dog violet is found on open grassy slopes, sandy flats behind dunes, and on the edge of brush under pines (Howell, 1970). While it is described as "rather common near the coast," including the Point Reyes dunes, distribution of the species is patchy. Abundance of western dog violet alone is not a good predictor of silverspot presence. Myrtle's silverspot presence also is associated with protection from high coastal winds that are common during the summer flight season (Launer et al., 1992). The complex habitat needs of breeding Myrtle's silverspots may be the species' limiting factor.

Populations of *Speyeria* butterflies experience large population fluctuations, and population increases of tenfold or more in a single year has been observed. In 1994/95, California's central coast experienced a very wet winter that reduced numbers of many late-spring and summer-flying butterflies (silverspots are the latter). Another wet winter occurred in 1997-98, which may have resulted in the low numbers for the central Point Reyes population observed in summer, 1998.

Due to the lack of historic data previous to the 1990s, it is not known if the silverspot has declined at Point Reyes. While surveys of the two populations during the period 1993-1997 found that the Tule Elk Reserve population remained stable and the central Point Reyes population declined sharply, such variation is well within that normally found in *Speyeria* species (USFWS, 1998).

A Masters thesis project, which will include mapping the distribution of larval host and nectar plants at PRNS and monitoring the response of these species to different grazing regimes is currently being developed by a member of PRNS Resource Management staff. Additionally, plant species composition response to tule elk grazing and to exclusion from grazing is being assessed as part of long-term monitoring of vegetation in the Tule Elk Reserve. Together with continued censusing of Myrtle's silverspot numbers, this research will help provide the needed grazing management information identified by the Myrtle's silverspot recovery plan (USFWS, 1998).

Western snowy plover (*Charadrius alexandrinus nivosus*) – Threatened

Western snowy plovers use the Point Reyes peninsula as both wintering and nesting habitat. Wintering birds occur around Drake's Estero and Abbott's Lagoon, and along Limantour Spit and the Great Beach. During the 1980s nesting took place along the entire Great Beach, Drake's Beach, and at Limantour Spit. In recent years, erosion along the southern portion of the Great Beach has diminished the upper beach area such that the entire beach can be washed by waves. Nesting is occurring on the northern portion of this beach, between the North Beach parking area and Kehoe Beach, which is backed by extensive dunes. Snowy plovers also nest along the

western edge of Abbott’s Lagoon. Although it had historically been used as nesting habitat by plovers, erosion has affected Limantour Spit and it no nests have been seen since 2000. In 2001 and 2002, all snowy plover nests observed were located on the northern portion of the Great Beach.

Monitoring of nesting snowy plovers in 1986-1989 and 1995-2002 indicates a decline in the number of nesting birds through 1996, followed by a gradual rebound (Table 32). Point Reyes Bird Observatory (PRBO) monitored individual nests at all nesting areas during this period. On the Great Beach, where most nesting took place, the number of chicks fledged per egg laid during 1986-89 and 1995 ranged from 1%-7%.

Table 32. Snowy plover Nesting at PRNS.

Year	Number of nests	Number of nesting birds	Number of chicks fledged	Percent chicks fledged per egg laid
1986	41	41-44	5	5
1987	74	50-54	15	7
1988	63	40-42	5	3
1989	60	34-37	1	1
1995	20	12	4	7
1996	9	10-11	14	58
1997	25	25	20	45
1998	14	16	21	58
1999	21	20	22	47
2000	28	31-37	14	19-20
2001	34	27-36	10	11-12
2002	30	34-37	17	22
2003	22	25	19	

In 1996 a program to increase snowy plover nesting success was initiated, and this program continues to the present. Several nesting areas, including Limantour Spit and sections of the Great Beach accessed by the Abbott’s Lagoon and Kehoe Beach trails, experience regular visitor use. In response, PRNS ropes off sensitive habitat and posts signs to divert visitor traffic. Visitors are advised to avoid walking on upper beach areas used by plovers, and dogs are prohibited from nesting areas. In 2000, observers found a higher rate of snowy plover chick loss in these areas on weekends, when disturbance by human visitors and dogs is more likely. In 2001, the Seashore initiated a snowy plover weekend docent program to increase awareness of plover habitat restrictions. Starting in 1996, exclosures were placed over plover nests to reduce avian and mammalian predation. Since the use of exclosures in 1995, the rate of chicks fledged per egg has increased to 20%-58% (Ruhlen and Abbott, 2000), and between one and three chicks per female have fledged. In 2000, although egg laying remained high, fledging rate started to decline. Causes for the decline likely includes predation by ravens, raptors, and disturbance by visitors. Ravens have been identified as the primary predator of eggs of plovers and any activities that increase the presence or productivity of ravens would potentially have a negative effect on the plovers. Ravens could benefit from prescribed fires by foraging on fleeing wildlife such as reptiles and rodents.

Fledging rates for snowy plovers before nest protection began were insufficient to maintain the species at PRNS, as indicated by declining numbers of nests and nesting adults in the period 1986-1995. Continuation of such low nest success rates could have resulted in loss of the PRNS breeding population of snowy plover. The current nest protection program has raised nest success rates to levels similar to those at other coastal California locations.

Additional Special Status Wildlife

Table 33 lists several animal species in the project area that are federal Species of Concern or listed by the state of California. In the federal system, Species of Concern are those where USFWS is collecting additional information to determine whether they warrant consideration for future listing. Table 33 lists nine species of mammals, 22 species of birds, three reptiles, two species of amphibians, three fish, and ten species of invertebrates. The table also shows which species are potentially subject to adverse effects. Because it may be more likely than other species to experience effects from fire or fire management activities, the Point Reyes Mountain Beaver is discussed in more detail below.

Point Reyes Mountain Beaver (Aplodontia rufa phaea) - Federal Species of Concern.

