APPENDIX F. WILDLAND AND PRESCRIBED FIRE MONITORING AND RESEARCH PLAN

APPENDIX F-WILDLAND AND PRESCRIBED FIRE MONITORING AND RESEARCH PLAN

F.1. INTRODUCTION

The Point Reyes National Seashore (PRNS) Fire Management Program uses prescribed fire and mechanical treatments for hazard fuel reduction and for natural and cultural resource benefit. Fire effects monitoring is a critical component of fire management and is aimed at providing information on the effectiveness of the Fire Management Program. The focus of the PRNS Fire Monitoring Program is assessing the condition of vegetation and fuels, and how they are affected by the application of fire or mechanical treatments. The PRNS Fire Monitoring Program also monitors fire weather and fire behavior during prescribed fires and in the event of a wildfire. This program would also provide post-fire monitoring in the event of a wildfire.

Informal fire effects monitoring began as early as the 1970s as the Seashore began implementing prescribed fires. The Fire Effects Crew was established for the Golden Gate National Recreation Area (GGNRA) and PRNS in 1990. In 1993, Joshua Tree National Park, Pinnacles National Monument and Santa Monica National Recreation Area were added to the Fire Effect Crew's workload. In 1997, Channel Islands National Park was added as well (Reeberg 2007). In 2000, a fire ecologist position was created for the San Francisco Bay Area Network parks. The fire ecologist is responsible for coordinating monitoring efforts. In 2002 the Central & Southern California fire effects crew moved their duty station from GNRA to PRNS. Since then, the fire ecologist and fire effects crew have been stationed out of PRNS.

The PRNS Fire Monitoring Program has been designed to determine whether fire management activities are meeting fire and resource management objectives and to document any unexpected consequences of fire management activities. The monitoring program is intended to continuously inform the staff about results of management activities so that the fire management program can adapt to changing conditions using the best available information. Integration of fire monitoring data is a shared responsibility between park's fire management and natural and cultural resource management staffs. Section F.6. details data management and analysis protocols.

As an appendix to the 2007 PRNS Operational Strategy Fire Management Plan (FMP), this monitoring plan describes the framework that is used for collecting, managing, evaluating and integrating fire effects information – the four core activities of the fire monitoring program. As new information and research results are obtained, relevant changes to the monitoring and/or fire management programs will be made. These changes may include new or alternative monitoring techniques, changes in treatment prescriptions, or refinement of management objectives. All changes to the PRNS Fire Monitoring Program will be reflected in annual updates to this document. Annual updates will occur each January along with updates to the FMP as described in Section 4.6 of that document.

F.2. FIRE AND FUELS MANAGEMENT

F.2.1. Strategies Used to Manage Fire

Fire Suppression
Suppression involves extinguishing a wildland fire that is burning out of prescription parameters, is not meeting fire or resource management objectives, or poses an immediate threat to life or property. Because of the extensive wildland-urban interface (WUI) of the Seashore all unplanned ignitions, whether natural or human-caused, are suppressed. Tactics for suppression are varied and depend on the particular situation (e.g., location, weather, safety considerations, etc.) for each individual fire. Suppression actions can include hand crews or bull dozers cutting a line around the fire perimeter to remove live and dead vegetation; water and retardant drops from aircraft; manual and mechanical thinning; "burn out" situations in which fire is used to remove live and dead vegetation in an effort to stop the fire; and "cold trailing" in areas of low fuel loads, where crews physically feel the ground and put out "hot spots."

Prescribed Fire
Prescribed fires are intentionally lit under predetermined conditions to meet fire and resource management goals and objectives. Prescribed fires include pile burning, where vegetation is cut and moved to a central location and burned, or broadcast burning, where fires are ignited within a predefined area and allowed to move through the vegetation within those boundaries. A written and approved prescribed fire plan must exist and within the plan are detailed prescription parameters that must be followed. For example, a burn prescription might require that the mid- flame wind speed be less than 12 mph and average flame lengths must range from 1 to 8 feet. If these parameters are not met, the fire is considered out of prescription and would be suppressed.

Non-fire Fuel Treatments
Non- fire fuel treatments include manual and mechanical thinning. In general, thinning involves removing live and dead vegetation (fuels) according to a prescribed plan to meet specific objectives related to hazardous fuels management. Thinning is also used as a pre-treatment for prescribed burning to remove smaller diameter trees, ladder fuels, etc. to help keep the fire within the designated area or to protect specific resources. Thinning is an effective treatment to reduce fuels in the WUI.

F.2.2. Fire Management Units

Fire management units (FMUs) are defined as areas with common fire and resource management objectives, similar biological and physical features, and/or similar political designation (e.g., Wilderness designation). Fire management strategies are specifically tailored for each FMU. PRNS is divided into 11 FMUs based on geography, fuels management and habitat improvement needs, and on values at risk (see PRNS Fire Management Plan Figure 4, page 21). Ten of the FMUs, totaling 21,856 acres, represent the portion of PRNS where nearly all fire management actions, such as prescribed

burning and mechanical fuel reduction treatments, take place. The eleventh FMU, the Minimum Management Unit, includes most of the park and totals 71,046 acres. Fire management actions in the Minimum Management FMU are limited primarily to vegetation clearing around buildings and along roads and trails, prescribed burns with research objectives and, like the remainder of the park, full suppression of all wildfires. Detailed descriptions of fire management activities within each FMU are discussed in Section 2.5 of the PRNS Fire Management Plan (pages 20-34).

F.3. ECOLOGY AND LANDSCAPE MANAGEMENT

PRNS is comprised of seven major vegetation types: bishop pine forest, Douglas-fir/mixed evergreen forest, coast redwood forest, maritime chaparral, coastal scrub, coastal grassland and coastal dune (See Figure 1).

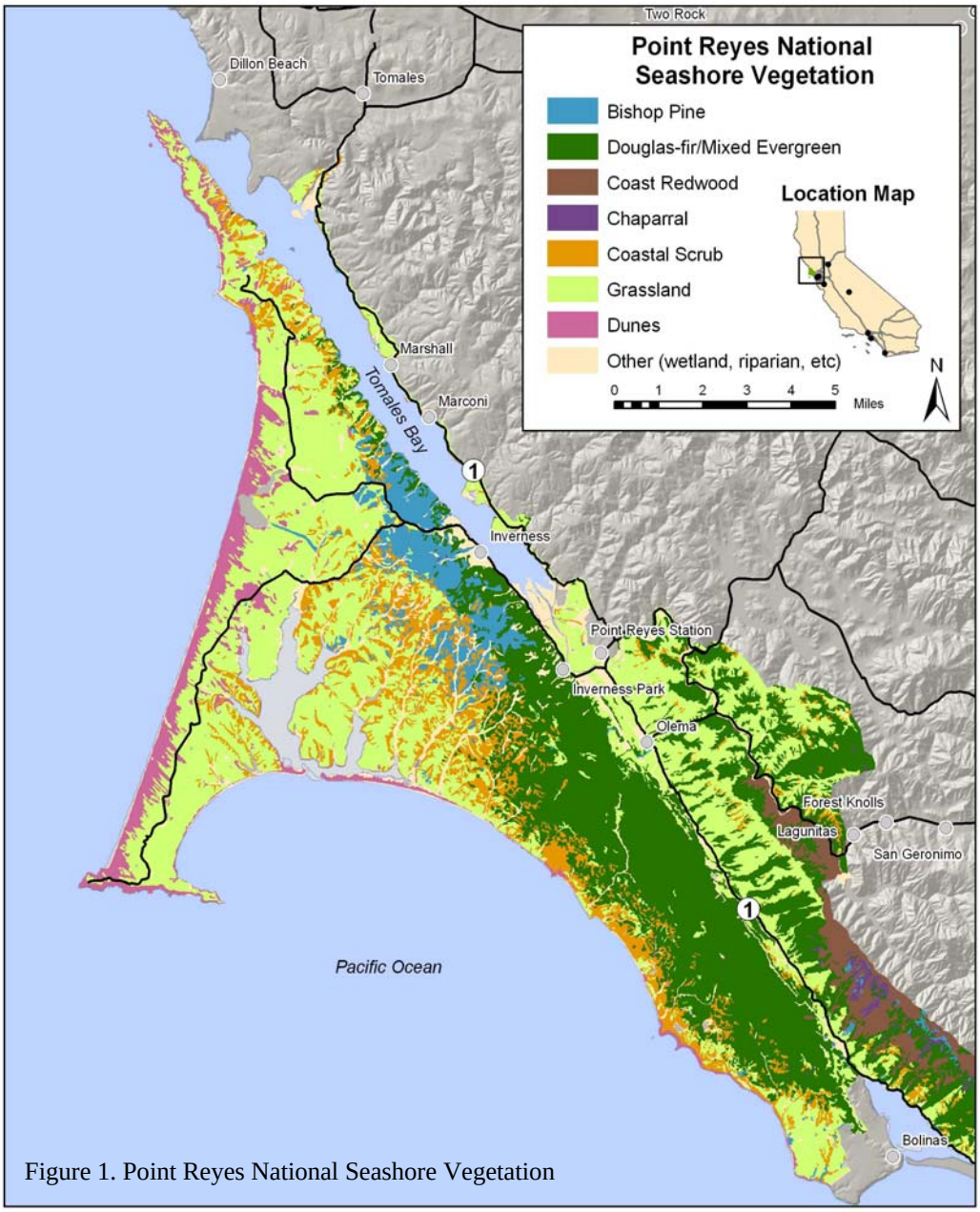


Figure 1. Point Reyes National Seashore Vegetation

These broad groups are divided into more specific vegetation communities, or monitoring units, for the purpose of fire effects monitoring. Monitoring units are established in areas where the Fire Management Program in conducting active management such as prescribed fire or mechanical treatments. PRNS currently has plots in nine different

monitoring units. Table 1 lists vegetation communities and monitoring units within the Seashore. The following section provides an overview of the fire history of the Seashore as well as details the fire ecology of each monitoring unit as well as of vegetation types that are not being treated or monitored. Desired future conditions are described for monitoring units that are being actively managed.

Table 1. Vegetation communities and fire effects monitoring types

Vegetation Community	Acres	Monitoring Unit	Monitoring Unit Code[a]	# of Plots	Active Fire Mgt
Bishop Pine	3,570	Bishop Pine Forest	FPIMU1D05	3	N
Douglas-fir/Mixed Evergreen	30,000	Douglas-fir Forest	FPSME1D10	1	N
		Eucalyptus forest	FEUGL1G08	10	Y
Coast Redwood	3,000	N/A	N/A	0	N
Chaparral	400	N/A	N/A	0	N
Coastal Scrub	15,500	Northern Coastal Scrub	BBAPI1D05	10	Y
Grassland	20,000	Deschampsia Coastal Prairie	BDECE1D01	7	Y
		Non-native Annual Grassland	BLOPE1D01	36	Y
		Harding Grass	BPHAQ1D01	7	Y
		Scotch Broom	BCYSC1D05	18	Y
		French Broom	BGEMO2D05	13	Y
Dunes[b]	2,000	N/A	N/A	0	N
Total				**105**	

[a] The naming convention for monitoring unity codes is described in the Fire Monitoring Handbook.

[b] Park staff have experimented with limited use of fire as part of a multi-approach dune restoration project. Monitoring of this is qualitative and is being carried out by the Fire Effects Program in conjunction with the Vegetation Management Program.

F.3.1. Fire History Overview

Fire is one of the most important processes in shaping landscape scale vegetation patterns across the western United States. Variations in the frequency, intensity and scale of fire disturbances determine patterns of plant community regeneration. (Turner et al. 1997, Agee 1998, Brown et al. 1999b) At Point Reyes National Seashore, the vegetation is comprised of a dynamic mosaic of plant communities which shift in response to disturbances such as fire and grazing as well as in response to biotic interactions (Callaway and Davis 1993).

Native American Influences (~10,000 BP – ~1800 AD)

Fire regimes at PRNS have been affected by a long history of human settlement on the peninsula. Native Americans are thought to have occupied the peninsula from at least 10,000 years ago (Cook 1976) with the Coast Miwok being the dominant group beginning approximately 4000 BP (Duncan 1992). One study (Treganza 1961) estimated that there were as many as 113 Miwok villages on the peninsula. While it is unlikely that they were all occupied concurrently, there were likely more humans inhabiting the peninsula at the time of Euro-American contact than there are presently.

There is extensive evidence that Native Americans throughout California used fire to manage vegetation. There are many accounts that tribes living in areas dominated by a mixture of grassland and scrub vegetation used fire on an annual basis to improve seed harvests and to control scrub encroachment into grasslands (Fletcher 1628, Menzies 1924, Stewart 1951, Clar 1957, Lewis 1973, Keeley 2002). These accounts come from early settlers of the area as well as from Native Americans themselves. For example, one author quotes an elderly woman from the Pomo tribe, who were found on the coast just north of the Coast Miwok of Point Reyes:

> As one old Pomo Indian told me: "The grass was burned every year. The fires were started and allowed to burn in every place. Burning was to make the weeds grow better and to keep down the brush." (Stewart 1951)

Early explorers provide some first hand accounts of Native American use of fire specific to the Point Reyes peninsula and vicinity. For example, the Coast Miwok apparently set fire to the vegetation on the bluffs above Drakes Bay upon the departure of Sir Francis Drake in 1579 (Fletcher 1628). More than 200 years later, in late October of 1793, Archibald Menzies sailed into Tomales Bay. He went ashore at Tomales Point with the intention of collecting botanical specimens, but "the grass and brush wood on this headland had been lately burned down so that I had little opportunity here to augment my botanical collection..." (Menzies 1924).

There is also evidence from fire scars on coast redwood and Douglas-fir which indicates that Native Americans either burned intentionally in forested areas or that fire escaped from village sites or grassland fires into neighboring forested areas (Jacobs et al. 1978, McBride and Jacobs 1978, Brown et al. 1999a). For example, one study (Jacobs et al. 1978) indicated a 20 to 30 year fire return interval in coast redwood forests near Muir Woods from the period between 1400 and 1850. This would have been significantly more frequent than could be explained by lightning occurrence. A fire and vegetation history study of the Seashore used sediment cores to examine trends in vegetation and fire occurrence over the last 15,000 years. This study showed a marked increase in the presence of charcoal in sediment cores at several sites between ~3,500 years before present and the historic period. This may correspond with increases in the Native American population on the peninsula (Anderson 2005).

Native American burning practices undoubtedly affected the mosaic of vegetation communities across the landscape. Although only anecdotal information is available about the distribution of vegetation communities prior to 1800, it is likely that grasslands were more common under the influence of native burning practices than they are today and that chaparral and coastal scrub were restricted to the higher slopes and ridges (Lewis 1993).

Spanish-Mexican Influences (~1800 AD - 1848)

The Spanish influence in the Point Reyes area increased rapidly after the discovery of

San Francisco Bay in 1769 and the establishment of a mission in San Rafael in 1817 (Toogood 1980). According to Slaymaker (1983), the majority of the Coast Miwok were gone from the peninsula by 1823. Two large Mexican land grants were given for the Point Reyes area in 1836 (Sugnet and Martin 1984). With the land grants, came the introduction of cattle and the extirpation of elk (Revere 1947). It is likely that grasslands began to shift from native perennial grasses to non-native annual grasses during this time. Fire regimes also shifted during the Mexican era. The Mexican ranchers burned scrub areas but avoided burning grasslands that they needed as year-round forage for cattle (Sugnet and Martin 1984).

American Influences to Modern Era (1849 AD - present)
In 1849, California was annexed by the United States and land use in Marin shifted to logging and dairying. The first mill in the Point Reyes vicinity was built in Bolinas in 1851. By 1858 four mills were operating in the area. Logging initially focused on the large redwoods growing in gullies at the base of Bolinas Ridge. One lumberman estimated that the average redwood tree coming through the mills was six feet in diameter. According to an 1880 history of Marin, the four Bolinas mills removed a total of thirteen million boardfeet of redwood. As the supply of redwood dwindled, the industry shifted to cutting pine, alder, and oak for firewood. Over the period from 1855 to 1880 500,000 cords of firewood were harvested (Toogood 1980). Among the legacies of this period are dense second-growth forests and high levels of siltation, such as at Bolinas Lagoon (Fairley 1987).

The second half of the 19th century is also marked by the introduction of several of the most problematic non-native species currently found within the Seashore. Eucalyptus was first planted in San Francisco Bay Area in 1856 (McClatchie 1902). Extolled for its qualities as a fast-growing timber species, eucalyptus became a widely planted for ornamental use, timber, and windbreaks. Many of these stands are still present at the Seashore today including the McCurdy grove, the Highway One grove and the Coast Guard grove among others. French broom (*Genista monspessulana*) and Scotch broom (*Cytisus scoparius*) were also introduced into California in the mid-1800s for landscaping and to control roadside erosion control. The ability of these plants to fix nitrogen, to produce copious amounts of long-lived seed, and to tolerate almost any soil condition allowed these species to grow rapidly and form dense stands, making regeneration of most native species difficult or impossible.

