VOLUME 2B: GOALS AND OBJECTIVES FOR THREATS/STRESSORS

1.0 ALTERED FIRE REGIME

1.1 OVERVIEW

Wildfire is a natural phenomenon in southern California shrublands and forests that affects ecosystem processes and influences the composition and structure of plant and animal communities. Most species are adapted to a natural fire regime; however, humans are altering the frequency of wildfires, which can have adverse effects on natural resources. This overview focuses on fire in coastal sage scrub and chaparral shrublands, as they are highly flammable and carry fire, and are the predominant vegetation communities within the MSPA where wildfire tends to occur. Fires in forested areas have different fire regimes and management needs than shrubland vegetation communities and are not addressed in this plan. Coniferous forest and montane hardwood vegetation communities in the eastern mountainous areas of the MSPA are largely outside the area of the MSP Roadmap management focus and fall under fire management policies developed by the U.S. Forest Service (USFS) and California State Parks.

San Diego County experienced extremely large human-caused Santa Ana wind-driven fires in 2003 and 2007, which caused the catastrophic loss of human life and property. These fires also impacted natural resources across a wide swathe of Conserved Lands within the MSPA. There has been considerable controversy over the last 2 decades about the best ways to reduce wildfire risk and to manage natural resources at risk of an altered fire regime. The fields of fire ecology and management are rapidly evolving as more research is conducted and society gains more experience with large catastrophic wildfires. The intent of this section is to provide a summary of the most recent literature about the southern California fire regime, fire ecology, and fire risk reduction management in order to provide a rationale for managing fire risk to MSP species and natural communities.

1.1.1 Southern California Fire Regime

Southern California's mediterranean climate is characterized by a cool wet growing season followed by a long hot summer and fall with little rainfall. The region's climate, shrublands, and extensive wildland urban interface (WUI) make it one of the most fire hazardous areas within North America (Keeley 2002). There are two primary categories of wildfires in southern California: (1) fires occurring in the summer months under hot, dry conditions and associated with weak onshore winds and (2) fires that typically occur in the fall months and are driven by strong offshore Santa Ana winds (Jin et al. 2014). The current wildfire regime in southern California consists of many small fires with relatively few large, intense stand-replacing crown fires, usually associated with strong Santa Ana winds (Barro and Conrad 1991; Keeley and Fotheringham 2001; Peterson et al. 2011). During the 20th century, fire return intervals averaged around 30–40 years, with high site variability (Keeley and Fotheringham 2001).

<u>Climatic Drivers of the Southern California Fire Regime</u>

Weather conditions and fuel moisture are related to the frequency and size of wildfires in southern California. The frequency of non-Santa Ana fires in southern California increased from 1959 to 2003 and was positively associated with total precipitation during the previous 3 winters, while fire size was negatively associated with relative humidity during the fire event and previous winter-spring precipitation (Jin et al. 2014). Mean daily temperature also had a significant positive effect on burn area for California fires from 1990 to 2006, and this effect was especially evident during winter and in southern California (Baltar et al. 2014).

Santa Ana wind-driven fires occur during extreme weather conditions (Moritz et al. 2004). A study in southwestern California from 1980 through 2009 showed that 64% of the variation in area burned in wildfires was a function of temperature, precipitation, relative humidity, Santa Ana winds, and geography (Yue et al. 2014). From 1959 through 2009, the number of Santa Ana wind-driven fires was highest during conditions of below average relative humidity during the fire event and below average fall precipitation (Jin et al. 2014). The amount of dead standing material as a function of extreme drought has been identified as a contributing factor to extremely large Santa Ana wind-driven fires in southern California (Keeley and Zedler 2009). An accumulation of dead fuels increases burning embers and spot fires driven long distances by strong winds. In the Santa Monica Mountains, total area burned was most strongly associated with the number of ignitions and number of Santa Ana wind events (Peterson et al. 2011), although fuel moisture <77% was an important threshold (Dennison et al. 2008). Spring precipitation (March through May) was strongly correlated with the 77% fuel moisture threshold. Another explanation for the recent increase in fire frequency, intensity, and spread in southern California chaparral is human suppression of fire over the last century that has caused a buildup of dense canopies and increased dead fuels (Minnich and Chou 1997).

High temperatures and severe drought with intense Santa Ana winds have resulted in extremely large wildfires over the last 15 years (Keeley et al. 2004; Keeley et al. 2009; Moritz et al. 2010; Baltar et al. 2014. The number of Santa Ana wind-driven fires surged abruptly since 2003 (Keeley and Zedler 2009; Jin et al. 2014). Eight Santa Ana wind-driven wildfires (>50,000 hectares) were documented from historical records in southern California from the 1870s through 2007, with 4 of these occurring since 2003 (Keeley and Zedler 2009). This rise in recent wildfires is attributed to extreme drought and is consistent with an analysis of large wildfires (>405 hectares) across the western U.S. from 1984 through 2011, in which wildfires increased in size and number over time and in correspondence with severe drought (Dennison et al. 2014).

Human Influence on the Southern California Fire Regime

In addition to climate factors, human activities affect fire regimes in southern California shrublands, with fire frequency increasing over the past few decades. Anthropogenic factors associated with an altered fire regime include development in fire-prone areas creating extensive WUI (Syphard, Clarke, et al. 2007; Syphard, Radeloff, et al. 2007; Moritz et al. 2014), an increase in human-caused fire ignitions (Syphard and Keeley 2015), introduction of invasive nonnative plants that alter flammability (Pausas and Keeley 2014a), and a build-up of fuels in some areas due to fire suppression over past decades (Minnich 2001). Large, intense fires have the potential to increase under global warming and a changing hydrological cycle (Bowman et al. 2011).