The US Fish and Wildlife Service and the California Department of Fish and Game list the Point Reyes mountain beaver, a muskrat-sized rodent found only in scrub habitat in western Marin, as a Species of Concern. Mountain beaver may be adversely affected by actions described in the Fire Management Plan alternatives, but most particularly by large-scale unplanned ignitions. Studies conducted following the 1995 Vision Fire in Point Reyes revealed that Point Reyes mountain beaver suffered high mortality. Surveys indicated that pre-fire estimates of approximately 5,000 individuals were in the burned area. After the Vision Fire, major changes in the habitat occurred. For example, there was a reduction in coastal scrub to charred sword fern bases and blackened skeletons of coyote brush. Post Vision Fire surveys suggested that only 19 mountain beavers survived within the surveyed fire area. This number represents only 0.4 – 1.2% of the population that park staff estimate had previously inhabited the surveyed area (Fellers et al., 2003). It is likely that the post-fire mortality was related to dehydration as this species requires up to two cups of water per day, normally provided through roots and vegetation, to survive. Monitoring in the years following the fire indicate that recovery of the populations has been slow (Fellers, 2000). Populations on the peninsula outside of the area burned in the Vision Fire remain healthy (Fellers, pers. comm. 2003).

Table 33. Animal Species of Concern and California-listed Species That May Occur in Areas Affected by PORE's Fire Management Plan (per USFWS Letter, May 24, 2001)

Common Name	Scientific Name	Known to Occur	Potentially Subject to Adverse Impacts
Mammals			
California myotis bat	<i>Myotis californicus</i>	yes	yes
Fringed myotis bat	<i>Myotis thysanodes</i>	yes	yes
Greater western mastiff-bat	<i>Eumops perotis californicus</i>	no	no
Long-eared myotis bat	<i>Myotis evotis</i>	yes	yes

Long-legged myotis bat	<i>Myotis volans</i>	yes	yes
Pacific western big-eared bat	<i>Corynorhinus (Plecotus) townsendii townsendii</i>	yes	yes
Point Reyes jumping mouse	<i>Zapus trinotatus orarius</i>	yes	yes
Point Reyes mountain beaver	<i>Aplodontia rufa phaea</i>	yes	yes
Yuma myotis bat	<i>Myotis yumanensis</i>	yes	yes
Birds			
Allen's hummingbird	<i>Selasphorus sasin</i>	yes	yes
American bittern	<i>Botaurus lentiginosus</i>	yes	no
Ashy storm petrel	<i>Oceanodroma homochroa</i>	yes	no
Bank swallow (CT) ^a	<i>Riparia riparia</i>	no	no
Bell's sage sparrow	<i>Amphispiza belli belli</i>	no	no
Bewick's wren	<i>Thryomanes bewickii</i>	yes	yes
Black rail (CT) ^a	<i>Laterallus jamaicensis coturniculus</i>	yes	no
Black-crowned night heron	<i>Nycticorax nycticorax</i>	yes	no
Common loon	<i>Gavia immer</i>	yes	no
Ferruginous hawk	<i>Buteo regalis</i>	rare	no
Grasshopper sparrow	<i>Ammodramus savannarum</i>	yes	yes
Harlequin duck	<i>Histrionicus histrionicus</i>	rare	no
Little willow flycatcher (CE) ^b	<i>Empidonax traillii brewsteri</i>	no	no
Loggerhead shrike	<i>Lanius ludovicianus</i>	rare	no
Long-billed curlew	<i>Numenius americanus</i>	yes	no
Olive-sided flycatcher	<i>Contopus cooperi</i>	yes	yes
Pacific-slope flycatcher	<i>Empidonax difficilis</i>	yes	yes
Rufous hummingbird	<i>Selasphorus rufus</i>	no	no
Saltmarsh common yellowthroat	<i>Geothlypis trichas sinuosa</i>	yes	no
Short-eared owl	<i>Asio flammeus</i>	yes	yes
Tricolored blackbird	<i>Agelaius tricolor</i>	yes	yes
Vaux's swift	<i>Chaetura vauxi</i>	yes	no
White-tailed (=black shouldered) kite	<i>Elanus leucurus</i>	yes	yes
Reptiles			
California horned lizard	<i>Phrynosoma coronatum frontale</i>	no	no
Northwestern pond turtle	<i>Clemmys marmorata marmorata</i>	yes	no
Alameda striped racer	<i>Masticophis lateralis euryxanthus</i>	no	no
Amphibians			
Foothill yellow-legged frog	<i>Rana boylei</i>	no	no
Northern red-legged frog	<i>Rana aurora aurora</i>	no	no
Fish			
Longfin smelt	<i>Spirinchus thaleichthys</i>	no	no
Pacific lamprey	<i>Lampetra tridentata</i>	yes	no
Tomales roach	<i>Lavinia symmetricus ssp.</i>	yes	no
Invertebrates			
Bumblebee scarab beetle	<i>Lichnanthe ursina</i>	yes	
Globose dune beetle	<i>Coelus globosus</i>	yes	no

Marin elfin butterfly	<i>Incisalia mossii</i>	unknown	unknown
Nicklin's peninsula Coast Range snail	<i>Helminthoglypta nickliniana awania</i>	unknown	unknown
Oplers longhorn moth	<i>Adela oplerella</i>	unknown	unknown
Point Reyes blue butterfly	<i>Icaricia icaridides ssp</i>	yes	yes
Ricksecker's water scavenger beetle	<i>Hydrochara rickseckeri</i>	no	no
sandy beach tiger beetle	<i>Cicindela hirticollis gravida</i>	yes	no
Sonoma arctic skipper	<i>Carterocephalus paleemon ssp</i>	unknown	unknown
William's bronze shoulderband snail	<i>Helminthoglypta arrosa williamsi</i>	unknown	unknown

a/ CT: Listed as threatened under the California Endangered Species Act b/ CE: Listed as endangered under the California Endangered Species Act

Habitats of Management Concern

Numerous habitat types within the project area are afforded protection under various laws and regulations. Through the 1997 Magnuson-Stevens Act, the National Marine Fisheries Service (NMFS or NOAA Fisheries) has designated all streams on NPS lands as Essential Fish Habitat (EFH). EFH waters support a variety of fish species. The USFWS has designated critical habitat for the protection of the California red-legged frog, which includes nearly all of the land within the project area.