Starting in the late 1800s, there are newspaper records of wildfires in the area. In spite of the adoption of fire suppression as the official government policy around 1900 (Office of the State Forester 1912), there are newspaper mentions of large fires in Olema Valley and on Bolinas Ridge in 1889, 1890, 1892, 1904, 1906, 1923, 1927 and 1945 (Sugnet and Martin 1984, Brown et al. 1999a). Smaller fires occurred in the mid-1950's and in 1970 (Sugnet and Martin 1984). The 1995 Vision Fire is the only large fire that has occurred in recent years. All of the recent fire ignitions have been human caused. Lightning occurrence in the area is low: the Seashore averages five lightning strikes per year. Most of these occur in the fall, when fire danger is highest (van Wagtendonk 2006).

F.3.2. Fire Ecology by Monitoring Unit

Bishop Pine Forest – FPIMU1D05

Bishop pine (*Pinus muricata*) forests are found primarily on the northern section of Inverness Ridge (see Vegetation Map, page 8 Figure 2) on granitic quartz-diorite soils (Kashiwagi 1985). The Point Reyes population is part of a larger population with limited distribution. The species is found in relict stands along the coast of California from Humboldt to Santa Barbara counties, on Santa Cruz and Santa Rosa Islands, and in isolated populations south to central Baja (Vogl et al. 1988). The distribution of bishop pine is maritime and populations are found between sea level and about 400m elevation. The climate in this coastal band is dominated by summer fog which is probably an important moisture source during the dry summer months(Vogl et al. 1988). According to the 1994 vegetation map for the Seashore, there were 3,570 acres of bishop pine forest prior to the Vision Fire. Approximately 35% of this total forest area was burned in the 1995 Vision Fire. Most of this came back as bishop pine post-fire. In addition, after the fire new patches of bishop pine established in areas that had been coastal scrub. The post Vision Fire area of bishop pine has not been quantified.

Bishop pine is the dominant tree species in this community. 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*). The areas burned in 1995 are currently 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).*

Figure 2. Left: Close view of 10 year old bishop pine regeneration; Right: mature bishop pine forest.

Bishop pine is a fire-adapted, serotinous pine species. Cones are produced each year, but

remain closed. Typically, cones are opened by fire, but they can also occasionally be opened on a hot day. The fire regime in bishop pine forests is generally a stand replacement regime. Bishop pine is not considered to be fire resistant (Sugnet and Martin 1984). Mature trees are killed by even low intensity fires and seeds are dispersed onto the newly burned ground where they germinate (Vogl et al. 1988). Bishop pine stands are normally even-aged and for the first 10-20 years after fire are extremely dense. Cone production was observed as early as five years after the Vision Fire (Holzman 2003). Holzman (2003) found seedling densities as high as 71 seedlings/m^2 with an average value of 25 seedlings/m^2 in the year immediately after the Vision Fire (See Figure 2).

Much of the bishop pine forest in the Seashore currently is about 12 years old, having established after the 1995 Vision Fire. Older stands, which did not burn in the Vision Fire, are found on the northern and eastern edges of Inverness Ridge. Some of these were sampled by Sugnet and Martin (1984) and were found to have established after the 1927 fire and after fires set by Ottinger during the 1950s. Bishop pines in Tomales Bay State Park were found to be as old as 71 years. Vogl (1988) suggests that trees not exposed to fire for a period in excess of 80 years will begin to succumb to diseases such as western gall rust and die without releasing seeds from their cones and therefore without reproducing. The non-native pathogen pine pitch canker (*Fusarium circinatum*) was recently discovered in the bishop pine forest at Point Reyes. The effects this disease will have on the population are unknown, but they are likely to be significant (Gordon et al. 2001). Researchers from UC Berkeley and UC Davis are working with PRNS to study the effects of pine pitch canker on bishop pine.

PRNS has conducted one small research burn in bishop pine forest. This 4 acre burn was carried out in October of 1978. This pre-dated the fire effects monitoring program, but two local researchers, Sugnet and Martin (1984), did conduct some vegetation monitoring. They found significantly decreased dead and downed fuel loading and close to 100% mortality in mature bishop pine in the burn. PRNS fire management staff had planned to conduct a second research burn in the bishop pine forest on Mt. Vision. Three bishop pine (FPIMU1D05) plots were installed and read once; however, the burn was never carried out and the plots were not reread.

Prescribed burns planned for the Limantour Road FMU include some small areas of post-Vision Fire bishop pine regeneration. A desired future condition has not been developed for the bishop pine in these units because bishop pine makes up such a small portion of these burn units. However, monitoring plots have been installed because little is known about the fire ecology of young bishop pine forests. In 2007, the Fire Effects Monitoring Program installed six modified Fire Management Handbook (FMH) (National Park Service 2003a) brush plots (three burn plots and three control plots) in patches of bishop regeneration along Limantour Road. These plots will provide valuable information about how susceptible young bishop pine trees are to fire and how well they are able to regenerate in response to fire.

Desired Future Condition: A desired future condition statement has not been developed for Bishop pine forest because this vegetation type is not being actively managed by the

PRNS Fire Management Program.

Douglas-Fir/Mixed Evergreen Forest - FPSME1D10

Douglas-fir (*Pseudotsuga menziesii*)/mixed evergreen forests at Point Reyes National Seashore are found primarily along the southern section of Inverness Ridge. They are found on marine derived sedimentary soils and also experience the coastal influence of summer fog (Kashiwagi 1985). This forest type is found from southern Oregon to southern California and is typified across its range by the dominance of broad-leaved sclerophyllous species with varied coniferous presence (Sawyer et al. 1988). At PRNS, the coniferous influence is significant and most mixed evergreen forests in the Seashore are dominated by Douglas-fir. This vegetation type comprises over 30,000 acres of the Seashore.

Figure 3. Douglas-fir with mixed understory

Douglas-fir-dominated forest is characterized by a significant 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 and comprised of 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 (See Figure 3).

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 mature stands. Trees often live more than 500 years. Douglas-fir is considered moderately shade tolerant and regenerates best in pasture edges, open areas, and post-disturbance. Further north in its range, Douglas-fir stands will give way to shade-tolerant associates such as western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and Pacific silver fir (*Abies amabilis*), but at PRNS, it is considered the climax species for the mixed evergreen species assemblage (Sawyer et al. 1988, Hermann and Lavender 1990).

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 (Hermann and Lavender 1990). Fire regimes vary greatly over the range of Douglas-fir. In Washington and Oregon, Douglas-fir often burns in infrequent (>100 years), stand-replacing fires. However, further south in its range, Douglas-fir often exhibits a mixed or moderate-low

severity fire regime. One study in the Klamath Mountains of Northern California found mean fire return intervals (MFRI) of 12 to 19 years (Taylor and Skinner 1998) in Douglas-fir forests.

Brown et al. (1999a) looked at the fire history of the Douglas-fir forest at PRNS. This study was able to obtain cross-dated fire history for two stands dating back to mid-1700s. However, there were relatively few fire occurrences prior to the mid-1800s, which the authors ascribed to missing fire dates. It is unclear why fires prior to the mid 1800s would be missing from the fire scar record, but the authors do not explain this. For the period from 1820 to 1905 at one site the MFRI was 7.7 ± 5.0 years and for the period from 1825 to 1918 at a second site the MFRI was 8.5 ± 5.3 years. No fires were recorded in this study after 1945. Most fires were recorded on one or a few trees, but were not recorded on all trees in a stand. The authors of this study conclude that, since natural ignition sources are infrequent, these fires were caused by Native Americans or by early settlers. The latter seems more likely given Slaymaker's (1983) conclusion that the Coast Miwok had been moved from the peninsula to local missions by the beginning of the 19th century.

Due to the lack of fires over the last century, there is concern that encroachment of Douglas-fir into meadows and coastal scrub is unnatural. This has been observed in many areas of the Seashore and other parts of the North Coast Range region. However, given the low frequency of natural ignitions, this expansion of Douglas-fir may be acceptable to some managers.

Some Douglas-fir stands at PRNS have substantial ladder fuel accumulations, which could result in crown fire. In particular, the southern section of Inverness Ridge, which was heavily logged during the mid-to-late 19th century, is extremely dense with dead and downed fuel loading ranging from 40 to 60 tons/acre. Another factor contributing to high fuel loads in Douglas-fir habitat at PRNS is Sudden Oak Death (SOD). SOD, first discovered at the Seashore in 2004, is causing significant mortality in tanoaks on the Bolinas and Inverness Ridges, leading to high fuel loads and increased ladder fuels in forests where these trees are a large component of the understory forest (Moritz et al. 2007).

In the late 1990's, fire management staff had planned a prescribed fire in Douglas-fir forest at Fir Top in order to reduce hazard fuel loading. In preparation for this burn, one Douglas-fir plot (FPSME1D10) was installed and read. However, the burn was never carried out and the plot has not been reread.

Desired Future Condition: A desired future condition statement has not been developed for Douglas-fir forest because this vegetation type is not being actively managed by the PRNS Fire Management Program.

Eucalyptus Forest - FPSME1D10

Eucalyptus forest at PRNS is found along Highway One in the Olema Valley, near the Bear Valley Visitor Center, along the boundary between G and H ranches, at the Palomarin trailhead and in other scattered locations through the Seashore. While there are many species of eucalypt, at PRNS this forest type is dominated by blue gum eucalyptus (*Eucalyptus globulus).* Eucalypts are non-native and originally come from Australia. They have been planted all over California and cover over 200 acres at PRNS.

Blue gum eucalyptus was first planted in the San Francisco Bay area in 1856 as a landscaping tree. Over the next decades it was planted extensively, both for landscaping and for lumber. Many of the eucalyptus trees at PRNS were originally planted to provide wind breaks and privacy around ranches. Today these old, large trees are surrounded by acres of younger trees which continue to reproduce. Because of their fast growth rates and extraordinary ability to take up water, eucalypts tend to out-compete and displace native plant and animal species. It is common to find eucalyptus monocultures in which few or no native plants persist (See Figure 4).

Eucalyptus forests are a fuels management concern because they present a significant fire hazard. They produce large amounts of leaf litter and shed their bark which leads to high levels of fuel loading and creates fuel continuity from the forest floor into the canopy. Dense eucalyptus forests contributed to the intensity of the 1991 Oakland hills fire. More recently, in 2004, 12 acres of eucalyptus forest in Golden Gate National Recreation Area, near the community of Tam Valley, burned in a wildfire. Again, the dense eucalyptus forest contributed to extreme fire behavior.

Figure 4. Eucalyptus monoculture with dead and downed fuels

At PRNS, the primary management tool used to decrease fire hazard in eucalyptus forest is mechanical thinning. Twenty-five acres were thinned in the Highway One FMU beginning in 2005. In 2007, fuels staff began thinning a second grove at the Palomarin trailhead in the Palomarin FMU. The Fire Effects program has installed ten plots in *Eucalyptus globulus* forest. Five of these are modified FMH forest plots (see Section F.5.3) and five are photo-monitoring plots based on protocols described in the fire monitoring handbook (National Park Service 2003a). The FMH plots are aimed at detecting changes in fuel loading, basal area, French broom cover, and stump resprouting. Data from 2006 showed a significant decrease in both basal area and fuel loading post-treatment. The treatment was also successful in reducing French broom cover and minimizing stump sprouting. Photomonitoring is designed to provide a visual record of changes in forest structure and composition resulting from the treatment. See Figures 5-7.

Figure 5. Eucalyptus basal area before and after treatment. Difference is significant at p=0.016.

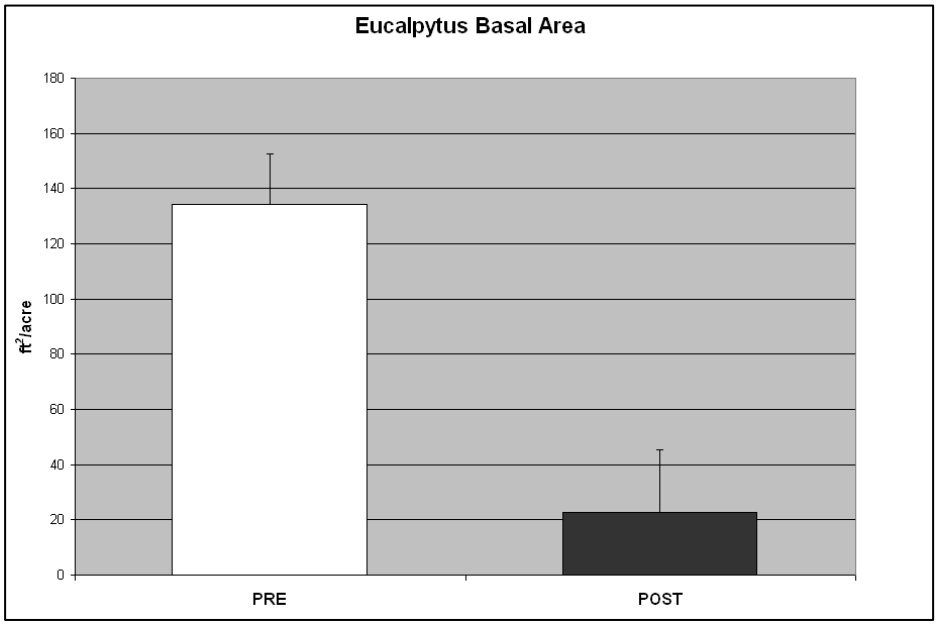


Figure 6. Eucalyptus fuel loading before and after treatment. Difference is not statistically significant at p=0.1

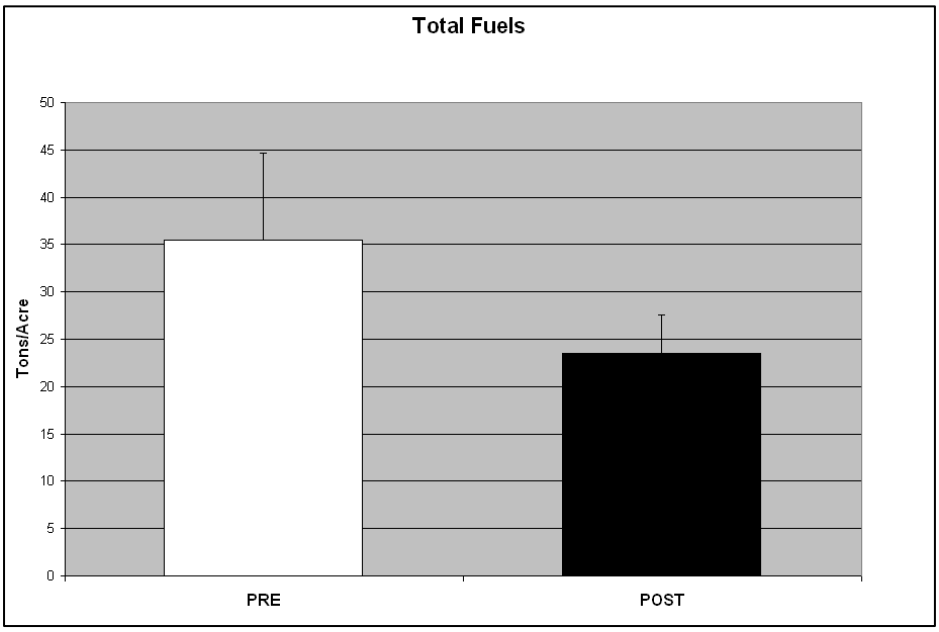


Figure 7. Photopoint depicting eucalyptus forest before and after treatment.

Desired Future Condition: Desired future condition for eucalyptus groves in PRNS is to reduce groves so that only the culturally significant trees remain and to minimize eucalyptus regeneration from remaining trees. All other areas of the *Eucalyptus globulus* forest would be restored to native forest or scrub.

Northern Coastal Scrub - BBAPI1D05

Coastal scrub is one of the most widespread plant community types with in the Seashore, covering approximately 15,500 acres. Large areas of this vegetation type are found along the western slope of Inverness Ridge out to the coastal bluffs and also on Tomales Point and in the vicinity of Drakes Estero. Coastal scrub is found in a band tens to hundreds of meters wide along the coast from Monterey to Oregon (Stuart and Stephens 2006). Southward from San Francisco and Marin, this vegetation type transitions to coastal sage scrub, which has its northern extent in Marin County (Heady et al. 1988).

Figure 8. Coastal scrub intermix with grass & bishop pine

Coastal scrub is dominated by coyote brush (*Baccharis pilularis*), a small-leaved evergreen shrub. Other common associates are California blackberry (*Rubus ursinus*), poison-oak (*Toxicodendron diversilobum*), coffeeberry (*Rhamnus californica*), thimbleberry (*Rubus parviflorus*), yellow bush lupine (*Lupinus arboreus*), bush monkeyflower (*Mimulus aurantiacus*), salal (*Gaultheria shallon*) and blue blossom (*Ceanothus thrysiflorus*). It may also be found in association with native and non-native grasses, sedges (*Carex* spp.) and rushes (*Juncus* spp.). Some coastal sage species are also present including California sagebrush (*Artemisia californica*) and buckwheat (*Eriogonum fasciculatum*).