Cultural Resources

In addition to a diverse mosaic of natural and physical features, Point Reyes contains a varied array of cultural resources within its boundaries. The NPS recognizes five types of cultural resources: archeological resources, structures, ethnographic resources, cultural landscapes, and museum objects. Archeological resources “are the remains of past human activity and records documenting the scientific analysis of these remains.” These include artifacts, ecofacts, and features. Structures “are material assemblies that extend the limits of human capacity,” and comprise such diverse objects as buildings, bridges, vehicles, monuments, vessels, fences, and canals. Ethnographic resources “are basic expressions of human culture and the basis for continuity of cultural systems” and encompasses both the tangible (native languages, subsistence activities) and intangible (oral traditions, religious beliefs). The management of ethnographic resources entails the recognition that traditional cultures can have different worldviews and the right to maintain their traditions. Cultural landscapes “are settings we have created in the natural world.” They are intertwined patterns of natural and constructed features that represent human manipulation and adaptation of the land. Finally, museum objects “are manifestations and records of behavior and ideas that span the breadth of human experience and depth of natural history.” Examples of typical museum objects include field and laboratory notes, artifacts, and photographs.

Historical Overview

Cultural resources abound on the Point Reyes peninsula. The Coast Miwok people inhabited the area for more than 2000 years before European explorers arrived, and human population density before contact was probably greater than it is today (Cook, 1943). At least 124 Native American archeological sites exist within PRNS, primarily on the coastal lowlands. These known

prehistoric sites are primarily “shell middens,” voluminous deposits of soil with a relatively high content of local shell that were created as a byproduct of human habitation or use of the site. The shell reflects the harvest of shellfish by the Coast Miwok as both food and raw material for the manufacture of shell beads, ornaments, and tools.

The interior core of the peninsula has not yet been surveyed for archeological sites, due in part to a combination of thick vegetation and rugged topography. The NPS recently estimated that between 41 and 123 additional Native American archeological sites are present within its boundaries. Ironically, these areas that have not been surveyed because of topographic constraints or thick vegetation may be those where fire would be most intense and likely to inflict damage.

The ethnographic Coast Miwok were a hunting and gathering people who harvested diverse, naturally occurring terrestrial and aquatic foods and materials. They created tools, clothing, weapons, structures, ornaments, baskets, and other items of material culture using resources that were primarily local but sometimes traded (e.g., obsidian). In addition they likely manipulated the local environment through limited burning to favor the reproduction of selected plant and animal species. Their settlement pattern is thought to reflect the “tribelet” model common to many Californian groups. In this model comparatively fewer and larger permanent village sites were each affiliated with several or smaller, semi-permanent villages or seasonally occupied habitation sites. These smaller sites were devoted to the harvest of specific, localized natural resources as they became available during the annual cycle. Coast Miwok people currently live in the area and are federally recognized as the Federated Indians of Graton Rancheria.

Most experts believe that Point Reyes contains the site of the first recorded English/Native American contact in North America. According to experts, Francis Drake is likely to have landed here in 1579 to careen his ship before sailing across the Pacific on a circumnavigation of the globe. In 1595 the first recorded shipwreck on the West Coast occurred when the Spanish galleon San Augustin wrecked in what is now Drake’s Bay. Since that year, Point Reyes history is replete with accounts of shipwrecks and underwater archeological surveys have been conducted to identify and record several of them. It was Spanish sailor explorer Sebastian Vizcaino who named Point Reyes (Punta de los Reyes) in 1602.

In the late 1700s and early 1800s the Spanish colonized California using the “Mission System.” The key Missions affecting the Coast Miwok were San Francisco de Asís (1776), San Rafael Arcángel (1817), and San Francisco Solano De Sonoma (1823). The Coast Miwok were encouraged and sometimes forced to remove from their local lands to the missions where they were further indoctrinated in the Catholic religion and assimilated into the Spanish colonial culture and economy. The profound changes in land use and economy initiated by the Spanish generally left them little choice if they were to survive at all. This eventually resulted in the almost complete collapse of the Coast Miwok people and culture and included the loss of most of their oral tradition.

In response to the many shipwrecks in treacherous coastal waters, the federal government established lighthouse and life-saving stations in the late 1800s and early 1900s. The historic Point Reyes Lighthouse was in service from 1870 to 1975. During that time, it endured many

hardships, including the 1906 earthquake. Forty-five shipwrecks occurred during the first 60 years of the Lighthouse's operation. Because of this ongoing problem, the U.S. Life-Saving Service established a life-saving station on the Great Beach in 1890. Four years later it was moved to Drakes Bay. The U.S. Coast Guard assumed the operation in 1915 and upgraded it in 1927. The life-saving station was designated a National Historical Landmark in 1989. The Lighthouse was listed on the National Register of Historic Places in 1978.

PRNS is home to the Marconi/RCA receiving and transmitting stations, which together with the Marconi receiving station site at Marshall (now the State Park-owned Marconi Conference Center) form the only known intact coast wireless station remaining in the United States dating from the birth of wireless communications. The Bolinas transmitting station was the site of the first trans-Pacific wireless communication in 1913. The two stations have been adaptively rehabilitated for park administrative and tenant office use, but retain significant historical radio equipment and antennas in operational condition. The sites are maintained and operated by park staff with significant assistance from park volunteers from the maritime Radio Historic Society.

Archeological Resources

Archeological resources typically consist of sites or isolated artifacts. In terms of location and period of origin archeological resources can be generally categorized as terrestrial or submerged, and either as prehistoric or historic. Prehistoric archeological sites may also include "protohistoric" components that reflect Coast Miwok occupation or use during the historic era, or that may contain early historic artifacts such as porcelain fragments originating from the Drake and Cermeno voyages. Historic archeological sites may also include or be in direct association with standing or ruined structures. Within PRNS, submerged archeological sites are typically historic shipwrecks that are either fully or partially submerged at high tide. Some sites include both prehistoric and historic components. Sites may singly or in combination contribute to, or even constitute cultural landscapes depending upon the character of their visible remains or landscape signatures. The Park estimates that approximately 87% of its terrestrial acres have not yet been surveyed for archeological resources. Archeological resources can be significant under any or all four criteria of the National Register of Historic Places.

In 2002 the Park determined that there were at least 124 recorded prehistoric, terrestrial sites. It was also estimated that there were from 41 to 123 additional, unknown terrestrial prehistoric sites within current Park boundaries. The highest probability for unknown prehistoric sites would be in the Tomales Point FMU, Limantour FMU, Headlands FUM, Highway One FMU, and Palomarin FMU because of their proximity to water and food resources. These sites are either habitation or use sites that reflect Coast Miwok occupation or resource processing sites. As described in the above *Historical Overview* most of the known prehistoric sites are shell middens of various sizes. Shell middens often contain a wide variety of cultural resources including, for example, human remains; cooking or food processing features (e.g., bedrock mortars); obsidian, chert and bone tools; shell ornaments; and the faunal remains of species harvested for food and materials. The depositional history reflected by a site's stratigraphy or layering, and the spatial organization of its contents are often critical for dating, understanding and interpreting Coast Miwok lifeways and cultural change over time. The geographic distribution of prehistoric sites on the land is important in itself for the information it can provide on Coast Miwok settlement systems.

The park also has counted 92 historic terrestrial archeological sites that have been recorded in various documents at different levels of intensity. In addition, it was estimated that 5 to 37 additional, unknown, historic terrestrial sites are likely to exist within the boundaries of PRNS. These sites typically reflect historic occupations and use of the peninsula; first by homesteaders and dairy ranch communities, and later by government lighthouse and lifesaving personnel and private radio telecommunications companies. They range in size and complexity from discrete trash pits containing old bottles, tins, broken tools and crockery; to now buried corduroy roads, ruined ranch sites, and radio communication facilities complete with antennae farms. As with prehistoric archeological sites, maintaining the integrity of the deposits or remains is crucial to understanding and interpreting them. Historic archival research is often important in predicting the location of such sites and also understanding what they once were and how they functioned.

Park cultural resource staff has also counted 9 known and recorded terrestrial archeological sites that contain both prehistoric and historic components (not necessarily related to each other). They estimate another 5 to 14 such sites within park boundaries exist but have not yet been identified.

The recently completed Point Reyes National Seashore Cultural Affiliation Report examining Native American affiliation at Point Reyes concluded that the Federated Coast Miwok people have a clear, exclusive affiliation with the lands managed by Point Reyes National Seashore extending back more than 2000 years. The Federated Coast Miwok are politically recognized by the federal government as the Federated Indians of Graton Rancheria.

Cultural Landscapes

PRNS manages 39 cultural landscapes; 23 are within the boundaries of Point Reyes National Seashore and 16 are within the North District of GGNRA. The landscapes primarily reflect the maritime, ranching, communications, and military history of the park. Two are ranching districts, which together comprise approximately 30,000 acres of parkland in the northern district of Point Reyes and the Olema Valley. Two other landscapes have national significance: the Lifeboat Station is a National Landmark and the Marconi/RCA sites (described above) are in the process of being nominated to the national register. Cultural landscapes identified in the NPS Cultural Landscapes Automated Information Management System (CLAIMS) are listed below in Table 34.

Table 34. Cultural Landscapes

Landscape Name	CLAIMS #	Location
Bolinas Copper Mines Hamlet	725194	Hwy One FMU, Olema Valley, GOGA
	725193	Not in FMU, Tomales Bay, GOGA*
North Pacific Coast Railroad Grade	725195	Bolinas Ridge FMU, Lagunitas Loop & Tomales Bay, GOGA
Olema Valley Ranches Historic District	725001	Highway One FMU, Olema Valley, GOGA
Cheda Ranch	725209	Not in FMU, Lagunitas Loop, GOGA
Five Brooks	725197	Wilderness South FMU, Olema Valley, GOGA
Hagmaier Ranch	725212	Highway One FMU, Olema Valley, GOGA
McFadden Ranch	725203	Not in FMU, Olema Valley, GOGA

Landscape Name	CLAIMS #	Location
McIsaac Ranch	725206	Not in FMU, Lagunitas Loop, GOGA
Ralph Giacomini Ranch	725014	Highway One Fmu, Olema Valley, GOGA
Stewart Ranch	725199	Wilderness South FMU, Olema Valley – GOGA
Teixeira Ranch	725211	Highway One FMU, Olema Valley, PORE
Truttman Ranch	725200	Not in FMU, Olema Valley, GOGA
Wilkin's Ranch	725003	Highway One FMU, Olema Valley, GOGA
Zanardi Ranch	725191	Not in FMU, Lagunitas Loop, GOGA
Tomales Bay Highway One	725482	Not in FMU, Tomales Bay, GOGA
Coast Guard Facilities	725161	Not in FMU, North District – PORE
Coast Guard Lifesaving Station & Navy Radio Direction Finder Station	725190	Not in FMU, South Beach – PORE
Point Reyes Lifeboat Station	725182	Headlands FMU, PORE
Point Reyes Lighthouse	725183	Headlands FMU, PORE
Coastal Defense Sites	725160	North & South District , PORE
Bolinas Military Reservation	725185	Palomarin FMU, PORE
Drakes Bay Artillery Installation	725186	Not in FMU, North District , PORE
SCR Radar Site	725184	Not in FMU, North District, PORE
Wildcat Military Reservation	725187	Wilderness South FMU, North District, PORE
Laird's Landing	725159	Not in FMU, Tomales Bay, PORE
Olema Lime Kilns	725158	Highway One FMU, Olema Valley, PORE
Point Reyes Ranches Historic District	725005	Not in FMU, North District, PORE
A Ranch	725012	Headlands FMU, PORE
B Ranch	725016	Not in FMU, North District, PORE
C Ranch	725017	Not in FMU, North District, PORE
D Ranch	725011	Not in FMU, North District, PORE
Home Ranch	725006	Estero FMU, North District, PORE
I Ranch	725167	Not in FMU, North District – PORE
L Ranch	725013	Not in FMU, North District, PORE
Upper Pierce Ranch	725177	Tomales Point FMU, North District, PORE
RCA Marine Radio Station	725162	Not in FMU, North & South Districts, PORE
RCA Receiving Station	725188	Not in FMU, North District – PORE
RCA Transmitting Station	725189	Not in FMU, Palomarin/Bolinas - PORE

*Not in FMU indicates that cultural landscape area is outside a Fire Management Unit that is proposed for treatment.