Coastal scrub is the climax community in some sites, seral to mixed evergreen forest in other locations, and exists in a shifting mosaic with grassland and forest in some situations. In many areas of the Seashore grasslands give way to coastal scrub in the absence of fire or grazing. Similarly, scrub may succeed to mixed evergreen forest in the absence of fire (e.g., in the Palomarin area) (McBride and Heady 1968). It has been estimated the absence of fire for a 50 year period will lead to site transition from scrub to mixed evergreen forest (Heady et al. 1988). At the northern end of Inverness Ridge, on the slopes from the ridge top westward to the ocean, coastal scrub exists in a mosaic with bishop pine forest and grassland. After the 1995 Vision Fire, bishop pine expanded from stands primarily at the top of Inverness Ridge to its current distribution which extends in patches nearly all the way down to the coast.

Most coastal scrub species do not need fire to reproduce, but respond well to fire. Many have the ability to sprout vigorously after fire. Coyote brush is normally not killed by fire and is able to sprout from the root crown post-fire. However, in more open coyote brush communities, the herbaceous vegetation component may provide enough surface heat to kill individuals by girdling the root crown so that they cannot resprout.

Before Mexicans and Americans suppressed Native American land-management practices, fire regimes in coastal scrub communities were likely greatly influenced by Native Americans given the low frequency of natural ignitions (Stuart and Stephens 2006). Because fires in scrub ecosystems burn in a crown fire regime, it is not possible to reconstruct fire history in these systems from fire scars. However, there is evidence that Native Americans used fire to convert scrub areas to grasslands. This would have required a fire return interval of less than five years (Keeley 2002, 2005).

In the early 1990s, two burns were conducted in the Tomales Point FMU to expand native grassland and to reduce non-native plant cover. Ten Northern Coastal Scrub (BBAPI1D05) plots were installed to monitor these burns. These plots were installed early in the fire effects monitoring program and clear monitoring objectives were never defined. They have all reached their ten year re-read and will not continue to be read. Currently, PRNS fire management staff is conducting a series of prescribed burns in order to create a strategic fuel break along Limantour Road. The vegetation in these burn units is a mixture of northern coastal scrub and Harding grass (*Phalaris aquatica*). Plots in these burn units are in the Harding grass monitoring unit, but do have a significant northern coastal scrub component.

Desired Future Condition: The PRNS Fire Management Program in not actively managing coastal scrub ecosystems with the exception of Limantour fuel break and so desired future conditions have not been developed for coastal scrub ecosystems generally. The desired future condition for the Limantour fuel break is to maintain an area of reduced fuels (live and dead fuels in the fine fuel classes) along Limantour Road while not adversely affecting native species.

Coastal Grassland - BDECE1D01, BPHAQ1D01, BLOPE1D01

Figure 9. *Deschampsia cespitosa* grassland at PRNS

Coastal grassland is used here to refer both to coastal prairie dominated by native grasses and to grasslands dominated by non-native species. Pristine coastal prairie is found in California from Santa Cruz County northward and generally within approximately 100 kilometers from the coast (Heady et al. 1988). Native coastal grasslands are an endangered vegetation type in California. The state has lost 99% of its native grasslands overall and 90% of its northern coastal bunchgrass to a combination of development and conversion to non-native species (Noss et al. 1995). Within PRNS, a large percentage of the coastal prairie habitat is dominated by non-native grasses, but an exact estimate is extremely difficult. Almost 20,000 acres of the Seashore is native or non-native grassland. Of this, approximately 70% is actively grazed by cattle. The majority of the Seashore's 50 rare plant species occur within this community.

Native coastal prairie is defined by perennial bunchgrasses including tufted hairgrass (*Deschampsia cespitosa*), California oatgrass (*Danthonia californica*), meadow barley (*Hordeum brachyantherum*), California brome (*Bromus carinatus*) and Pacific reedgrass (*Calamagrostis nutkaensis*) among other species. Non-native grasslands are dominated by annual grasses, such as annual Italian wild rye (*Lolium multiflorum*), farmer's foxtail (*Hordeum murinum*) and rattail fescue (*Vulpia* spp.). Non-native perennial species are also common and are of management concern. These species include purple velvet grass (*Holcus lanatus*) and Harding grass.

Coastal prairies have been greatly impacted since European settlement due to several factors including greatly increase intervals between fires and the introduction of both domestic livestock and the non-natives plants (Heady et al. 1988). Native Americans likely burned grasslands in order to improve harvests of grains, tubers, and bulbs (Fletcher 1628, Menzies 1924, Clar 1957, Slayermaker 1983, Keeley 2002). This would have prevented many grasslands from succeeding to shrublands or forests. Coastal prairies have also been impacted by a combination of cattle grazing and the introduction

of non-native annual grasses. These non-native species are strong competitors with the native grasses, particularly in the context of intense grazing pressure (Heady et al. 1988).

While coastal prairies probably burned frequently under Native American management, their fire ecology now must be considered in a different context due the presence of large numbers of non-native grasses. One study compared the effects of burning versus grazing in native coastal prairie systems and found that none of the three native grass species present on the site (*D. californica, Nassella pulchra* and *Nassella lepida)* were significantly affected by fire. Non-native annual grasses are disfavored by fire if burned in spring. Non-native annuals and perennials alike may be favored by fall burning and should be considered on a species by species basis (D'Antonio et al. 2001).

In the absence of Native American burning, much of the grassland vegetation at the Seashore is maintained by cattle grazing. Grazing is ongoing for dairy and beef farming operations over approximately 32,000 acres of the Seashore. Most of this acreage is in the Minimum Management FMU and is not being actively managed by the Fire Management Program. Disturbance from grazing favors a vegetation shift towards grassland over coastal scrub. Of the total grazed acreage in the Seashore over 18,000 acres is classified as grassland or pasture according to the 1994 PRNS Vegetation Map while only approximately 6,000 acres is classified as coastal scrub.

The Seashore is planning to conduct a prescribed burn in native coastal prairie habitat in the fall of 2008. This burn unit, in the Limantour FMU, contains a mixture of native coastal prairie, non-native grasses, Bishop pine, and coastal scrub. The burn objectives are to reduce hazard fuel loading (live and dead fuels in the fine fuel classes), mostly in the areas of bishop pine and coastal scrub, while not adversely affecting native species and to decrease the density of bishop pine along the roadside. Seven coastal prairie plots (BDECE1D01) dominated by *Deschampsia* have been installed to monitor the effects of the burn on native species composition. The objective of these plots is to determine if non-native species increase in percent cover following treatment.

Also in the Limantour FMU, several prescribed burns have been conducted in areas vegetated by a mix of northern coastal prairie and Harding grass. These burns are aimed at reducing hazard fuels, but PRNS staff is concerned that fire will facilitate the spread of non-native Harding grass. To monitor this, seven Harding grass plots (BPHAQ1D01) were installed. Based on plot data one year after fire, Harding grass decreased in burn plots. See Figure 10. Monitoring will continue until 10 years post-fire.

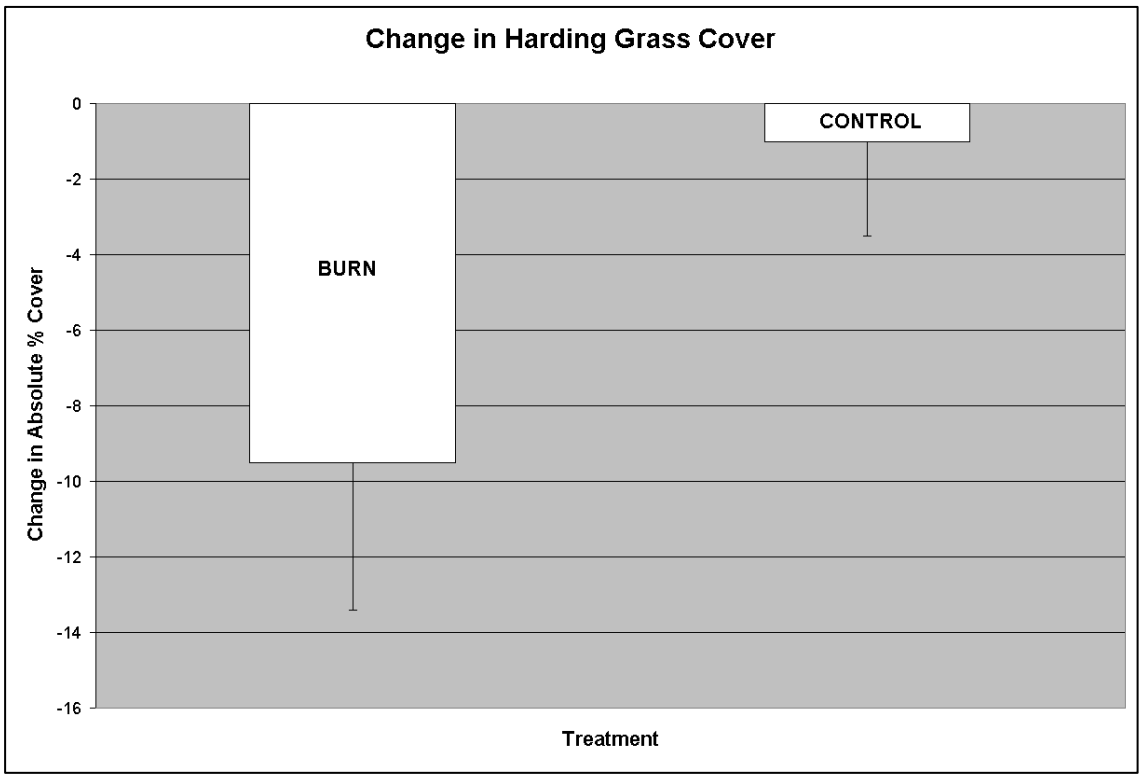


Figure 10. Harding grass cover before and after treatment. Difference is statistically significant (p=0.07)

There are also 36 non-native grass plots (BLOPE1D01) located in the Tomales Point and Minimum Management Unit FMUs. The Tomales Point burns were conducted in the early 1990's with the aim of increasing diversity and cover of native grassland species. 27 plots are located in this FMU and all have reached their 10 year read and will not be re-read. In the Minimum Management FMU, at D Ranch, 60 acres were burned in 2004 and 2005. These burns were intended to remove organic material from the site in order to prepare for planting with native seed. This experimental restoration treatment is being monitored with nine fire effects plots. Based on the data from one and two years post-fire, the burning and seeding treatment has not been effective in increasing cover and diversity of native species.

Desired Future Condition: The desired future condition for coastal grasslands is to restore native prairie species and reduce the cover of non-native species to the greatest extent possible.

Non-native French and Scotch Broom – BGEMO2D05, BCYSC1D05

French (*Genista monspessulana*) and Scotch (*Cytisus scoparius*) broom are leguminous shrubs native to the Mediterranean. They are highly invasive, spread quickly and convert native grass and shrub habitat into dense broom monocultures. At PRNS, French broom is found along the Highway One corridor south of Olema. Scotch broom is restricted to the northern part of the park in the vicinity of Drakes Estero.

Both French and Scotch broom are difficult to control because they are prolific seeders and form large, long-lived seed banks. Much research has been done on the efficacy of various treatment methods. Prescribed fire can be effective if it is applied annually or biennially for at least three treatments. This approach works by flushing the seedbank with the first one to two burns and then killing the germinants with the following burn(s) (Odion and Haubensak 1997, Alexander 2001, Alexander and D'Antonio 2003a, 2003b). Some studies have found that it is necessary to prep burn sites by cutting broom prior to burning, particularly in younger stands where there is less fuel loading (Odion and Haubensak 1997).

This has been attempted, with some success, at PRNS. Along Highway One, PRNS fire management staff began conducting prescribed burns to control French broom in the mid-1990's. These treatments continue and are being monitored with 13 French broom (BGEMO2D05) plots. These plots have most recently had a two year post-fire read and will continue to be read until ten years post-burn. At Drakes Estero, PRNS fire management staff burned to control Scotch broom from the mid-1990s through 2001. In most cases, broom areas were mowed and cut broom was allowed to cure before burning. Figure 11 shows results from the fire effects data of Scotch broom percent cover before and one year after burning at the Drakes Estero plots. Figure 12 shows the effect of multiple burns on percent cover of broom at the Drakes Estero plots.

There are some disadvantages to using fire as a treatment to manage broom. Firstly, follow-up is critical. If an area is burned only once, the broom problem will be much worse due to the seedbank response than if the area had never been treated (Paynter et al. 1998, Downey and Smith 2000). Further, after the multiple burns are completed, a few plants can be expected to germinate each year, so a low intensity, hand treatment level of follow-up is required indefinitely. At Drakes Estero, areas that haven't been retreated since 2001 or 2002 (5+ years since last treatment) are now covered with broom at close to pre-treatment levels. Lastly, Point

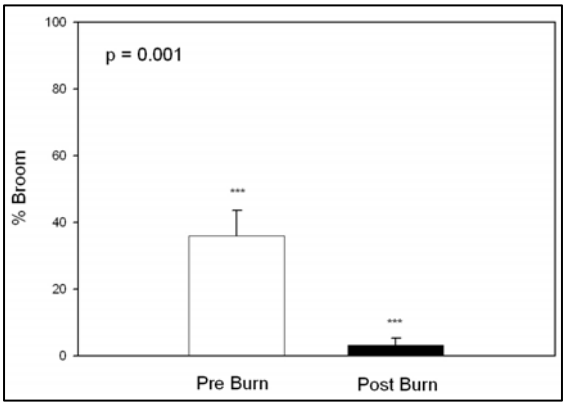


Figure 11. Change in % Broom Cover

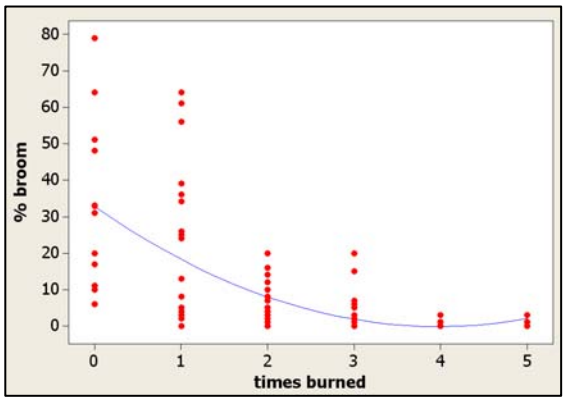


Figure 12. Effects of Multiple Burns on % Broom Cover

Reyes fire effects monitoring data indicates that repeated burning favors non-native over

native species, so even if broom removal is effective, sites are being recolonized with other non-natives (See Figure 13). Figure 14 shows a prescribed burn being carried out in French broom along Highway One.

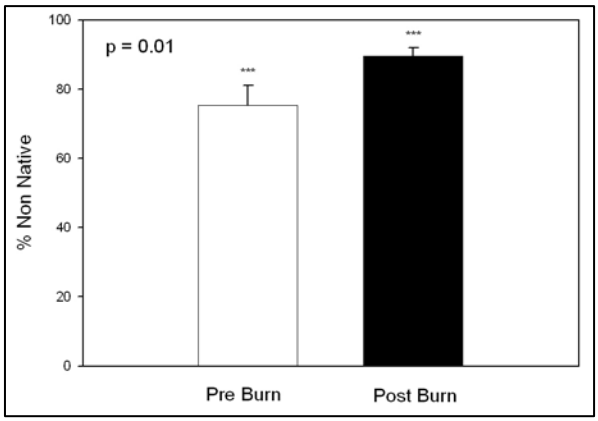


Figure 13. Changes in non-native cover after fire

Figure 14. Prescribed fire in French broom along Hwy 1

Staff is currently considering an integrated approach to Scotch broom management and may recommence prescribed fire treatments in this area. 18 Scotch broom plots (BCYSC1D05) have been installed and will reach their 10 year read in 2011. They will not be re-read after that, unless prescribed fire treatments resume in the Estero FMU.

Desired Future Condition: The desired future condition for areas infested with French and Scotch broom is to reduce broom cover to 5% or less.

F.3.2. Fire Ecology of Vegetation Types Without Plots

Coast Redwood Forests

Coast redwood (*Sequoia sempervirens*) forest is found within the Seashore primarily along Bolinas Ridge with a few small pockets west of Olema Valley. Coast redwood, a California endemic, is one of the world's tallest trees (Zinke 1988). This forest type is found in a narrow strip 450 miles long and 5 to 35 miles wide along the California coast from Del Norte

Figure 15. Coast redwood forest at Muir Woods National Monument

County (and a few isolated stands in extreme southern Oregon) in the north to Monterey County in the south (Olson et al. 1990). This species is thought to be fog-dependent and intolerant of sea spray (Olson et al. 1990). Coast redwood forest occupies approximately 3,000 acres of PRNS.