Structures

Over 300 hundred historic structures are found on land managed by PRNS. The majority of these structures are located outside the FMUs to be treated; however, the Headlands, Tomales Point, and Highway One FMUs do have some historic structures. The structures range from simple timber-framed barns to the cast-iron Point Reyes Lighthouse to the concrete Mission Revival Marconi transmitting station. Historic structures are found throughout most of the park (none in the wilderness area) and mark the built history of PRNS.

Approximately two thirds of PRNS's listed structures are ranch structures managed under leases and permits. The remaining structures primarily reflect the Park's maritime and radio communication history. Four sites are listed on the National Register, including the Point Reyes Lifeboat Station - a National Historic Landmark. Three additional properties have been determined eligible for the National Register and several additional properties are in review (see Table 35). 297 historic structures are on the List of Classified Structures, the NPS inventory of historic and prehistoric structures.

Table 35. National Register Status

NR Status	Property Name	Property Type & Date
National Register Listed	Olema Lime Kilns, #76000217, 10/08/76	structure/site, c. 1850
	Point Reyes Lifeboat Station, #85002756, 11/07/85	complex of buildings/features, c. 1927
	Designated as NHL 12/20/89	
	Upper Pierce Ranch, #85003324, 12/06/85	complex of buildings/features, c. 1858-1935
Determined Eligible	Point Reyes Light Station, #91001100, 09/03/91	complex of buildings/features, c. 1870-1960
	Sarah Seaver Randall House (GOGA) 08/29/79	single house, c. 1880
	Olema Valley Rural Historic District (GOGA) 01/02/79. Revision & resubmittal in progress.	district, c. 1834-present
	Hamlet (Jensen's Oyster Beds) (GOGA) 01/24/90	complex of buildings/features, c. 1900-1945
National Register Submittal Pending	Point Reyes NS Rural Historic Landscape District 04/03/95	district c. 1834-present
	Point Reyes Peninsula Archeological District	district, prehistoric
Determination of Eligibility Pending	Marconi/RCA Receiving and Transmitting Stations (in review)	complex of buildings/features, c. 1914-1945
	Bolinas Copper Mines (GOGA) (in review)	ruins/site, c. 1863-1918
	North Pacific Coast RR Grade (GOGA) (in review)	linear structure/sites, c. 1873-1933
	Tocaloma Bridge (GOGA) (in review)	single structure, c. 1927

Visitor Use and Visitor Experience

The project area is unique not only in its assemblage of natural and cultural features, but also in its proximity to a major urban population. This juxtaposition makes PRNS's resources and recreational opportunities readily accessible to a large number of people, and enhances the importance of the special qualities for which it was set aside. Over 2.25 million people visit PRNS annually. Visitation estimates for 2002 found that the North District of the park (north of Bear Valley) receives roughly 60% of the overall visitation. Over 700,000 visitors went to the 3 park visitor centers and over 70,000 visitors have extended contacts with park interpretive staff through ranger-led programs.

The area supports 147 miles of hiking trails, backcountry campgrounds, and numerous beaches. Activities include hiking, water sports, horseback riding, fishing, camping, wildlife viewing, and other interpretive opportunities.

Hiking is primarily a day-use activity. Approximately 50 trails are designated throughout PRNS, and they encompass a range of habitat types from wooded mountains to sandy beaches. Overnight stays are available through 4 backcountry campgrounds, the Stewart Horse Camp, the Point Reyes Hostel, a private campground, and local hotels and inns. Dozens of visitors bring horses to ride on designated horse trails, and hundreds rent horses every week from commercial stables.

Water sports include kayaking, canoeing, boating, and swimming. The majority of paddle crafts use Tomales Bay as it provides protection from ocean waves and surf, while power boaters more freely use the ocean. Though Stinson Beach and Bolinas attract more surfers, North Beach is known as a challenging surfing area. Nature study and wildlife viewing are important activities at Point Reyes. Visitors make special trips to PRNS to see migrating whales, shorebirds, breeding elephant seals, tule elk, and spring wildflowers. Information received from visitor surveys conducted by Sonoma State University (NPS, 1997 and NPS, 1998) found that most park visitors spend 2-6 hours at PRNS in a variety of activities dependent upon the season, ranging from whale watching and kayaking to hiking and bird watching.

The NPS gathers standardized annual surveys for each park unit to determine the percent of visitor satisfaction based on park facilities, visitor services, and recreational opportunities. During Fiscal Year 2002, based on a random visitor survey conducted by the University of Idaho, the park received a 98% visitor satisfaction ranking (NPS, 2002a).

Tomales Point FMU. Approximately 500,000 visitors a year visit Pierce Point Ranch and use the trails in the Tomales Point FMU. An important draw to the area is the trail to the tip of Tomales Point and the opportunity to see the tule elk herds. One out of five visitors will also stop at McClures or Kehoe Beach while in this northernmost portion of the park. Kayakers from the east side of Tomales Bay will pull out along the east coast beaches; overnight camping on the beach is permitted. Tomales Point provides solitude and vistas of Tomales Bay and the Ocean. Park docents provide information to visitors during the Tule elk rutting season from August to early October. The area is designated wilderness (with the exception of a buffer along Pierce Point Road) and no bicycles are allowed.

Headlands FMU. During the whale-watching season (December through April), the demand for visitation to the Headlands is so high and parking so limited that private vehicle use is restricted on weekends and visitors are shifted to a shuttle bus system. Sea lions, tule elk, shorebirds, and spring wildflowers all attract their share of eager observers. Year-round the historic lighthouse and Chimney Rock trail are heavily visited and unlike most areas of the park, visitors are relatively concentrated as they climb the lighthouse stairs or walk the short trail to Chimney Rock. Park staff provide interpretive programs on whales, wildflowers, pinnepeds, the lifeboat station, and the lighthouse. Lighthouse tours are also conducted once or twice a month in the evening. School programs are popular on weekdays during the school year. From June to September, most interpretive programs are held on the weekends.

Inverness Ridge FMU. The principal visitor use in this FMU is hiking and some bicycling. The experience is largely one of solitude and of wide vistas taking in the 1995 burn area, Tomales Bay, and the Ocean.

Estero FMU. The trail network in the Drakes Estero FMU does not receive high numbers of visitors according to monthly visitation counts. Portions of the trail network are open to bicyclists. The Estero is the site of harbor seal pupping from March 15 to June 30th. Other times of the year kayakers may put into the Estero from the area near Johnson's Oyster Farm. The trail network is very popular year-round with birdwatchers and hikers.

Palomarin FMU. Primarily wilderness, visitors hike to the coast to see harbor seals and go down to the tidepools. The experience is largely solitary with a view of the coastline north to the lighthouse. Visitors hike into Bass Lake to swim. No bicycles are allowed. The area is popular with birdwatchers and PRBO runs volunteer programs and research mist netting programs.

Highway One FMU. Visitors bicycle and horseback ride along the Olema Valley Trail and swim naked in Hagmeier Pond. Much of the visitation is from the highway corridor with occasional wildlife viewing at pulloffs. Mountain bikers can access the Bolinas Ridge Trail via McCurdy and Randall Trail.

Bolinas Ridge FMU. Hiking and biking on the Bolinas Ridge Trail and connecting McCurdy and Randall Trails attracts roughly 35,000 visitors a year. Visitation is relatively light and the experience is solitary though traffic noise from Highway One is perceptible.

Limantour FMU. The eastern portion of Limantour FMU includes the administrative offices and visitor center at Bear Valley. Nearly 700,000 visitors come to the visitor center annually and many continue to the Earthquake trail or Bear Valley trail. The Limantour and the Headlands FMUs have the highest visitor concentrations. Once visitors hike beyond the Bear Valley Trail to backcountry trails, the experience is remote from urban influences, though other hikers are seen regularly on the trails. Limantour Beach at the western end of the FMU is the closest beach to Highway One and the destination for approximately 180,000 visitors at year. The American Youth Hostel is sited in this FMU as is the Clem Miller Environmental Education Center. The Center has residential programs during the school year and service camps and weekend seminars in the summer months. The Limantour parking area is one of several points used to hike to the backcountry campsites.

Wilderness North and South. Accessed from the Bear Valley Visitor Center, Five Brooks, and Limantour Road, the wilderness trails are popular with day hikers, backpackers, and horseback riders. A corridor through the wilderness permits mountain bikers to use trails to reach the backcountry campground. The trails get regular use and other trail users are frequently passed.

Park Operations

Staffing and Facilities

The park has an outstanding and dedicated staff. Currently the park has about 90 permanent staff, 23 term employees, and 47 temporary staff working on a variety of projects and programs. This represents about 115 FTE (full time equivalents or one person for a full year). During the peak summer months, the park staff increases to about 160 staff members, including Youth Conservation Corps enrollees who provide assistance in a number of ways to Point Reyes National Seashore. This work force is supplemented by 20,000 hours of Volunteers-in-Parks service, three Student Conservation Assistants, and AmeriCorps.

The Fire Management Office is staffed by a Fire Management Officer, a program analyst, a hazardous fuels specialist, an eight-person hazard fuels crew, one engine foreman, and a four-person engine crew. Three fire staff members are also trained as emergency medical technicians

at the basic life support level. Providing technical assistance to both the fire management offices at PRNS and GGNRA are technical staff including a GIS technical specialist, an education specialist, and an environmental planner. PRNS, GGNRA, and Pinnacles share a fire ecologist and a team of five fire effects monitors. PRNS has mutual aid agreements with Marin County Fire Department, Bolinas Fire Protection District, Inverness Public Utility District, and Nicasio Volunteer Fire Department. While PRNS has direct protection authority for federal lands, Marin County has been given “delegated initial attack responsibility” for these same lands. This allows Marin County to assume authority of initial suppression actions until Seashore firefighters arrive.

PRNS (including GGNRA North District) maintains the necessary infrastructure to support an annual park visitation of 2.25 million people, provide offices, support structures and limited housing for the permanent and seasonal park staff. Park structures include:

- 3 visitor centers
- 2 environmental education centers
- 30 restroom complexes
- 4 backcountry campgrounds
- 17 water systems
- 147 miles of trails
- Over 100 miles of roads
- Over 100 public and administrative structures, and
- 27 sewage treatment systems

PRNS also manages and protects park cultural resources including:

- 297 historic structures
- 127 recorded archaeological sites
- 11 identified cultural landscapes
- 498,000 museum objects

Financial resources available to achieve the park’s annual goals include a base-operating budget of approximately \$4,900,000. In addition, the park receives supplemental support for fire operations, cyclic maintenance, special natural resource projects, and repair and rehabilitation of structures. Fire funding for operations is approximately \$770,000 annually for wildfire suppression, mechanical treatments, and prescribed fire. For the last three years, Point Reyes and GGNRA have received an additional \$700,000 annually for Wildland Urban Interface (WUI) projects. Staffing for all aspects for fire management is approximately 13 FTE’s.

Commercial Leases/Permits

Apart from the NPS program, there are numerous commercial leases within PRNS operating businesses, farms, ranches, and an aquaculture production. Leases include:

- 7 dairies
- 19 beef cattle ranches
- Silage production on approximately 1,000 acres of land,

- Oyster production in Drakes Estero, and
- Water supply to Bolinas Community

Wilderness Operations

More than half of PRNS, the 32,373-acre Philip Burton Wilderness Area, must be managed in conformance with the 1964 Wilderness Act, NPS Management Policies (NPS 2000, Chapter 6), and the Director's Order and Reference Manual 41 for Wilderness Preservation and Management. Generally, the public purpose of wilderness in the national parks includes the preservation of wilderness character and wilderness resources in an unimpaired condition, as well as for the purposes of recreational, scenic, scientific, educational, conservation, and historical use. Management includes the protection of the areas, the preservation of the wilderness character, and the gathering and dissemination of information regarding their use and enjoyment as wilderness.

The Wilderness Act requires that, except as necessary to meet the minimum requirements for the administration of a wilderness area, "there shall be no temporary roads, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, or no other form of mechanical transport, and no structure or installation" within the wilderness. (16 U.S.C. 1131 et seq., Section 4 (c))

Prescribed Fire and Fuel Reduction. Actions proposed under the FMP, such as prescribed burns and vegetation management actions, would be conducted to provide information to support objectives to return wilderness habitats to a more natural fire return interval conforming to data in the fire history record.