Coast redwood at PRNS is found in association with California bay (*Umbellularia californica*), tanoak (*Lithocarpus densiflorus*) and Douglas-fir (*Pseudotsuga menziesii*). The shrub and herbaceous understory is variable, but often includes huckleberry (*Vaccinium ovatum*) and swordfern (*Polystichum munitum*). The PRNS type is somewhat unique in that it grades from redwood forest into chaparral from Bolinas Ridge down towards Olema Valley. Down slope of the ridge top it is not uncommon to see regenerating redwood trees mixed amongst (*Arctostaphylos* spp.) and chinquapin (*Chrysolepis chrysophylla*).

Coast redwood are adapted to fire and other disturbance. Redwood is a vigorous sprouter and often sprouts from the bole or root crown in response to fire (Zinke 1988, Olson et al. 1990, Stuart and Stephens 2006). Reproduction from seed rarely occurs without disturbance as seeds germinate best on mineral soil exposed by flooding, fire, or wind throw. Seeds do occasionally germinate on duff and logs. Redwood seedlings and saplings prefer full sunlight and grow rapidly. Mature trees are extremely large and long-lived. The oldest known tree is 2,200 years old. It is not uncommon for trees to reach heights of 200-300 feet.

The fire return interval in coast redwood forests varies greatly with latitude, microclimate and distance from the coast. In general, forests that are further north, closer to the coast, or located on mesic sites tend to burn less frequently. Fire return intervals range from as long as 500 years on wetter, northern sites to 5-25 years on drier, southern sites (Stuart and Stephens 2006). Point Reyes National Seashore falls closer to the shorter end of the fire return interval spectrum. Brown et al. (1999a) report a fire return interval of 7.7 years for redwood stands at the Seashore. A study by McBride and Jacobs (1978) of redwood stands on Bolinas Ridge and Mount Tamalpais found point estimates of fire return interval ranging from 21.7 to 27.3 years. Because of the infrequency of natural ignitions in the San Francisco Bay area, it is likely that these relatively high fire frequencies are indicative of Native American burning practices.

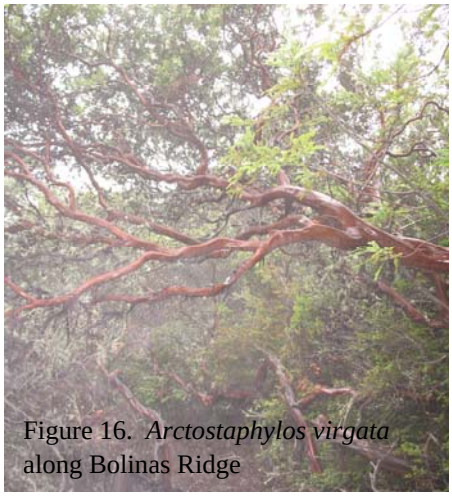


Figure 16. *Arctostaphylos virgata* along Bolinas Ridge

Maritime Chaparral

Maritime chaparral is found within the Seashore primarily along the southwest facing slopes of Bolinas Ridge. There are also patches of this vegetation type along Inverness Ridge. Maritime chaparral is found along the California coast from northern Santa Barbara County to Sonoma County. It is generally found within 6 to 12 miles from the coast. It is characterized by a relatively large number of rare and

endemic species and is threatened by development pressure (Van Dyke and Holl 2001, Davis and Borchert 2006). At Point Reyes, this vegetation type covers approximately 400 acres according to the 1994 vegetation map. However, this should be considered just an estimate as this vegetation type occurs as a shifting mosaic interspersed with Douglas-fir and Bishop pine forest. Thousands of manzanita individuals germinated after the 1995 Vision Fire and thus were not captured by the 1994 mapping process.

Maritime chaparral at PRNS intergrades with mixed evergreen forest and is bordered by coast redwood (*Sequoia sempervirens*) groves and riparian woodlands, which occupy moist drainages. In some locations, maritime chaparral dominated by Marin manzanita (*Arctostaphylos virgata*) is an early successional vegetation type and is eventually shaded out by Bishop pine or Douglas-fir. In other locations, such as along Bolinas Ridge, maritime chaparral appears able to persist as the dominant vegetation type indefinitely (Sweicki and Bernhardt 2006). Common maritime chaparral species at PRNS include Eastwood's manzanita (*Arctostaphylos glandulosa*), sensitive manzanita (*Arctostaphylos sensitiva*), chamise (*Adenostoma fasciculatum*), chinquapin (*Chrysolepis chrysophylla*), buckbrush ceanothus (*Ceanothus cuneatus*) and chaparral pea (*Pickeringia montana*). Also of importance in this vegetation type are the rare species Marin manzanita (*Arctostaphylos virgata),* Point Reyes ceanothus (*Ceanothus gloriosus* var. *exaltatusi*) and Mason's ceanothus (*Ceanothus masonii*).

Maritime chaparral is a fire-adapted vegetation type. Many maritime chaparral species are obligate seeders and require fire in order to reproduce (Odion 2000, Van Dyke and Holl 2001, Davis and Borchert 2006). Species such as the rare manzanita and ceanothus species listed above are examples of species that reproduce only from seed. Although occasional germination from seed may occur in disturbed areas along trails, these species require fire to scarify seeds and expose mineral soil to allow for reproduction at an ecologically meaningful scale. The most recent fires Bolinas Ridge occurred in 1906 and 1923 (exact fire boundaries are not known). There are accounts of abundant germination of Mason's ceanothus following the 1923 fire (McMinn 1942). On Inverness Ridge, the 1995 Vision fire burned through areas of chaparral. In these areas all three rare species exhibited vigorous post-fire seedling establishment (Parravano 1999). In some locations these post-fire populations are now (12 years post-fire) being shaded out by tree species such as bishop pine.

The fire regime in maritime chaparral in the absence of humans would probably have been quite long since, as discussed above, lightning along the coast is uncommon. However, fire return intervals may have been shorter prior to Mexican and American settlement of the peninsula due to Native America burning. Because fire regimes in maritime chaparral are stand-replacing, it is not possible to determine fire return intervals from tree rings. Little is known about seed bank longevity in maritime chaparral. One study of a chaparral community on the Central Coast indicated that a fire return interval of 40 years could be too short for obligate seeding species to build up a sufficient seed bank for recruitment of enough seedlings to maintain the population post-fire (Odion and Tyler 2002). Another study looked at vegetation change in a maritime chaparral community that had not burned in at least 70 years and over the course of their study, the

authors noted a shift from chaparral species to oak woodland species and a complete lack of recruitment of obligate seeding species (Van Dyke and Holl 2001).

Coastal Dune

Native dune habitat in California is rare and is threatened both by development and by non-native species. The majority of dune habitat at Point Reyes is dominated by non-native European beachgrass and iceplant. Approximately 2,000 acres of the Seashore is coastal dune habitat.

Native dune habitat is comprised primarily of dune sagebrush (*Artemisia pycnocephala*), coast buckwheat (*Eriogonum latifolium*), dune lupine (*Lupinus chamissonis*), or goldenbush (*Ericameria ericoides*). Non-native dune habitats are dominated by European beachgrass (*Ammophila arenaria*) and iceplant (*Carpobrotus edulis*).

Total vegetation cover in coastal dune ecosystems is often low and interspersed with bare sand. Although there may be thatch buildups in stands of European beachgrass, these communities are generally not very flammable.

Prescribed fire is being used as part of an experimental treatment to eradicate European beachgrass from the coastal dunes at Limantour Spit. The experimental approach uses a combination of herbicide and prescribed fire and is based on successful treatments carried out by California State Parks (Hyland and Holloran 2005). Two small areas were treated in the fall of 2006: 0.26 acres were burned, 0.006 acres were cut with a weed whacker, and 0.006 acres were both cut and burned. In the fall of 2007, these areas will be treated with herbicide. Treatment effectiveness is being monitored qualitatively with repeat photography and if burning is determined to be effective, treatment will be expanded to a larger area.

Figure 17. Native coastal dune vegetation at Abbotts Lagoon

F.4. MANAGEMENT GOALS AND OBJECTIVES

F.4.1. Fire and Resource Management Goals

The 1999 Point Reyes National Seashore Resource Management Plan (National Park Service 1999) lays out a series of goals for natural and cultural resources management.

The overall goal is to ensure the "...identification, protection, and perpetuation of significant cultural and historic resources and of the diversity of natural ecosystems representative of the California seacoast." The plan also lists the following, more specific, objective which is related to fire, "To enhance knowledge and expertise of ecosystem management through research and experimental programs relating to wildlife, prescribed burning techniques, non-native plant and animal reduction, regulation and control of resource use, restoration of native ecosystems and pollution control."

The Fire Management Plan lists the following additional goals:

1. Protect firefighters and the public.

2. Protect private and public property.

3. Maintain or improve conditions of natural resources and protect these resources from adverse impacts of wildland fire and fire management practices.

4. Maintain or improve conditions of cultural resources and maximize efforts to protect cultural resources from adverse effects of wildland fire and fire management practices.

5. Foster and maintain effective community and interagency fire management partnerships.

6. Foster a high degree of understanding of fire and fuels management among park employees, neighbors, and visitors.

7. Improve knowledge and understanding of fire through research and monitoring and continue to refine fire management practices.

F.4.2. Fire Ecology Program Goals and Objectives

1. Use an adaptive management approach to work with fire and resource managers to identify resource management challenges, desired future vegetative conditions, and treatment and monitoring objectives for vegetation communities to be treated with fire or non-fire fuels treatments.

2. Act as a liaison between fire management and resource management staff.

3. Gather information on basic fire behavior and weather conditions during prescribed fires.

4. Establish and implement a sampling design and data collection protocol for vegetation communities to be treated with fire or thinning activities.

5. Document and analyze short- and long-term fire effects on vegetation communities.

6. Use all available information (fire behavior observations, weather conditions, data collected on vegetation plots, and scientific literature) to determine if fire and resource management objectives are being met.

7. Identify where or if additional fire effects research is needed.

F.4.3. Treatment and Monitoring Objectives

Table 2 lists treatment and monitoring objectives for monitoring units listed in Table 1 and discussed in section F.3.2.

Table 2. Treatment and Monitoring Objectives by Monitoring Type

Monitoring Unit	Monitoring Unit Code	Treatment	Treatment Objective	Monitoring Objective
Bishop Pine Forest*	FPIMU1D05	Prescribed fire: never executed	1. Reduce dead and downed fuel loading in all size classes 60% or greater immediately post-burn.	1. Determine the degree of reduction of dead and downed fuels. 2. Assess effects of fire on Bishop pine, particularly percent mortality. 3. Examine post-fire regeneration
Douglas-fir Forest*	FPSME1D10	Prescribed fire: never executed	1. Reduce dead and downed fuel loading by 40 to 80% in all size classes. 2. Create opportunities to research the effects of fire on wildlife. 3. Create or maintain healthy Douglas-fir forests	1. Determine the degree of reduction of dead and downed fuels. 2. Determine the number of live Douglas-fir by size class. 3. Assess fire induced mortality
Eucalyptus forest	FEUGL1G08	Mechanical Thinning	1. Decrease the standing basal area of eucalyptus. 2. Decrease dead and downed fuel loading. 3. Minimize resprouting. 4. Maintain or increase cover of native shrubs; reduce or maintain cover of French broom.	1. To estimate the mean decrease in basal area with 80% confidence that the mean is within 20% of the true value. 2. To estimate the mean change in dead and downed fuels with 80% confidence that the mean is within 20% of the true value. 3. To estimate the mean percent of resprouting stumps with 80% confidence that the mean is within 20% of the true value. 4. To measure the cover of shrubs before and after treatment. To estimate mean change in native shrub cover with 80% confidence that the mean is within 20% of the true value.
Northern Coastal Scrub*	BBAPI1D05	Prescribed fire	1. Reduce non-native species 2. Reduce fuel loading	1. Detect changes in percent cover *Baccharis pilularis*
Bishop Pine brush	BPIMU1D04	Prescribed fire	1. Reduce dead and downed fuel loading 2. Reduce stem density of bishop pine	1. To be 80% certain of detecting a 20% decrease in the cover of native species. 2. To be 80% certain of detecting 20% mortality in Bishop pine. 3. To be 80% certain of detecting a 20% increase Bishop pine regeneration.
Deschampsia Coastal Prairie	BDECE1D01	Prescribed fire	1. Reduce fuel loading 2. Maintain or increase cover of native species.	1. To be 80% certain of detecting a 20% decrease in the cover of native species. 2. To be 80% certain of detecting a 20% increase in the cover of velvet grass. 3. To be 80% certain of detecting a 20% increase in the cover of Harding grass.
Non-native Annual Grassland	BLOPE1D01	Prescribed fire	1. Reduce fuel loading 2. Maintain or increase cover of native species.	1. To be 80% certain of detecting a 20% decrease in the cover of native species. 2. To be 80% certain of detecting a 20% change in the cover of *Lolium multiflorum*.
Harding Grass	BPHAQ1D01	Prescribed fire	1. Reduce fuel loading 2. Maintain or increase cover of native species. 3. Maintain or decrease cover of Harding grass.	1. To be 80% certain of detecting a 20% decrease in the cover of native species. 2. To be 80% certain of detecting a 20% change in the cover of *Harding grass*.
Scotch Broom	BCYSC1D05	Prescribed fire	1. Reduce fuel loading 2. Maintain or increase cover of native species. 3. Maintain or decrease cover of Scotch broom.	1. To be 80% certain of detecting a 20% decrease in the cover of native species. 2. To be 80% certain of detecting a 20% change in the cover of Scotch broom.
French Broom	BGEMO2D05	Prescribed fire	1. Reduce fuel loading 2. Maintain or increase cover of native species. 3. Maintain or decrease cover of French broom.	1. To be 80% certain of detecting a 20% decrease in the cover of native species. 2. To be 80% certain of detecting a 20% change in the cover of French broom.

*These monitoring units were developed early in the program and lack quantitative monitoring objectives. Most plots are close to retirement; objectives will be updated if new plots are installed.

F.5. MONITORING DESIGN

F.5.1. Monitoring Levels

The NPS Fire Monitoring Handbook (National Park Service 2003a) identifies four levels of monitoring. The most basic of these, Level 1, is the monitoring of environmental conditions including weather, fuel conditions, fire danger rating, etc. Baseline data has already been gathered for PRNS (for example, topography, vegetation cover, and fuel loading) and is being maintained by the San Francisco Bay Area Network Inventory and Monitoring program (SFBAN I&M). The SFBAN I&M is currently in the planning and/or early implementation phases of monitoring for early detection of non-native plants, rare plants, plant community change, riparian plant communities, and landscape change. Plant community change monitoring may incorporate fire effects monitoring plots. The operations division of the PRNS Fire Program collects data on fire weather and fire danger. The fire effects crew collects live fuel moisture data during the fire season (June through October) at the request of the Fire Management Officer or Fuels Specialist using the protocols described in the report Measuring Moisture Content in Living Chaparral: A Field Users Manual (Countryman and Dean 1979).

Monitoring Level 2 is fire observation, including observing and documenting fire behavior, smoke volume and movement, fire location and size, etc. Data is collected at Level 2 on prescribed fires and wildfires to satisfy the requirements for a Post-Fire Report for prescribed fires (see Addendum 12.5. Post-Burn Report for an example) or to provide information for the NPS Wildland Fire Report (formerly DI-1202) or the Wildland Fire Implementation Plan – Stage II or Stage III for wildland fires. Protocols for Level 2 post-wildfire monitoring follow the Fire Monitoring Handbook and use datasheets FMH-1(A), -2(A), and -3(A) (National Park Service 2003a). Additionally, burn severity assessments are completed for all fires greater than 500 acres and Composite Burn Index plots are installed in association with the burn severity assessment. For mechanical projects, treatment prescriptions and locations are documented and photo-monitoring takes place.

Levels 3 and 4 are the monitoring of short-term (≤ 2 years) and long-term (> 10 years) change. Variables monitored at these levels of change include fuel loading and vegetation composition among others. Level 3 and 4 monitoring takes place in all monitoring units that are being actively managed by the fire management program through prescribed fire or mechanical treatment. Level 3 and 4 monitoring follows the Fire Monitoring Handbook protocols in most cases and uses some of the following datasheets: FMH -4, -6, -7, -8, -9, -10, -11, -15, -16, -17, -19, -20, -21, -22, -23 (National Park Service 2003a). For most monitoring units, plots are monitoring for 10 years post-treatment and then retired. Some plots may continue to be monitored beyond 10 years if there are questions that require further monitoring to answer. Level 3 and 4 monitoring will also take place for wildfires greater than 500 acres. Monitoring after wildfire will focus on remeasurement of plots installed for the PRNS vegetation map. Protocols for these plots

are described in the PRNS vegetation map final report (Schirokauer et al. 2003). Protocols for non-native and rare plant monitoring post-wildland fire will be developed in conjunction with the SFBAN I&M program and the Point Reyes National Seashore Vegetation Management Program.

Table 3. Recommended Monitoring Levels by Fire Management Strategy

Monitoring Level	Fire Management Strategy		
	Wildland Fire	Prescribed Fire	Mechanical Treatment
Level 1 - Environmental	Yes	Yes	Yes
Level 2 - Fire Conditions	Yes	Yes	No
Level 3 - Short-term change	Yes	Yes	Yes
Level 4 - Long-term change	Yes	Yes	Yes

F.5.2. Monitoring Units

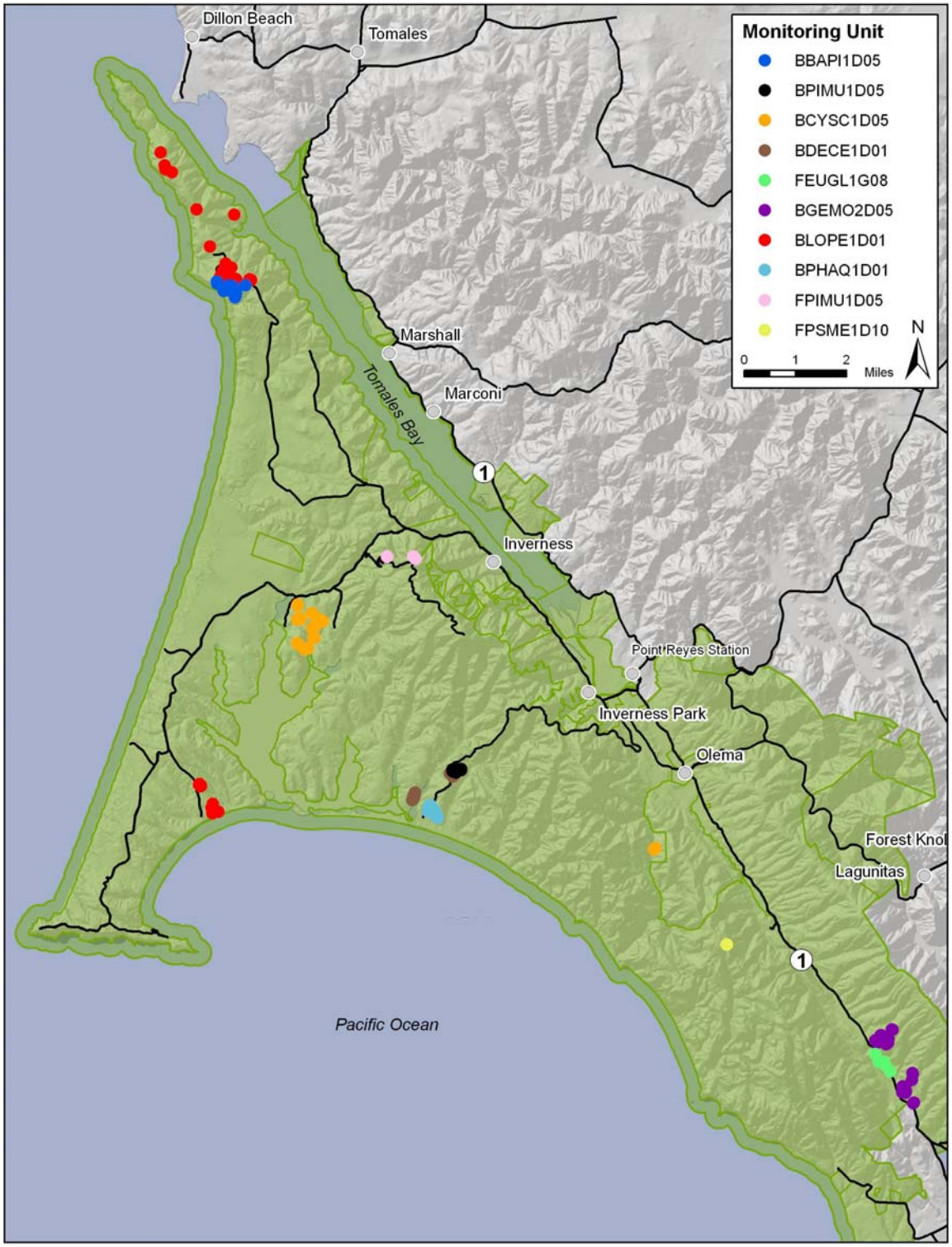
There are nine different monitoring units at Point Reyes National Seashore. Monitoring unit naming conventions follow the Fire Monitoring Handbook (National Park Service 2003a). There are descriptions of these units by general vegetation type in section F.3.2 of this document. Addendum F.12.2. includes monitoring unit description sheets which detail specific inclusion parameters and rejection criteria for each monitoring unit. Figure 18 depicts the location of plots by monitoring unit. Table 4 lists plots and their status by monitoring unit. Retired plots will no longer be read, but rebar will be left in place. Addendum F.12.4 is a monitoring schedule and lists the years of past and future plot reads by monitoring unit.

Table 4. Plot Status by Monitoring Unit

Monitoring Unit	Vegetation Type	# of Plots	Status	Comments
BBAPI1D05	Northern Coastal Scrub	10	YR10	Can be retired.
BCYSC1D05	Scotch Broom	18	~YR05	Can be retired if broom research is initiated.
BDECE1D01	*Deschampsia* Coastal Prairie	7	Pre	Native grassland monitoring; should continue to be read.
FEUGL1G08	Eucalyptus	5	YR01	Mechanical thinning monitoring; should continue to be read.
BGEMO2D05	French Broom	13	YR01	Can be retired if broom research is initiated.
BLOPE1D01	Non-native	17	YR10	Can be retired.

	Annual Grassland	9	YR02	Grassland restoration monitoring; should continue to be read.
		10	Never burned	Can be retired.
BPHAQ1D01	Harding Grass	7	YR02	Monitoring for Harding grass spread in fuel break; should continue to be read.
BPIMU1D05	Bishop Pine – brush	6	Pre	Bishop pine monitoring; should continue to be read.
FPIMU1D05	Bishop Pine	3	Never burned	Can be retired.
FPSME1D10	Douglas-fir	1	Never burned	Can be retired.

Figure 18. Plots by monitoring unit



F.5.3. Sampling Design

Sampling design in all monitoring units, with the exception of FEUGL1G08, follows the protocols in the Fire Monitoring Handbook. See the handbook for plot schematics and specific information on variables measured (National Park Service 2003a). Monitoring frequency also follows the Fire Monitoring Handbook. Plots are monitored before, immediately after, and one, two, five and ten years post-fire. Any monitoring after ten years post-fire is considered on a case-by-case basis by the fire ecologist. Decisions to extend monitoring to twenty years are based upon the ecological questions being considered and on whether relevant additional information would be gained by continuing monitoring efforts. When new plots are added, they are randomly located using the FEAT-GIS toolbar random plot tool. Monitoring should occur in late spring/early summer when most grasses and forbs are flowering, before dry-up.

For the BPIMU1D05 plots, an adapted FMH brush plot is used. These are typical brush plots with a two meter brush belt. However, post-fire bishop pine individuals are counted at shrub species in the brush belt rather than as overstory species. Because regeneration of bishop pine is so thick, it is not practical to measure this vegetation type using a standard FMH forest plot.

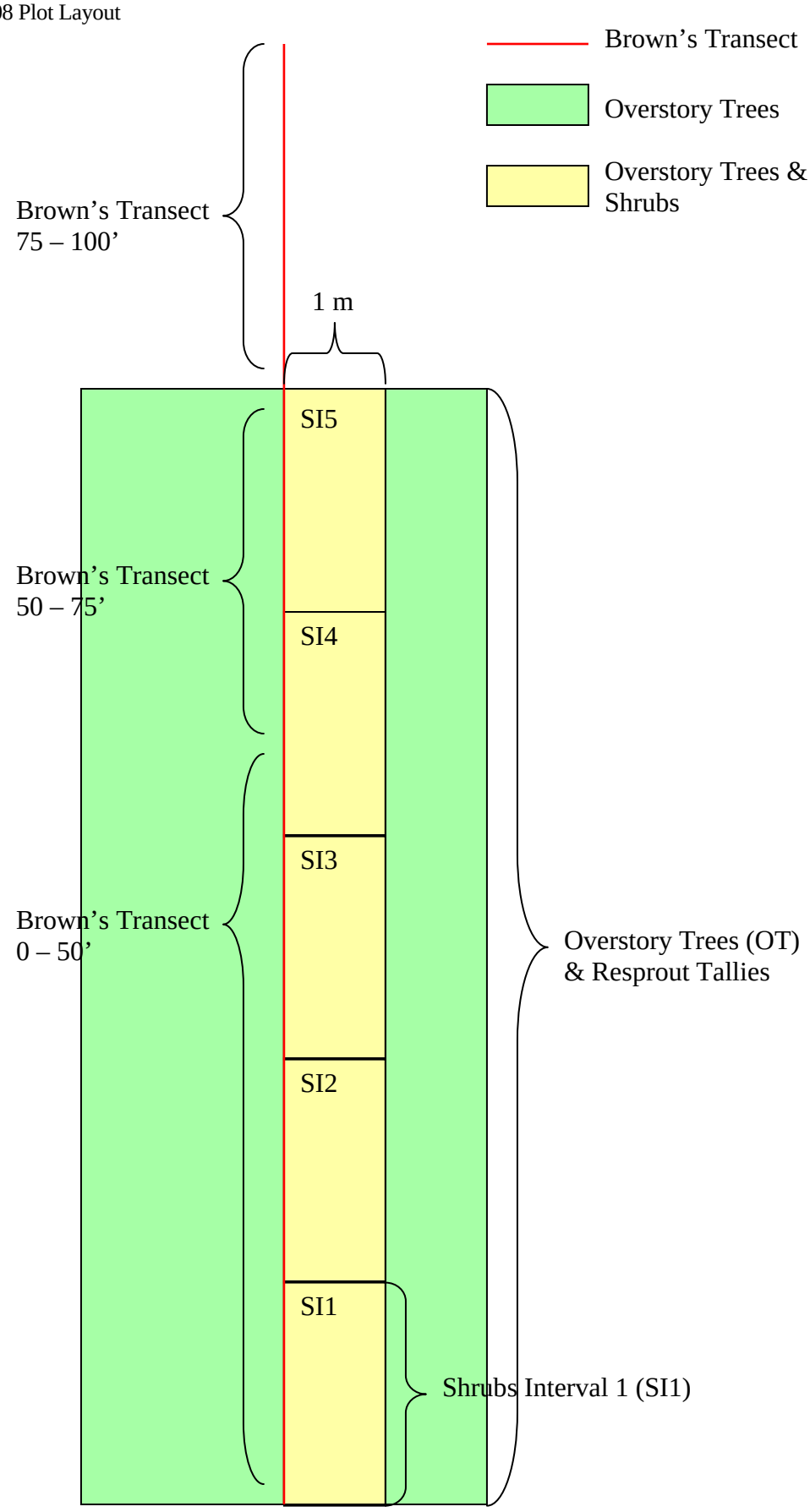
For the FEUGL1G08 plots, an adapted FMH forest plot is used. Sampling design for these plots was developed by the park fire ecologist in collaboration with the regional fire ecologist. Then pilot plots were installed and were used to adjust the final sampling design and to determine the minimum number of plots to install. These plots measure a number of variables as described below. Plots are permanently marked at the origin and end of each transect with rebar. The location of each origin and end will also be measured and recorded with a GPS unit. Monitoring frequency is similar to that for traditional FMH plots; data is collected at each permanent plot before, and one, two, five and ten years after treatment. The following variables are measured:

1. Standing fuels (Overstory trees):
   Record the DBH and species of all trees (with a DBH >= 1cm) in a fixed 25 x 4 m plot. See Figure 19. Trees will be marked with chalk as they are measured to avoid skipping or double-counting individuals.
2. Dead and downed fuels:
   One 50 foot Brown's transect (Brown et al. 1982) will be established at each sampling plot. Along the transect, the following parameters will be measured:
   a. Tally time-lag fuels
      i. 1 & 10 hour fuels are recorded for the first 6ft of the transect.
      ii. 100 hour fuels are recorded for the first 12ft of the transect
      iii. 1000 hour fuels are recorded for the entire length of the transect.
   b. Measure litter and duff at 1, 5, 10, 15, 20, 25, 30, 35, 40, and 45 ft.

3. Resprouting
   In post-treatment reads, stumps will be tallied as sprouting or non-sprouting within the 25 x 4m overstory plot.
4. Native species (Shrubs/Seedlings):
   Tally all shrubs by species in a fixed 25 x 1 m plot. The plot will be located on the right side of the transect (when standing at the plot origin and facing the end of the plot) and will be broken down into a series of 1m x 5m intervals. See Figure 19. Since some of the plots have such a thick cover of *Genista monspessulana* (as many as 73 stems/m^2), this species will only be measured in the first 5 x 1 m^2 interval. Seedlings of overstory species will also be tallied by species in this first 5 x 1 m^2 interval.
5. Treatment Monitoring
   The fire effects monitoring crew observes and takes digital photographs of each plot as it is treated (thinned).
6. Photomonitoring
   Each time plot data are collected, digital and traditional photographs (slide film) will be taken from the origin and end of each transect. For traditional pictures, the focal length will be recorded. All pictures include the top of the rebar at the plot origin and include as much of the plot as possible. They should be taken horizontally. Prints of previous plot photos should be taken into the field and used to help set up photopoints. Photographic information should be recorded on the photographic record sheet (see Addendum F.12.3.). Additionally, the fire effects crew will take supplemental photographs as they deem appropriate.
7. Understory
   Herbaceous species will not be captured quantitatively in this monitoring protocol. However, there will be an opportunity for the field crew to list the species present and comment qualitatively on the understory at the treatment site. Non-native species such as cape ivy, pampas grass, and vinca, among others, should be noted in this comment section.

Plot layout is depicted in Figure 19. Data sheets are included in Addendum F.12.3. Because of difficultly with rebar being knocked out and lost during the mechanical thinning operation, only photomonitoring is being conducted for FEUGL1G08 plots 6-10.

Figure 19. FEUGL1G08 Plot Layout



F.6. DATA MANAGEMENT AND ANALYSIS

F.6.1. Data Management and Quality Control

Paper Data
Data is entered and then checked for errors by the Fire Effects Monitoring Crew. Error checking is performed by two people by reading the data aloud, line by line, and checking it against what has been entered. If only one data checker is available it should be visually checked line by line against what has been entered. Once data is entered, it is filed in the Fire Effects Monitoring Program office at the North District Operations Center (NDOC) at PRNS. This is where original copies of all data sheets are stored. Copies of all data sheets are sent to the parks where the data was collected. At the end of each field season, data is randomly spot checked by the Lead Fire Effects Monitor.

Electronic Data
Electronic data is entered into and managed in the Fire Ecology Assessment Tool (FEAT) (Spatial Dynamics 2006). The master FEAT databases live on the Fire Effects master computer at NDOC. The identification number for that computer is INPPORE104679. Backups of all park FEAT databases are stored on the Teams server (INPPORE05) at PRNS in the folder N:\Fire Effects\Backup data\FEAT. Backup park FEAT databases are also sent to each park annually.

Photos
Plot photos are in slide format only for the early years of the program and are currently taken in both digital and slide format. Digital photos and slides are labeled with the monitoring unit, plot number, stake from which photo is taken (For example, a photo taken from the 0P stake looking to the 30P stake would be labeled 0P – 30P.) and date. Slides are stored at NDOC in slide sleeves in a fire-proof filing cabinet along with the original plot datasheets. Digital photos are stored on the Fire Effects master computer at NDOC in the folder C:/Digital Photos. Digital photos are backed up to DVD and external hard drive annually and stored in the electronic equipment filing cabinet in the Fire Effects office at NDOC.

GIS Data
GIS data and metadata are stored on the GIS server at PRNS (INPPORE07) in the folder S:\GIS\vector1\fire\FMH. This data is backed up weekly via the park-wide backup system.

F.6.2. Data Analysis

Data is analyzed annually by the Fire Ecologist. This normally occurs in conjunction with the preparation of the Annual Report in January of each year. For all monitoring units with plots that are active, minimum plot calculations have either already been performed, or will be performed one year post-treatment. Data will be tested for a normal distribution. If data is normally distributed, data will be analyzed using

parametric tests such as t-test and ANOVA. Statistical analysis will be targeted to monitoring objectives for each monitoring unit. For example, in the French broom monitoring unit a paired t-test will be used to compare percent cover of French broom before and after burning in order to meet the stated objective of being 90% certain of detecting a 20% change in cover of French broom. If data is not normally distributed, a statistician will be consulted.