As required by the Wilderness Act, actions necessary to prepare and execute prescribed burns, fuel reduction activities, and resource enhancement projects must be examined to assure that they are necessary. If so, the park is required to use the least invasive methods possible to carry out the needed treatment. This "minimum requirement" process is designed to ensure the least disturbance and disruption of wilderness values and maximum protection of natural and cultural resources. At PRNS, the examination of minimum requirements is undertaken and documented by the interdisciplinary team reviewing projects for compliance to the National Environmental Policy Act.

NPS Management Policies (NPS, 2000, §6.3.5) outline the minimum requirement concept as a two-step process to determine: 1) whether the proposed management action is appropriate or necessary for administration of the area as wilderness and does not pose a significant impact to wilderness resources and character; and 2) which techniques and types of equipment should be used to ensure that impact to wilderness resources and character is minimized.

If no strategy can be developed without seriously affecting wilderness resources or character, only actions that ultimately preserve wilderness character and/or have only localized, short-term adverse impacts can be implemented. In effect, the benefits must outweigh the impact and the decision must be well documented.

Use of motorized equipment and/or mechanical transport can be allowed only: If determined by the superintendent to be the minimum requirement needed by management to achieve the purposes of the area as wilderness, including the preservation of wilderness character and values; or In emergency situations (search and rescue) involving the health or safety of persons actually within the area. Such management activities would be conducted in accordance with all applicable regulations, policies, and guidelines, including minimum requirement protocols as practicable.

Suppression of Wildland Fire. Director's Order 41 (1999) states that all wildland fires within wilderness would be managed to include the application of minimum requirement suppression techniques, the consideration of firefighter and public safety, a cost/benefit analysis sensitive to natural and cultural resources, and the strategic and tactical options described in an approved fire management plan. Further, fire management plans must address the effects of fire management decisions on wilderness resources and character, air quality, smoke management, water quality, and other pertinent natural and cultural resource management objectives. Until a fire management plan is approved, all wildland fires in wilderness must be suppressed.

Given the proximity of the Philip Burton Wilderness Area to developed areas and the potential for a wildland fire to spread beyond park boundaries, fire management planning at PRNS puts special emphasis on suppression of wildland fire in wilderness. According to Director's Order 41, if a wildland fire requires Point Reyes management to delegate fire-fighting authority, park personnel would first inform them of the appropriate emphasis on the protection of wilderness resources. The methods used to suppress all wildland fires should be those that minimize the impacts of the suppression action and the fire itself, commensurate with effective control and the preservation of wilderness values.

Fire suppression actions in the wilderness would be directed by minimum requirement strategies geared to avoid resource impacts to the greatest extent feasible given the severity of the wildland fire. Information on the location of sensitive plant and wildlife habitats, cultural resources, wetlands, and creeks would be used to direct the construction of fire lines, siting of staging areas, water intake, and other potential impacting actions. Fire suppression teams at the park are trained in the concepts of wilderness fire management and minimum tool use. These techniques would be implemented to the extent feasible to control wildland fire and protect life and property.

Current Activities in Wilderness. NPS activities in the Philip Burton Wilderness are restricted to those necessary to allow for safe recreational use of the area. Non-wilderness fire road corridors allow maintenance staff motorized vehicle access to clean the four backcountry campsites. Wilderness trails are brushed back every two to three years using hand tools to allow enough clearance for safe passage by recreational users. Special projects are implemented as needed and in conformance with minimum requirements assessments. For example, a bridge may be replaced on a hiking trail when needed for public safety and to prevent off-trail use and disturbance. Each project is assessed individually for potential effects on the environment and wilderness setting by an interdisciplinary team of park staff and in accordance with NEPA, the Endangered Species Act, the Wilderness Act, and NPS policies. Table 36 shows which of the

FMUs contain lands that are designated federal wilderness, how many acres of wilderness are included in each of these FMUs, and what percent of the FMU is federal wilderness.

Table 36. Federal Wilderness in the Fire Management Units

FMUs within the Federal Wilderness	Total Acres in FMU	Wilderness Area Acreage	
		Acres of Wilderness in the FMU	% of FMU in Wilderness
Tomales Point	2,783 acres	2,746 acres	98.6%
Headlands	881 acres	245 acres	28%
Limantour	4,144 acres	2,518 acres	61%
Wilderness North	1,591 acres	1,336 acres	84%
Wilderness South	2,298 acres	1,480 acres	64%
Highway 1	2,868 acres	67 acres	2%
Palomarin	2,022 acres	843 acres	42%

Source: Point Reyes National Seashore, GIS.

Public Health and Safety

The 2001 Federal Fire Policy sets the protection of human life as the first priority for federal wildland fire management; all federal Fire Management Plans and activities must reflect this commitment (Interagency Working Group, 2001). This is reflected in the primary objective of the Point Reyes FMP - to protect firefighters and the public. Related FMP objectives are to protect private and public property, foster and maintain effective community and interagency fire management partnerships, and foster a high degree of understanding of fire and fuels management among park employees, neighbors, and visitors.

The Federal Fire Policy is being implemented through the National Fire Plan, which recognizes that effective fire management requires close coordination of federal agencies with local communities, particularly those communities that are in the wildland-urban interface. As the management of private lands has become a key factor in the fire-risk equation, the federal government has recognized the importance of providing outreach, education, and support for local communities who play a primary role in reducing fire hazards in and near their communities.

As part of the data gathering process in support of the National Fire Plan, the federal government identified key communities nationwide at risk from wildfire due to their proximity to federal lands managed by the Departments of Agriculture and Interior. An extensive listing was published in the Federal Register (Vol. 66, #160, Friday, 8/17/01) and included Inverness, Bolinas, and Olema, as well as communities near Point Reyes National Seashore. In recognition of potential risk, the National Park Service, through the Wildland Urban Interface Program, has been funding fire education, fuel reduction, and roadway improvement projects in these communities; 2002 is the third year of local National Fire Plan funding.