F.7. REPORTING AND ADAPTIVE MANAGEMENT

A critical function of the Fire Ecology Program within the National Park Service is to facilitate adaptive management (National Park Service Reference Manual 18 Wildland Fire Management). An important part of adaptive management is a process whereby management actions are monitored, evaluated, and, if necessary, adjusted so that objectives are being met. Communication of monitoring results is a key step in the adaptive management process and occurs both formally and informally within the Fire Ecology Program.

Annual Report
Accomplishments and results from data analysis are formally written up each year in the Fire Ecology and Fire Effects Monitoring Annual Report. This report is completed each January and is shared in both hard copy and electronic format with resource management, fire management, and upper division managers at the parks, with regional office staff as well as with interested parties outside of the National Park Service. It is also posted on InsideNPS by national office staff.

Fire Effects Forum
In addition to the annual report, a Fire Effects Forum is held each winter to formally share and discuss fire effects monitoring results with natural resource and fire managers. The Fire Effects Forum is a half day meeting which rotates amongst the network parks. Data analysis is presented for each park, presentations on other aspects of the fire program are given, and both past and upcoming projects are discussed. Any changes to the Fire Management Plan discussed in this meeting are incorporated via the annual update process.

Informal Reporting
Informal reporting occurs via conversation, phone and email on a routine basis between both the Fire Ecologist and the Lead Fire Effects Monitor and resource and fire management staff in each of the parks.

F.8. RESEARCH

The NPS is committed to supporting fire research to promote sound fire management decisions.
The policy direction for fire research within the NPS is found in RM #18, Chapter 15 (http://www.nps.gov/fire/download/fir_wil_rm18_ch11.pdf). Fire research has been ongoing at PRNS since the mid-1990s. The objectives of fire research at PRNS are two-

fold. The primary research objective is to collect and analyze data on specific biological resources in a scientifically rigorous manner to determine positive or adverse effects of prescribed burning on targeted resources. The secondary objective is to improve the knowledge base about prescribed fire and wildfire such that fire research will contribute both to science and to fire management.
Research has been conducted by park staff and by outside researchers. It is the goal of the fire program at PRNS to continue in-park research efforts and to recruit high caliber research from outside organizations.

F.8.1. Completed Projects

Past fire research at PRNS has been focused on two primary areas: the effects of the 1995 Vision Fire and the fire history of the area. The 1995 Vision Fire provided a rare opportunity to study the role of fire in the unique ecosystems of PRNS. Much of the post-Vision Fire research is summarized in the publication, "Lessons Learned from the October 1995 Vision Fire" (National Park Service 2003b). Studies in this publication examine a wide array of topics including the effects of fire on the Point Reyes Mountain Beaver, changes in ectomycorrhizal communities following fire, and post-fire vegetation response.

Fire history at PRNS has also been the subject of several research studies. Researchers have used dendrochronology and sediment core analysis to reconstruct historical patterns of fire history and vegetation (Brown et al. 1999, Anderson 2005).

F.8.2. Current and Future Projects

Several fire-related research projects are currently ongoing at PRNS. One project, being carried out by PRNS in collaboration with University of California at Berkeley through the Cooperative Ecosystems Studies Unit program is examining the effects of Sudden Oak Death on forest structure, composition, and fuel loading. As of December 2007, the initial work for this study has been completed and a report is being finalized. However, plots established in this study will continue to monitored by fire effects or I&M staff as Sudden Oak Death progresses. Another ongoing research collaboration with San Francisco State University is examining the ecology of Marin manzanita, a rare maritime chaparral species. Long term monitoring of field plots established for this study will continue in the future.

A draft fire research plan for PRNS was drafted in 2001 and is currently being revised (Parravano and Moritsch 2001). When completed, it will be added to this document. High priority topics for future fire research include the effects of fire on invasive species with a particular emphasis on broom, Harding grass, and velvet grass; the effects of fire on rare chaparral plants; the effects of fire on the spread of Sudden Oak Death; the effects of fire on wildlife species that are of high management priority; and the reconstruction of historical vegetation patterns.

F.9. ROLES AND RESPONSIBILITIES

Roles and responsibilities are detailed in Section 4.1 of this document. Work plans are developed annually between staff members and their supervisor in conjunction with the performance evaluation process.

F.10. CONSULTATION, COLLABORATION AND REVIEW

F.10.1. Consultation

This document was compiled in consultation with much of the fire and resource management staff of Point Reyes National Seashore. This includes Jane Rodgers, Roger Wong, Jordan Reeser, Wende Rehlaender, and Wendy Poinsot.

F.10.2. Collaboration

Other Network Parks
The Point Reyes National Seashore is part of the San Francisco Bay Area Network of National Parks which also includes Golden Gate National Recreation Area, Pinnacles National Monument, Eugene O'Neill National Historic Site and John Muir National Historic Site. The Point Reyes Fire Ecology Program works extensively with other network parks, in particular Pinnacles National Monument and Golden Gate National Recreation Area. Parks collaborate on projects and treatment strategies and share resources well.

Inventory and Monitoring Program
The Fire Ecologist participates in the San Francisco Bay Area Inventory and Monitoring vegetation working group. The Inventory and Monitoring coordinator is included in Fire Ecology Program happenings and updates. The SFBAN I&M is currently in the planning and/or early implementation phases of monitoring for early detection of non-native plants, rare plants, plant community change, riparian plant communities, and landscape change. Plant community change monitoring may incorporate fire effects monitoring plots. In the case of a wildfire at PRNS, these monitoring efforts would track vegetation change.

Exotic Plant Management Team (EPMT)
The Fire Ecology Program works closely with the California EPMT. The two programs collaborate on weed removal projects that use fire as a tool. The Fire Ecologist is currently working with the EPMT and the park vegetation management staff to develop an integrated plan for the management of Scotch broom at PRNS.

F.10.3. Reviewers

Marie Denn, Pacific West Region Aquatic Ecologist

Paul Reeberg, Pacific West Region Fire Ecologist
Andrea Williams, San Francisco Bay Area Network Inventory and Monitoring Natural Resource Specialist

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F.12. ADDENDA

F.12.1. Plant List and Voucher Collection

The plant list used by the Fire Effects Program is the plant database developed by for the vegetation and wetland mapping project at PRNS. It can be found on the PRNS network at U:\Natural_Databases\Vegetation\Plant List.mdb. When NPSpecies is finalized for the park, the Fire Effects Program will convert to using that.

Voucher specimens are stored in the Fire Effects Office at NDOC and are maintained by the Lead Fire Effects Monitor.

F.12.2. Monitoring Unit Descriptions

F.12.2.1 Bishop Pine Forest (FPIMU1D05)

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: FPIMU1D05 **Date Described**: 9/10/92

Monitoring Type Name: Bishop Pine Forest

Preparer(s) (FEMO/RMS/FMO): Paul Reeberg and Tom Leatherman

Burn Prescription (including other treatments):
Date of Burn (mo-mo).....08-11
Air Temp. (F).....45-85 Rate of Spread (ch/hr)..0.0-152.0
Rel. Humidity (%).....30-80 Heat per Area (btu/ftý).223.0-757.0
1-hr TLFM (%).....4-11 Fireline Intns (btu/ftý)1.0-2115.0
10-hr TLFM (%).....12 Flame Length (ft).....0.5-15.0
Herb Moisture (%).....50-150 Scorch Height (m).....0.0-14.0
Midflame Wind (mph).....1.0-12.0

Management Objective(s): Reduce dead and down fuels in all size classes by 60% or greater immediately post burn.

Monitoring Objective(s): Determine degree of reduction of down and dead fuels. Assess effects of fire on bishop pine trees, particularly percent mortality. Examine regeneration of the forest. Use data to aid in elucidating best management techniques for bishop pine forest.

Fire Monitoring Variable(s): Fuel loading, percent mortality of Bishop pine trees by size class, number of bishop pine seedlings per hectare, brush density.

Physical Description: Includes north, east and west aspects; gradients range from 0-40% slope (average 15%); contains lower slope, midslope and upperslope areas; elevation ranges from 120 to 1,320 feet.

Biological Description: This community is dominated by bishop pine (*Pinus muricata*). Trees grow up to 100 ft tall in an open forest, with a dense nderstory of shrubs, ferns, and bunch grasses. Understory species composition s spatially variable; dominant species may be *Polystichum munitum, Gaultheria hallon, Vaccinium ovatum, Rubus ursinus, Calamagrostis nutkaensis*, or assorted forbs.

Rejection Criteria: Areas within 20 meters of a paved or dirt road or trail, unless the width of the monitoring type is restrictive, then 10 meters from a road or trail will suffice;

greater than 30% barren soil or rock; areas within 20 meters of a riparian zone; forest cover less than 75%.

Notes (This Entire Monitoring Type): Do not collect brush density data for *Gaultheria shallon*.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS	(Circle One)			(Circle One)	
Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn					
Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for Shrubs: 2m

Herbaceous Frame Dimensions: n/a
Herbaceous Density Data Collected At: n/a

Burn Duff Moisture (Opt) Y N Flame Depth (Opt) Y N

100 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FOREST PLOT PROTOCOLS	(Circle One)	(Circle One)

Overstory **Area Sampled: Q1-Q4; all quarters**
Live Tree Damage (Opt) Y N Live Crown Position (Opt) Y N
Dead Tree Damage (Opt) Y N Dead Crown Position (Opt) Y N

Pole-size **Area Sampled: Q1, Q2; two quarters**
Height (Opt) Y N Poles Tagged/Rec (Opt) Y NHeight (Opt) Y N

Seedling **Area Sampled**
Seedling Height (Opt) Y N Seedlings Mapped (Opt) Y N

Fuel Load
Sampling Plane Lengths: 65ft

Postburn
Char Height (Opt) Y N Mortality/Rec (Opt) Y N

F.12.2.1 Douglas-fir Forest (FPSME1D10)

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: FPSME1D10 **Date Described**: 09/15/99

Monitoring Type Name: Douglas Fir Forest

Preparer: Reeberg, Rehlaender

Burn Prescription:

Date of Burn (mo-mo).....09-11	Wind Direction (deg.).....0,359
Air Temp. (F).....45-85	10-hr TLFM (%).....12
Rel. Humidity (%).....30-80	Herb Moisture (%).....50-150
1-hr TLFM (%).....4-11	Midflame Wind (mph).....3.0-12.0

Fire Management Objectives: Reduce down and dead woody materials by 40-80% in all size classes. Create opportunities to research the effects of fire on wildlife. Create or maintain a healthy Douglas fir forest! (need something specific regarding what exactly this means)

Fire Monitoring Objectives: Determine degree of reduction in fuel loading. Determine numbers of live Douglas fir trees by size class. Assess fire-caused mortality.

Fire Monitoring Variables: Fuel loading; number of live trees per hectare, by size class; percent tree mortality, by size class.

Physical Description: All aspects, slopes from 0 to 50%, elevations ranging from 800 to 1400 feet. Soils are of the Miramar soil association, developed from quartz diorite mixed with marine sandstone and shale.

Biological Description: Douglas-fir (*Pseudotsuga menziesii*) forest, with occasional small pockets of bay (*Umbellularia californica*). The forest was logged within the last 25 years: trees are relatively small and second growth, although old growth trees occur scattered in the forest. Overstory density varies from 20 to 200 trees/ha, and midstory density from 50 to 500 trees/ha. In both layers the frequency of Douglas-fir is at least 80%. Understory is variable, in species composition and in continuity. Percent understory cover can range from 40 to 100%. Dominant understory species are *Polystichum munitum, Vaccinium ovatum, Sambucus racemosa,* and *Rubus ursinus*. Other species can include *Corylus cornuta, Toxicodendron diversilobum*, nettles, various grasses, and moss. Areas of moderate to heavy down and dead woody materials of all sizes.

Rejection Criteria: Sites within 20m of roads, trails, firelines, cut banks, hitching posts, research areas, anomalous vegetation, meadows, seeps, or other changes in vegetation type. In addition, reject areas containing large amounts of barren ground or disturbance, or areas bisected by streams or riparian vegetation.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS	(Circle One)			(Circle One)	
Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn					
Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for Shrubs: 2m

Herbaceous Frame Dimensions: n/a
Herbaceous Density Data Collected At: n/a

Burn Duff Moisture (Opt) Y N Flame Depth (Opt) Y N

100 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FOREST PLOT PROTOCOLS	(Circle One)	(Circle One)

Overstory **Area Sampled: Q1-Q4; all quarters**
Live Tree Damage (Opt) Y N Live Crown Position (Opt) Y N
Dead Tree Damage (Opt) Y N Dead Crown Position (Opt) Y N

Pole-size **Area Sampled: Q1, Q2; two quarters**
Height (Opt) Y N Poles Tagged/Rec (Opt) Y N

Seedling **Area Sampled**
Seedling Height (Opt) Y N Seedlings Mapped (Opt) Y N

Fuel Load
Sampling Plane Lengths: 65ft

Postburn
Char Height (Opt) Y N Mortality/Rec (Opt) Y N

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: FEUGL1G08 **Date Described**: 12/19/07

Monitoring Type Name: Non-native blue gum eucalyptus forest

Preparer(s) (FEMO/RMS/FMO): Alison Forrestel

Burn Prescription (including other treatments): The thinning prescription is to remove nearly all accessible trees under 18 inches dbh which comprise the majority of stems. Trees roughly between 24 and 18 inches dbh that are readily accessible from the primary trails are also be removed where feasible. Where feasible native species, including Douglas-fir, coast live oak, and California bay, are protected and retained during thinning and dragging. Work is conducted using chainsaws and hand tools to cut the wood and, in some areas, chains or winches to haul sections of trunk upslope, and a chipper to chip and spread wood on site. Stumps are immediately treated with the herbicide glyphosate as soon as the tree is cut in order to prevent resprouting. The herbicide is applied directly to the cut stump by staff with the necessary training and qualifications.

Management Objective(s): Reduce the standing basal area of eucalyptus. Decrease dead and downed fuel loading. Minimize resprouting. Maintain or increase cover of native shrubs; reduce or maintain cover of French broom.

Monitoring Objective(s): To estimate the mean decrease in basal area with 80% confidence that the mean is within 20% of the true value. To estimate the mean change in dead and downed fuels with 80% confidence that the mean is within 20% of the true value. To estimate the mean percent of resprouting stumps with 80% confidence that the mean is within 20% of the true value. To measure the cover of shrubs before and after treatment. To estimate mean change in native shrub cover with 80% confidence that the mean is within 20% of the true value.

Physical Description: This is a non-native plant community that is found throughout the Seashore regardless of soil type, slope, aspect or topographic position.

Biological Description: This is a non-native ecosystem which is dominated by blue gum eucalyptus (*Eucalyptus globulus*). There is often a significant non-native component in the shrub and understory layers as well including French broom (*Genista monspessulana*), cape ivy (*Delairea odorata)*, English ivy (*Hedera helix*), velvet grass (*Holcus lanatus*). Potential native trees and shrubs include Douglas-fir (*Pseudotsuga menziesii*), California bay (*Umbellularia californica*), coast live oaks (*Quercus agrifolia*), coffeberry (*Rhamnus californica*), poison-oak (*Toxicodendron diversilobum*), California blackberry (*Rubus ursinus*) and coyote brush (*Baccharis pilularis*).

Rejection Criteria: Eucalyptus cover less than 50% cover; slopes greater than 60%.

Notes: Plot protocols described in section F.5.3. of this document.

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: BBAPI1D05 **Date Described**: 9/9/92

Monitoring Type Name: Northern coastal scrub

Preparer(s) (FEMO/RMS/FMO): Paul Reeberg

Burn Prescription (including other treatments): Fall burn (September to November); 1 hour TLFM 4-6.7%; 10 hour TLFM 6-11%; midflame windspeed 0-10 mph; temperature 45-65°F; relative humidity 35-40%.

Management Objective(s): Monitor the fire behavior and effects to verify the perpetuation of native species. Reduce invading species. Reduce fuel when appropriate

Monitoring Objective(s): Percent cover of Baccharis pilularis

Physical Description: Includes south, east, and west aspects;(mostly south); gradients range from 0-60% slope (average 25%); contains valley bottomlands, lower slope, midslope, upper slope, and ridgetop areas; elevation ranges from sea level to 1,500 feet.

Biological Description: An early successional phase of northern coastal scrub dominated largely by *Baccharis pilularis* with occasional sub-dominants of *Toxicodendron diversilobum*, *Artemisia californica, Mimulus aurantiacus, Rubus ursinus,* and *Heracleum lanatum*. Near the coast often interspersed with northern coastal prairie, dominated by *Plantago lanceolata*, *Stipa pulchra,* and *Vulpia bromoides*.

Rejection Criteria: Areas within 20 meters of a paved or dirt road or trail unless the width of the monitoring type is restrictive, then 10 meters from a road or trail will suffice; greater than 30% barren soil or rock; areas within 20 meters of a riparian zone; areas greater than 15%; grassland cover greater than 40%.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS	(Circle One)			(Circle One)	
Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn					
Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for Shrubs: 2m

Herbaceous Frame Dimensions: n/a
Herbaceous Density Data Collected At: n/a

Burn Duff Moisture (Opt) Y N Flame Depth (Opt) Y N

7 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: _BPIMU1D04_____ **Date Described**: 9/13/07

Monitoring Type Name: Post Vision Fire Bishop Pine

FGDC Association(s):

Preparer(s) (FEMO/RMS/FMO): Alison Forrestel

Burn Prescription (including other treatments): Burning will occur between August and November. Treatment will be repeated every 5 – 10 years.

Management Objective(s): To reduce dead and downed fuel loading. To reduce stem density of bishop pine.

Monitoring Objective(s): To be 80% certain of detecting a 20% decrease in the cover of native species. To be 80% certain of detecting 20% mortality in bishop pine. To be 80% certain of detecting a 20% increase bishop pine regeneration.

Objective Variable(s): Density of Bishop pine, density and percent cover of bishop pine seedlings, and percent cover of native species.

Physical Description: Bishop pine occurs along the coast and may prefer poor, granitic soils.

Biological Description: Many areas that burned in the 1995 Vision Fire are now covered with dense bishop pine regeneration. These trees are now 12 years old, several meters tall and producing cones. Stands are composed almost entirely of bishop pine and self-thinning is beginning to occur. These stands are of interest because little is known about how young bishop pine will respond to fire.

Rejection Criteria: Bishop pine less than 50% cover; less than 5 m from a road or trail; slopes greater than 60%; riparian areas.

Notes: Bishop pine seedlings should be counted in the shrub belt

Date Entered: / / FMH-4

FMH-4 **PLOT PROTOCOLS**

GENERAL PROTOCOLS		(Circle One)			(Circle One)	
	Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
	Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
	OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
	Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn						
	Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for Shrubs: 2m *Bishop pine seedlings should be counted in the shrub belt, post-fire Bishop pines should be recorded as shrubs
Herbaceous Frame Dimensions: n/a
Herbaceous Density Data Collected At: n/a

Burn Duff Moisture (Opt) Y N Flame Depth (Opt) Y N

7 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: _BDECE1D01_____ **Date Described**: 6/28/07

Monitoring Type Name: Deschampsia coastal prairie

FGDC Association(s):

Preparer(s) (FEMO/RMS/FMO): Alison Forrestel

Burn Prescription (including other treatments): Burning will occur between August and November. Treatment will be repeated every 5 – 10 years.

Management Objective(s): To reduce hazard fuels.

Monitoring Objective(s): To be 80% certain of detecting a 20% decrease in the cover of native species. To be 80% certain of detecting a 20% increase in the cover of velvet grass. To be 80% certain of detecting a 20% increase in the cover of Harding grass.

Objective Variable(s): Percent cover of velvet grass, Harding grass, and of native species.

Physical Description: This is a rare plant community that occurs along the coast, requires a lot of moisture, and may prefer poor soils.

Biological Description: This is a rare native coastal prairie ecosystem. Along with *Deschampsia cespitosa, Danthonia californica, Bromus carinatus, Elymus glaucus, Festuca californica, Iris douglasii*, and *Baccharis pilularis* among other species may be present. This community is threatened by invasion from *Holcus lanatus* and *Phalaris aquatica*.

Rejection Criteria: Native grass less than 50% cover; *Holcus lanatus* more than 50% cover; *Baccharis pilularis* more than 50% cover; less than 5 m from a road or trail; slopes greater than 60%; ecotones between scrub/grassland and forest; riparian areas.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS	(Circle One)			(Circle One)	
Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn					
Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for Shrubs: 2m

Herbaceous Frame Dimensions: n/a
Herbaceous Density Data Collected At: n/a

Burn Duff Moisture (Opt) Y N Flame Depth (Opt) Y N

7 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: _BLOPE1D01_____ **Date Described**: 9/9/92

Monitoring Type Name: Non-native annual grassland

Preparer(s) (FEMO/RMS/FMO): Paul Reeberg

Burn Prescription (including other treatments): Fall burn (September to November); 1 hour TLFM 4-6.7%; 10 hour TLFM 6-11%; midflame windspeed 0-10 mph; temperature 45-65°F; relative humidity 35-40%.

Management Objective(s): Ensure perpetuation of native species; reduce invasive species; reduce hazard fuels when appropriate.

Monitoring Objective(s): To be 80% certain of detecting a 20% decrease in the cover of native species. To be 80% certain of detecting a 20% increase in the cover of non-native grasses.

Physical Description: Includes south, east, and west aspects;(mostly south); gradients range from 0-60% slope (average 25%); contains valley bottomlands, lower slope, midslope, upper slope, and ridgetop areas; elevation ranges from sea level to 1,500 feet.

Biological Description: Annual grassland community dominated by *Lolium perenne* and *Bromus diandrus*. Other non-native grasses may include *Avena barbata, Lolium multiflorum, Holcus lanatus, Vulpia bromoides,* and *Bromus hordeaceus*. Occasional shrubs are also present including *Baccharis pilularis*. Native grasses are occasional and are dominated by *Bromus carinatus, Elymus glaucus,* and *Danthonia california*. This community is often a highly disturbed disclimax of coastal prairie.

Rejection Criteria: Areas within 20 meters of a paved or dirt road or trail unless the width of the monitoring type is restrictive, then 10 meters from a road or trail will suffice; greater than 40% barren soil or rock; areas within 20 meters of a riparian zone; seepage areas greater than 15%; shrub or tree cover greater than 30%; less than 40% non-native species.

Date Entered: / / FMH-4

FMH-4 **PLOT PROTOCOLS**

GENERAL PROTOCOLS		(Circle One)			(Circle One)	
	Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
	Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
	OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
	Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn						
	Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for

Shrubs: 2m

Burn Duff Moisture (Opt)Y N Flame Depth (Opt) Y N

100 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: _BPHAQ1D01_____ **Date Described**: 12/19/07

Monitoring Type Name: Harding grass

Preparer(s) (FEMO/RMS/FMO): Alison Forrestel

Burn Prescription (including other treatments): Fall burn (August to November); 1 hour TLFM 4-6.7%; 10 hour TLFM 6-11%; midflame windspeed 0-10 mph; temperature 45-65°F; relative humidity 35-40%.

Management Objective(s): Reduce fuel loading, maintain or increase cover of native species, maintain or decrease cover of Harding grass

Monitoring Objective(s): To be 80% certain of detecting a 20% decrease in the cover of native species. To be 80% certain of detecting a 20% increase in the cover of Harding grass.

Physical Description: This is a non-native plant community that is found throughout the Seashore regardless of soil type, slope, aspect or topographic position.

Biological Description: Annual grassland community dominated by *Phalaris aquatica.* Other non-native grasses may include *Avena barbata, Lolium perenne, Holcus lanatus, Vulpia bromoides,* and *Bromus hordeaceus*. Occasional shrubs are also present including *Baccharis pilularis*. Native grasses are occasional and are dominated by *Bromus carinatus, Elymus glaucus,* and *Danthonia california*. This community is often a highly disturbed disclimax of coastal prairie.

Rejection Criteria: Areas within 20 meters of a paved or dirt road or trail unless the width of the monitoring type is restrictive, then 10 meters from a road or trail will suffice; greater than 40% barren soil or rock; areas within 20 meters of a riparian zone; seepage areas greater than 15%; shrub or tree cover greater than 50%; less than 50% Harding grass.

Date Entered: / / FMH-4

FMH-4 **PLOT PROTOCOLS**

GENERAL PROTOCOLS		(Circle One)			(Circle One)	
	Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
	Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
	OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
	Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn						
	Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for

Shrubs: 2m

Burn Duff Moisture (Opt)Y N Flame Depth (Opt) Y N

7 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: _BCYSC1D05_____ **Date Described**: 12/19/07

Monitoring Type Name: Scotch broom

Preparer(s) (FEMO/RMS/FMO): Alison Forrestel

Burn Prescription (including other treatments): Fall burn (August to November); 1 hour TLFM 4-6.7%; 10 hour TLFM 6-11%; midflame windspeed 0-10 mph; temperature 45-65°F; relative humidity 35-40%.

Management Objective(s): Reduce fuel loading, maintain or increase cover of native species, maintain or decrease cover of Scotch broom

Monitoring Objective(s): To be 80% certain of detecting a 20% decrease in the cover of native species. To be 80% certain of detecting a 20% increase in the cover of Scotch broom.

Physical Description: This is a non-native plant community that is found throughout the Seashore regardless of soil type, slope, aspect or topographic position. The population is currently restricted to the northern district of the Seashore in the vicinity of Drake's Estero.

Biological Description: This is a shrubland community dominated by Scotch broom (*Cytisus scoparius*). A variety of native and non-native species may also be present including *Avena barbata, Lolium perenne, Holcus lanatus, Vulpia bromoides*, *Bromus diandrus* and *Baccharis pilularis*. Scotch broom is highly invasive, spreads quickly and converts native grass and shrub habitat into dense broom monocultures.

Rejection Criteria: Areas within 20 meters of a paved or dirt road or trail unless the width of the monitoring type is restrictive, then 10 meters from a road or trail will suffice; areas within 20 meters of a riparian zone; less than 50% Scotch broom.

Date Entered: / / FMH-4

FMH-4 **PLOT PROTOCOLS**

GENERAL PROTOCOLS		(Circle One)			(Circle One)	
	Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
	Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
	OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
	Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn						
	Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for

Shrubs: 2m

Burn Duff Moisture (Opt)Y N Flame Depth (Opt) Y N

7 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

FMH-4 MONITORING TYPE DESCRIPTION SHEET

Monitoring Type Code: _BGEMO2D05_____ **Date Described**: 12/19/07

Monitoring Type Name: French broom

Preparer(s) (FEMO/RMS/FMO): Alison Forrestel

Burn Prescription (including other treatments): Fall burn (August to November); 1 hour TLFM 4-6.7%; 10 hour TLFM 6-11%; midflame windspeed 0-10 mph; temperature 45-65°F; relative humidity 35-40%.

Management Objective(s): Reduce fuel loading, maintain or increase cover of native species, maintain or decrease cover of French broom

Monitoring Objective(s): To be 80% certain of detecting a 20% decrease in the cover of native species. To be 80% certain of detecting a 20% increase in the cover of French broom.

Physical Description: This is a non-native plant community that is found throughout the Seashore regardless of soil type, slope, aspect or topographic position. The population is currently restricted to the southern portions of PRNS, primarily along the Highway One corridor.

Biological Description: This is a shrubland community dominated by French broom (*Genista monspessulana*). A variety of native and non-native species may also be present including *Avena barbata, Lolium perenne, Holcus lanatus, Vulpia bromoides, Bromus diandrus* and *Baccharis pilularis*. French broom is highly invasive, spreads quickly and converts native grass and shrub habitat into dense broom monocultures.

Rejection Criteria: Areas within 20 meters of a paved or dirt road or trail unless the width of the monitoring type is restrictive, then 10 meters from a road or trail will suffice; areas within 20 meters of a riparian zone; less than 50% French broom.

Date Entered: / / FMH-4

FMH-4 **PLOT PROTOCOLS**

GENERAL PROTOCOLS		(Circle One)			(Circle One)	
	Control Treatment Plots (Opt)	Y	N	Herb Height (Opt)	**Y**	N
	Herbaceous Density (Opt)	Y	N	Abbreviated Tags (Opt)	**Y**	N
	OP/Origin Buried (Opt)	Y	N	Herb. Fuel Load (Opt)	Y	N
	Voucher Specimens (Opt)	**Y**	N	Brush Fuel Load (Opt)	Y	N
Preburn						
	Count Dead Branches of Living Plants as Dead (Opt)				Y	N

Width Sample Area Species Not Intercepted But Seen in Vicinity of Herbaceous Transect(s): 5m
Length/Width Sample Area for

Shrubs: 2m

Burn Duff Moisture (Opt)Y N Flame Depth (Opt) Y N

7 Pt. Burn Severity (Opt) Y N Herb. Fuel Load (Opt) Y N

Postburn

Herbaceous/Shrub Data (Opt): FMH-15/16/17/18

F.12.3. Data Sheet Examples

PhotoMonitoring Data Sheet

Date_____ Plot ID_____
Recorders_____
Treatment Status (Pre, Post1, 2, 5, 10)_____

Origin Photographs
Digital
Number of photos taken:_____
Frame numbers:_____
Zoom:_____
Film:
Number of photos taken:_____
Frame numbers:_____
Zoom:_____

End Photographs
Digital
Number of photos taken:_____
Frame numbers:_____
Zoom:_____
Film:
Number of photos taken:_____
Frame numbers:_____
Zoom:_____

Overstory Trees Data Sheet

Date_____ Plot ID_____
Recorders_____
Treatment Status (Pre, Post1, 2, 5, 10)_____

Record all trees with a measurable DBH

#	Species	DBH
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
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34		
35		
36		
37		
38		
39		
40		

#	Species	DBH
41		
42		
43		
44		
45		
46		
47		
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54		
55		
56		
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80		

Shrubs/Seedlings Data Sheet

Date_____ Plot ID_____
Recorders_____
Treatment Status (Pre, Post1, 2, 5, 10)_____

Shrubs (*GEMO is only recorded in Interval 1)

Interval (SI1-5)	Species	Tally

Seedlings

Interval (SI1-5)	Species	Tally
1		
1		
1		
1		
1		
1		
1		

Herbaceous Species Observed Along 25m x 1m Shrub Intervals_____
_____
_____
_____

General Description of Understory_____
_____
_____
_____

Resprout Data Sheet

Date_____ Plot ID_____
Recorders_____
Treatment Status (Post1, 2, 5, 10)_____

Stumps with resprouts	**Stumps without resprouts**

F.12.4. Monitoring Schedule

TRANSECTS CLASSIFIED BY MONITORING TYPE

PLOT #	BURN UNIT	PR01	PRE	BURN DATE	POST STATUS	YR01	YR02	YR03	YR04	YR05	YR06	YR07	YR09	YR10
Northern Coastal Scrub - BBAPI1D05														
01-C	Chute Gulch		6-15-92						6-19-96		08/20/98			
06-C	Chute Gulch		6-17-92						6-27-96		08/20/98			
09	RX9001		6-11-90	11-7-90	01 POST	06/11/91	06/11/92							
	Elk Range 3			10-25-93	02 POST	06/17/94	06/21/95			06/23/98				7-23-03
10	RX9001		6-11-90	11-7-90	01 POST	06/12/91	06/11/92							
	Elk Range 3			10-25-93	02 POST	06/17/94	06/21/95			06/23/98				7-23-03
11	Elk Range 3		6-12-90	10-25-93	01 POST	07/01/94	07/05/95			07/30/98				7-23-03
22	Elk Range 3	7-17-90	8-11-93	10-25-93	01 POST	07/19/94	07/19/95			07/08/98				7-28-03
23	Elk Range 3		7-17-90	10-25-93	01 POST	07/25/94	07/25/95			07/15/98				7-24-03
24	Elk Range 3		7-18-90	10-25-93	01 POST	07/25/94	07/25/95			07/30/98				7-23-03
28-C	Chute Gulch		8-5-91							8-12-96		08/19/98		
30-C	Chute Gulch		8-9-91							8-14-96		08/19/98		
Scotch Broom - BCYSC1D05														
01	**RX9402**	6-17-91	7-22-94	11-3-94	01 POST	7-18-95	7-25-96		6-22-98	7-1-99				
	McDonald '99			10-5-99	02 POST	6-29-00	7-16-01							
	McDonald '01			11-5-01	03 POST	6-18-02	7-15-03			7-14-06				
02	**McDonald**		6-19-91	9-14-93	01 POST	6-16-94								
	RX9401			11-2-94	02 POST	6-20-95	7-2-96							
	RX9601			10-16-96	03 POST	7-1-97	6-25-98							
	McDonald			10-5-99	04 POST	7-6-00	7-17-01							
	McDonald '01			11-5-01	05 POST	6-18-02	7-15-03			7-20-06				
03	**RX9402**	7-9-91	7-20-94	11-3-94	01 POST	7-18-95	7-25-96		6-22-98	7-1-99				
	McDonald '99			10-5-99	02 POST	6-29-00	7-16-01							
	McDonald '01			11-5-01	03 POST	6-17-02	7-9-03			7-14-06				
04	**McDonald**		7-10-91	9-14-93	01 POST	7-20-94								
	RX9401			11-2-94	02 POST	7-19-95	8-1-96							