Prioritization of projects needed in the wildland urban interface has been informed by a study of strategies for rehabilitating the resources in the Vision Fire burn area and preventing similar occurrences in the future. Prepared for the Environmental Action Committee of West Marin,

“After the Vision Fire,” prepared by the Phoenix Team, documented many of the projects that have subsequently been funded and implemented on private and federal lands with Wildland Urban Interface funding.

Like the National Fire Plan, the EAC Phoenix Report (1996) recognizes that the most fundamental line of defense to increase public safety is to promote conformance with code requirements for defensible space and reduced fuels around homes and along streets providing emergency ingress and egress. No amount of fuel reduction on federal lands can compensate for the hazards presented by high fuel loading on private lots. Many of the fire education, community chipper programs, safety assessments, and roadway improvement projects funded by the NPS have focused facilitating code conformance on private property.

In the first two years of Wildland Urban Interface (WUI) funding, projects in the interface with PRNS focused on public health and safety by:

- Improving the safety of subdivision roads that would be used as evacuation routes by residents and for ingress and egress by emergency responders,
- Providing assessments for individual homeowners on safety deficits on their properties,
- Providing chipper days in several communities to facilitate disposal of vegetation cleared from private lots, and
- The dissemination of fire education materials promoting defensible space concepts.

In the Inverness/Inverness Park area, over 16 miles of subdivision roads, have had roadside vegetation brush cut or thinned to reduce fuels, overhanging branches limbed up to provide overhead vehicle clearance for emergency vehicles, trees presenting treefall hazard removed, and pullouts and turnarounds either re-established or constructed. Fire hazard assessments were completed for the Seahaven and Paradise Ranch Estates subdivisions with each private parcel rated under four safety categories. This information is provided to the homeowner to help them understand the relative hazard presented by the condition of their parcel and help the homeowner focus their efforts in productive directions.

The next round of WUI funded projects focus on creating shaded fuel breaks between open space lands and residential areas in addition to continued chipper days, further education materials, and a hazard assessment program for Bolinas. The fuel breaks would serve as zones of reduced fuel to slow the progress of wildland fires, provide firefighters with an area from which to launch suppression actions, and provide alternate evacuation routes to residents. The proposed fuel break would cross state park, national park, and private-held lands.

The FMP alternatives demonstrate a clear focus on reducing risk to neighboring communities by identifying project areas on the federal side of the interface that complement the WUI projects on private and state-owned lands. FMP projects in the Inverness Ridge, Limantour, Palomarin, and Olema FMUs would improve safety to responding firefighters, reduce fuels along existing fire roads, and create zones of reduced fuels to impede fire spread.

Following the completion of the EIS process, the park will select one alternative to become the FMP. It will be a procedural document outlining response, suppression, and proactive strategies for managing fire in PRNS. The FMP would be implemented by the Point Reyes Fire Management Office staff led by the Fire Management Officer under the direction of the Superintendent, a program analyst, a hazardous fuels specialist, a 10-person hazard fuels crew, and 1-2 engine technicians. The Fire Management Office staff and equipment has been housed in the southern portion of the Peninsula. As part of the current FMP EIS, PRNS is proposing to move the Fire Management Office to a new fire cache building at the central area of the park in Bear Valley (for further description see Alternatives, Actions Common to All Alternatives). The move would improve communication, response time, and facilitate coordinated efforts with the local fire departments in Inverness and Point Reyes Station.

The principal effect of FMP activities on public health is generation of smoke, especially particulate matter, from prescribed fires and unintended wildland fire. Particulate matter, found in the air-liquid droplets and small solid particles of minerals and soot can penetrate deep into the lungs. In smoke, roughly 80% of the particulate matter is smaller than 2.5 micrometers in diameter.

Healthy adults are not usually at risk from particulate matter; they may experience runny noses and coughing but these symptoms usually subside as the smoke disperses. People with heart or lung diseases, such as congestive heart disease, chronic obstructive pulmonary disease, emphysema or asthma, can be at risk. People with these conditions may find it difficult to breathe, may cough or feel short of breath. Children and the elderly are generally more susceptible to the harmful effects of smoke (CARB, 2003).

Baseline air quality information is found in this chapter under the heading of Air Quality. The Bay Area Air Quality Management District (BAAQMD) in accordance with the California Smoke Management Guidelines manages the generation of smoke by prescribed burning. The goal of smoke management guidelines is to continue prescribed burning as a resource management tool while minimizing smoke impacts to public health in populated areas.

Socio-Economics

PRNS is one of the 30 most visited parks in the National Park System. It is a destination park for national and international visitors, as well as a regularly visited resource for the 5 million residents of the 9 counties that comprise the greater San Francisco Bay Area. Visitation to the park is approximately 2.5 million annually and unusually is consistent year round, averaging roughly 200,000 visitors monthly.

Marin County has a \$500 million annual tourist industry. It is estimated that PRNS contributes over \$150 million to the regional economy visitor expenditures on dining, fuel, gifts, groceries, and lodging (NPS, 2002a). According to a visitor survey conducted by Sonoma State University (1997), 74% of the visitors to Point Reyes National Seashore are traveling to the Seashore as their main destination, 50% of park visitors are staying between 2-6 hours in the park (30%

overnight), and 40% of visitation comes from Marin, Sonoma, and San Francisco Counties (16.5% come from outside of California).

Point Reyes National Seashore received 2.35 million visitors in 2000 accounting for 930 travel party days/nights in the area. An average visitor party spends \$94 per party per night in the local area (\$109 if locals excluded). Total visitor spending was \$87 million in 2000, \$80 million excluding local visitors. This spending of visitors from outside the local region generates \$69 million in sales by local tourism businesses, yielding \$25.6 million in direct income and supporting 1,100 jobs. Each dollar of tourism spending yields another \$.63 in sales through the circulation of spending within the local economy. Including these secondary effects, the total economic impact of the park on the local economy is \$113 million in sales, \$42 million in wages and salaries, and 1,800 jobs (Michigan State University, 2001).

The park has not received complaints from visitors during past prescribed fires in the park (pers. comm. Neubacher, 2003). Park visitation dropped dramatically for the first few months after the 1995 Vision Fire, but returned to normal within six months.