	RX9601		10-16-96	03 POST	7-1-97	6-25-98			
	McDonald		10-5-99	04 POST	7-6-00	7-17-01			
	McDonald '01		11-5-01	05 POST	6-18-02	7-15-03		7-20-06	
05	**McDonald**	7-11-91	9-14-93	01 POST	7-20-94				
	RX9401		11-2-94	02 POST	7-18-95	7-24-96			
	RX9601		10-16-96	03 POST	7-16-97	6-25-98			
	McDonald		10-5-99	04 POST	7-6-00	7-18-01			
	McDonald '01		11-5-01	05 POST	6-19-02	7-15-03		8-14-06	
06	**McDonald**	7-15-91	9-14-93	01 POST	7-20-94				
	RX9401		11-2-94	02 POST	7-18-95	7-24-96			
	RX9601		10-16-96	03 POST	7-16-97	6-25-98			
	McDonald		10-5-99	04 POST	7-6-00	7-18-01			
	McDonald '01		11-5-01	05 POST	6-19-02	7-15-03		8-14-06	
09	McDonald plot abandoned in '04, stakes remain					10-28-03*			
10	McDonald		11-9-01	01 POST		10-28-03*	9-1-04	7-20-06	
11	McDonald		11-9-01	01 POST		10-28-03*	9-1-04	8-11-06	
12	McDonald		11-9-01	01 POST		10-29-03*	9-1-04	8-23-06	
13	McDonald		11-9-01	01 POST			8-25-04	7-18-06	
14	McDonald		11-9-01	01 POST			8-25-04	7-18-06	
15	McDonald		11-9-01	01 POST			9-15-04	7-18-06	
16	McDonald		11-3-94	01 POST					
			10-5-99	02 POST					
			11-5-01	03 POST			8-26-04	8-15-06	
17	McDonald		11-3-94	01 POST					
			10-5-99	02 POST					
			11-5-01	03 POST			8-26-04	8-5-06	
18	McDonald	2004	11-3-94	01 POST					
			10-5-99	02 POST					
			11-5-01	03 POST			9-15-04	8-23-06	

French Broom - BGEMO2D05

~~01~~	~~McCurdy~~	~~09/29/95~~	~~05/06/97*~~	~~10/01/97~~	01 POST	~~05/11/98~~	~~5-13-99~~		Rejected plot	
	*reread as a control for GEMO2 02 burned in 1996; also a preburn, post-brush clearance read			-						
02	McCurdy	--	10/02/95	09/20/96	01 POST	05/06/97				
				10-17-	02 POST	5-11-98	5-13-99		7-11-01	5-29-02

				97								
				10-25-02	03 POST	5-20-03		6-29-05				
				9-21-05	04 POST	6-27-06	6-25-07					
03	Strain Hill	--	07/17/97	10/24/97	01 POST	07/10/98	7-6-99					
				11-4-99	02 POST	7-13-00	7-11-01					
				11-5-02	03 POST	5-21-03		6-28-05				
				9-28-05	04 POST	6-27-06	6-18-07					
04	Strain Hill	--	07/18/97	10/24/97	01 POST	07/10/98	7-6-99	--	--	--	--	
				11-4-99	02 POST	7-13-00	7-10-01					
				11-5-02	03 POST	5-21-03	9-9-04	6-29-05				
				9-28-05	04 POST	6-19-06	6-19-07					
05	Strain Hill	--		10/24/97	01 POST							
				11-4-99	02 POST							
				11-5-02	03 POST			7-15-05				
				9-28-05	04 POST	6-19-06	7-11-07					
06	Strain Hill	--		10/24/97	01 POST							
				11-4-99	02 POST							
				11-5-02	03 POST			7-15-05				
				9-28-05	04 POST	6-22-06	6-19-07					
07	Strain Hill	--		10/24/97	01 POST							
				11-4-99	02 POST							
				11-5-02	03 POST			7-18-05				
				9-28-05	04 POST	6-26-06	6-18-07					
08	Strain Hill	--		10/24/97	01 POST							
				11-4-99	02 POST							
				11-5-02	03 POST			7-18-05				
				9-28-05	04 POST	6-21-06	7-18-07					
09	Strain Hill	--		10/24/97	01 POST							
				11-4-99	02 POST							
				11-5-02	03 POST			7-19-05				
				9-28-05	04 POST	6-21-06	7-16-07					
10	Strain Hill	--		10/24/97	01 POST							
				11-4-99	02 POST							
				11-5-02	03 POST			7-19-05				
				9-28-05	04 POST	6-22-06	6-20-07					
11	McCurdy	--		09/20/96	01 POST							
				10-17-97	02 POST							
				10-25-02	03 POST			7-21-05				
				9-21-05	04 POST	6-27-06	6-25-07					
12	McCurdy	--			01 POST							

					02 POST			7-25-05	7-5-06	6-25-07		
13	McCurdy	--		09/20/96	01 POST							
				10-17-97	02 POST							
				10-25-02	03 POST			7-26-05				
				9-21-05	04 POST	6-27-06	6-22-07					
14	McCurdy	--			01 POST							
					02 POST			7-26-05	7-5-06	7-10-07		
Non-native Annual Grass - BLOPE1D01												
01	RX9002 (Overlook Burn)		04/26/90	11-8-90	01 POST	5-1-91	5-6-92			5-8-95		5-4-00
02	RX9002 (Overlook Burn)		05/14/90	11-8-90	01 POST	6-3-91	5-18-92			5-26-95		5-4-00
03	RX9002 (Overlook Burn)		04/26/90	11-8-90	01 POST	4-30-91	5-6-92			5-8-95		5-4-00
04	RX9001		5-14-90	11-7-90	01 POST	6-11-91	5-15-92					
	Elk Range 3			10-25-93	02 POST	5-26-94	6-1-95			6-24-98		6-12-03
05	RX9001		05/15/90	11-7-90	01 POST	5-9-91	5-18-92					
	Elk Range 3			10-25-93	02 POST	5-26-94	6-1-95			6-19-98		7-7-03
06	RX9001		05/15/90	11-7-90	01 POST	6-4-91	5-18-92					
	Elk Range 3			10-25-93	02 POST	5-26-94	6-1-95			6-24-98		6-19-03
07	Elk Range 3		06/17/92	10/25/93	01 POST	6-16-94	6-19-95			7-8-98	9-3-02	6-11-03
	Read as burn plot for T.P. '02											
08	Elk Range 3	07/09/90	06/02/93	10/25/93	01 POST	7-19-94	6-19-95			7-8-98		6-11-03
09	Elk Range 3	07/12/90	06/02/93	10/25/93	01 POST	7-1-94	6-20-95			7-15-98	9-4-02	7-7-03
	Read as control plot for T.P. '02											
10	Elk Range 3	07/12/90	06/02/93	10/25/93	01 POST	7-19-94	7-5-95			7-15-98		7-7-03
	No immed. post data for LOPE 10											
11-C	Tomales Point		6-3-93					6-27-96		7-9-98		7-14-03
12-C	Tomales Point		5-28-93					6-5-96		7-14-98		8-6-03
13-C	Tomales Point		6-3-93					6-5-96		7-14-98		8-11-03

14-C	Tomales Point		6-3-93				6-5-96	7-14-98	8-6-03	
15-C	Tomales Point		5-28-93				6-5-96	7-9-98	8-11-03	
16-C	Tomales Point		5-27-93				6-28-96	7-9-98	7-18-03	
17-C	Tomales Point		5-27-93				6-28-96	7-9-98	7-14-03	
18	Tomales Point '02	in big unit	9-3-02	burned '93						
19	Tomales Point '02	in big unit	8-30-02	burned '93						
20	Tomales Point '02	in big unit	9-3-02	burned '93						
21	Tomales Point '02	in big unit	8-30-02	burned '93						
22-C	Tomales Point '02		9-4-02	no burns						
23-C	Tomales Point '02		9-4-02	burned 2X						
24-C	Tomales Point '02		9-4-02	burned 2X						
25-C	Tomales Point '02		9-4-02	burned 2X						
26	Tomales Point '02	small unit	8-29-02	no burns						
27	Tomales Point '02	small unit	9-3-02	no burns						Plots read way too late, data could be more reliable
28	D Ranch	8-21-03	6-17-04	9-14-04	01 POST	5-31-05				
				2005	02 POST	6-29-06	6-11-07			
29	D Ranch	8-21-03	6-18-04	9-14-04	01 POST	6-2-05				
				2005	02 POST	6-29-06	4-4-07			
30	D Ranch	8-21-03	6-17-04	9-14-04	01 POST	6-3-05				
				2005	02 POST	6-29-06	4-5-07			
31	D Ranch	9-4-03	6-17-04	9-14-04	01 POST	6-3-05				
				2005	02 POST	6-29-06	2-14-07			
32	D Ranch	9-4-03	6-17-04	9-14-04	01 POST	5-31-05				
				2005	02 POST	6-29-06	4-5-07			
33	D Ranch	9-4-03	6-17-04	9-14-04	01 POST	5-31-05				
				2005	02 POST	6-29-06	5-16-07			
34	D Ranch		9-28-04			6-3-05	6-14-06	2-14-07		
35	D Ranch		9-28-04			6-3-05	6-14-06	4-17-07		
36	D Ranch	9-26-03	6-30-04			6-3-05	6-14-06	4-6-07		

Plots 18-27 were set up to look at Holcus on the Elk Range. They were never burned for this experiment, although some of them have burned in previous burn units.

Non-native Perennial Grass - BPHAQ1D

01	Limantour	8-9-04	9-14-05	01 POST	6-15-06	6-21-07	
02	Limantour	8-9-04	9-14-05	01 POST	5-22-06	6-21-07	
03	Limantour	8-9-04	9-14-05	01 POST	6-15-06	6-21-07	
04	Limantour	8-10-04	9-14-05	01 POST	6-15-06	6-21-07	
05	Limantour	8-10-04				6-15-06	6-22-07
06	Limantour	8-10-04				6-15-06	6-22-07
07	Limantour	8-24-04				6-15-06	6-21-07

Deschampsia Coastal Prairie - BDECED

1	Limantour E	6-29-07
2	Limantour E	7-12-07
3	Limantour E	7-3-07
4	Limantour E	7-2-07
5	Limantour E	7-12-07
6	Limantour E	7-13-07
7	Limantour E	7-13-07

Bishop Pine Post Vision Fire - BPIMU

1	Limantour E	9-14-07
2	Limantour E	9-14-07
3	Limantour E	9-14-07
4	Limantour E	10-10-07
5	Limantour E	10-10-07
6	Limantour E	10-10-07

Bishop Pine Forest - FPIMU1D02

01	Mount Vision	07/24/90
02	Mount Vision	08/08/90
03	Vision	9-22-99

Douglas-fir forest - FPSME1D08

01	Firtop	9-29-99

F.12.5 Sample Burn Report

Limantour Unit C Prescribed Burn Report
Point Reyes National Seashore
October 31, 2006

The Limantour Unit C burn unit was the second in a planned series of burns along Limantour Road, which runs cross-wise through the park. The goal is to create a zone of reduced fuels adjacent to the road, to aid in suppression actions in the event of a wildfire. Unit C was 25 acres in size, and was long and skinny in shape, with the long axis running north-south. Boundaries were Limantour Road on the northwest flank, the '05 burn on the rest of the west flank, and an old roadbed that had been mowed on the east. The vegetation was a mixture of coyote brush (*Baccharis pilularis*) and grasses. Other dominant components were blackberry (*Rubus ursinus*), poison oak (*Toxicodendron diversilobum*), and scattered 11-year-old pines (*Pinus muricata*).

As mentioned above, the main goal of the burn was hazard fuel reduction. There were two specific objectives that related to fuel reduction:

> Reduce dead and down fuels in all size classes by 40% or greater immediately post burn.
>
> Induce mortality in live non-native plant species by 40% or greater immediately post burn.

Weather

The day of the burn was cool, with temperatures not breaking the 60° mark, and relative humidities were in the 50's and 60's (Table 1). Winds were light, increasing somewhat over the burning period, and were out of the SW and SSW. Skies were mostly clear, with sometimes a scattering of thin clouds. All of the environmental variables measured were well within the prescribed range (Table 2).

Table 1: Weather observations

Time	Dry Bulb (o F)	Wet Bulb (o F)	Relative Humidity	Wind Speed (Gusts)	Wind Direction
11:20	60	51	53%	1-4	SW
11:50	58	52	67%	1-4 (6)	SSE
12:30	60	51	53%	3-5 (7)	SSW
13:00	60	54	68%	2-5 (7)	SSW
13:30	60	52	58%	3-6 (9)	SSW
14:00	59	52	62%	3-5 (9)	SW
14:30	59	52	62%	5-7 (9)	SW
15:30	58	51	61%	3-5 (6)	SSW

Table 2: Prescribed versus actual conditions during the burn

Factor	Prescribed	Observed

Temperature	40-85 deg	58-60 deg
Relative Humidity	30-80%	50's & 60's
Wind Direction	any	SW, SSW
Wind Speed	3-12 mph	1-7 mph
1 hr Fuel Moisture	5-11%	not det.

Ignition Pattern and Fire Behavior

Ignition began at 11:25, with a test burn in the NW corner of the burn unit next to Limantour Road. In this area the fuels were mainly thick tall coyote brush (*Baccharis pilularis*). The decision was made to go ahead, and burning continued, progressing from the test burn out along both flanks to create a blackline on both sides.

The finer fuels in coyote brush, comprising mainly leaves, are on the outer portions of the shrubs, with mostly larger stems in the interior and on the lower parts. Thus in order for fire to carry well through *Baccharis*, understory fuels are generally needed. This was clearly seen throughout this burn. In the early stages of the burn, the coyote brush encountered was taller and less interspersed with other species. Although sometimes *Baccharis* did flare up with flamelengths (FL) of 15-20 feet after being doused with drip mix, combustion wasn't always sustained.

As the burners progressed southwest, the unit became wider and flatter. The fuels changed as well, the coyote brush becoming shorter and much more interspersed with grass and forbs. Accordingly, fire spread was more continuous. Sometimes it is difficult to get our coastal evergreens to burn, but apparently there had been a long enough drying period (despite a little precipitation a while back), that the fuel bed was sufficiently dry to be ready to burn, and also there was a good amount of fine, cured fuels. This area burned in the 1995 Vision Fire, so the vegetation was 11 years old. The scattered small pines also burned, especially if there were ladder fuels (many had been limbed up to four feet above the ground).

During the first hour or so of burning, holders had to be vigilant for glowing embers floating over the west line. One spot fire did occur on the slope across the road, but was caught at about 10 feet in diameter. Other embers were still hot when they touched the ground, but were easily extinguished with a boot. After the taller brush was passed, burning embers ceased to be a problem.

The west side of the unit was blacklined first, being on the upslope, upwind side. After a good blackline had been established, burners on the east started making parallel strips into the interior. Because of the SW wind direction, these strips were laid down at an angle, instead of being directly perpendicular to the line.

In the wider part of the unit, ignition was done by formations of one to three burners laying down strips from the interior out, on both flanks. Ignition patterns were adjusted to accommodate wind and slope changes, for example when we had some intermittent crosswinds.

Smoke

The smoke rose straight up off the burn, and then headed to the north. After the burn got going, the column was rising at least a thousand feet before angling north. A one point midway through

the burn it looked like higher level winds were bringing the smoke back to the southwest. When ignition was complete at 14:25, the smoke was rising straight up several thousand feet.

Immediate Post-fire Effects, and Wrap-up Comments

After the burn, it was evident that fire had passed very quickly through the fuels. With few exceptions, the coyote brush shrubs had only scorched leaves and flowers (it was in bloom), and no consumption. Unfortunately the unit wasn't walked until after a rainstorm, making it harder to discern the color of the ash. But there appeared to be little white ash, indicating lower burn intensities. In the north corner of the unit, an explanation for fire not carrying well was in the form of a bare ground surface, which lacked the ash layer that would have formed if fine fuels had been present to burn.

Continuing south through the burn unit, pine boughs were scattered where they had been left after the trees were limbed. Although these branches had been on the ground for a couple of weeks (allowing a little bit of drying), there was almost no consumption. The needles were in most cases half consumed, but the rest of the needles, the twigs, and the main stems were only scorched, and were left intact. This demonstrates the lack of residual burning after the main fire front swept through.

In the more open areas of the unit there were some native bunch grasses. Generally the bunches were burned down to no less than 2" of stubble. This is defined as "lightly burned" by the Fire Monitoring Handbook. (When the unit was visited one week after the burn, there was already new green growth in the burned bunch grasses.) Patches of another grass, probably non-native tall fescue (*Festuca arundinacea*) were burned a little more heavily, leaving white ash. There were also patches of iris in the unit (*Iris douglasii*), and some were burned down to nubs.

Although much of the coyote brush was only scorched, there were narrow swaths where there'd been "mini-runs." These higher intensity areas were identified by shrubs whose leaves, and even some small twigs, had been consumed.

The pine trees, which at the time seemed to be burning, escaped with only minor scorching for the most part, especially those that had been limbed. However there were a couple groups of closely-spaced trees, and within these groups the vertical and horizontal continuity had led to torching of multiple trees. Cones did open on some bishop pine.

The burn was carried out in a safe and efficient manner, with no mishaps. On this Halloween burn, there was even a vision from the distant past in the form of a young man with a 70's-style marvelous mane.

Prepared by Wende Rehlaender
Weather observations by Alison Forrestel
November, 2006