In southern California, human-related factors explained 72% of variability in fire frequency and 50% of variability in burn area in 2000 (Syphard, Radeloff, et al. 2007). These anthropogenic factors included the amount of WUI where developed lands intermix with natural vegetation, human population density, and distance to the WUI. The spatial pattern of development is important, with a high frequency of human-caused fires at intermediate levels of development where people and natural vegetation coexist (Syphard, Clarke, et al. 2007; Syphard, Radeloff, et al. 2007). There are few fires in sparsely populated areas where human-caused ignitions are less frequent, although large fires can establish in these areas as fire detection and response times may be delayed in remote areas. Fire frequency is also low in highly urbanized areas where even with high potential for human-caused ignitions, there is little natural vegetation to burn and a quick response to suppress any fires.

Humans have attempted to suppress fires since the early 1900s in southern California chaparral. One viewpoint is that these efforts led to a buildup of fuels and increased fire hazard resulting in unnaturally large fires under extreme weather conditions (Minnich and Bahre 1995; Minnich and Chou 1997; Minnich 2001). This altered fire regime is in contrast to a more natural fire regime in northern Baja California characterized by frequent small to medium, slow-moving fires in a fine-grain patchy age class of fuels that result from a lack of fire suppression. The alternative viewpoint is that there is no strong relationship between fuel age and the likelihood of burning and that the natural fire regime includes infrequent but large Santa Ana wind-driven fires, including the largest fire recorded in California that burned through San Diego and Orange Counties in 1889 (e.g., Keeley and Fotheringham 2001; Moritz et al. 2004; Keane et al. 2008; Keeley and Zedler 2009; Price et al. 2012). Regardless of the historical fire regime, the recent surge in extremely large fires has resulted in a landscape that is increasingly dominated by younger age fuels (see Fire Regime in MSPA section, below).

Starting with the arrival of the first Spaniards in California, humans have introduced a variety of nonnative plants into the natural ecosystems. Among these early invaders were European annual grasses and forbs (Minnich and Dezanni 1998). Southern California shrublands are susceptible to type conversion to nonnative invasive annual grassland through repeated fire (Minnich and Dezzani 1998; Keeley 2002; Keeley and Brennan 2012; Pausas and Keeley 2014a). Conversion of shrublands to nonnative grasslands has a positive feedback on increasing fire frequency as a result of fine fuels that ignite easily and readily carry fire.

Global warming under a high emission pathway is predicted to increase burned areas in California 36% to 74% by 2085, with the greatest increases in the northern part of the state (Westerling et al. 2011). The primary factors driving this upsurge in fire are warmer temperatures increasing evapotranspiration and a reduction in precipitation. Modeling of climate change and predicted fire risk indicate that future fire risk in southern California depends on future precipitation levels; fire risk could increase with higher precipitation and increased vegetation biomass and decrease with lower precipitation and availability of fine fuels (Westerling and Bryant 2008). More recent modeling indicates that global warming has the potential to double the area burned in southwestern California by 2046–2065 under a scenario of moderate growth in greenhouse gases (Yue et al. 2014). A longer fire season is also predicted by the mid-21st century due to warmer, drier weather and Santa Ana wind conditions shifting into November and December (Miller and Schlegel 2006; Yue et al. 2014). However, models also show that while conditions will be hotter and drier, the frequency of Santa Ana winds could decrease by 20% by the mid-21st century (Hughes et al. 2011).

1.2 FIRE REGIME IN THE MSPA

Large areas of land have burned within the MSPA since 2000 (Figure V2B.1-1). A total of 661,550 acres (37%) of developed and undeveloped lands burned at least once between 2000 and 2014 in the 1,765,148-acre MSPA (Table V2B.1-1). The burned area includes 564,246 acres (48%) of undeveloped lands, of which 98,577 acres burned at least twice during this period. Fifty percent of Conserved Lands have burned since 2000 totaling 339,228 (51%) of the acres that burned. Management unit (MU)10 had the largest area burned between 2000 and 2014 with 150,419 acres, followed by MUs 4, 5, and 3. At least 65% of Conserved Lands burned in these 4 MUs.

Exceptionally large and intense human-caused Santa Ana wind-driven wildfires occurred in the MSPA in 2003 and 2007 (Figure V2B.1-2). In 2003, the Cedar, Paradise, Roblar, and Otay/Mine fires simultaneously burned a combined total of 369,619 acres during extreme Santa Ana wind conditions in late October (Figure V2B.1-3a). This scenario was repeated again in late October 2007 when 8 fires, including the Witch Creek, Poomacha, Harris, and Rice fires, simultaneously burned over 314,508 acres. Across the MUs, 95,076 acres (26%) of land that burned in 2003 also burned in 2007. MUs 3, 5, and 10 had over 25,000 acres burned in both fires, with MU5 having the highest proportion of land reburned. More land burned in MUs 4 and 10 during the 2003 wildfires, while MUs 3 and 5 were most affected by the 2007 wildfires. Acres of Conserved Lands burned in the 2003 and 2007 wildfires totaled 210,204 and 141,523 acres, respectively. Conserved lands in MUs 3, 4, 5, and 10 were most affected by the 2003 and 2007 fires (Figure V2B.1-3b). A total of 57,165 acres (27%) of Conserved Lands that burned in 2003 also burned in 20017.

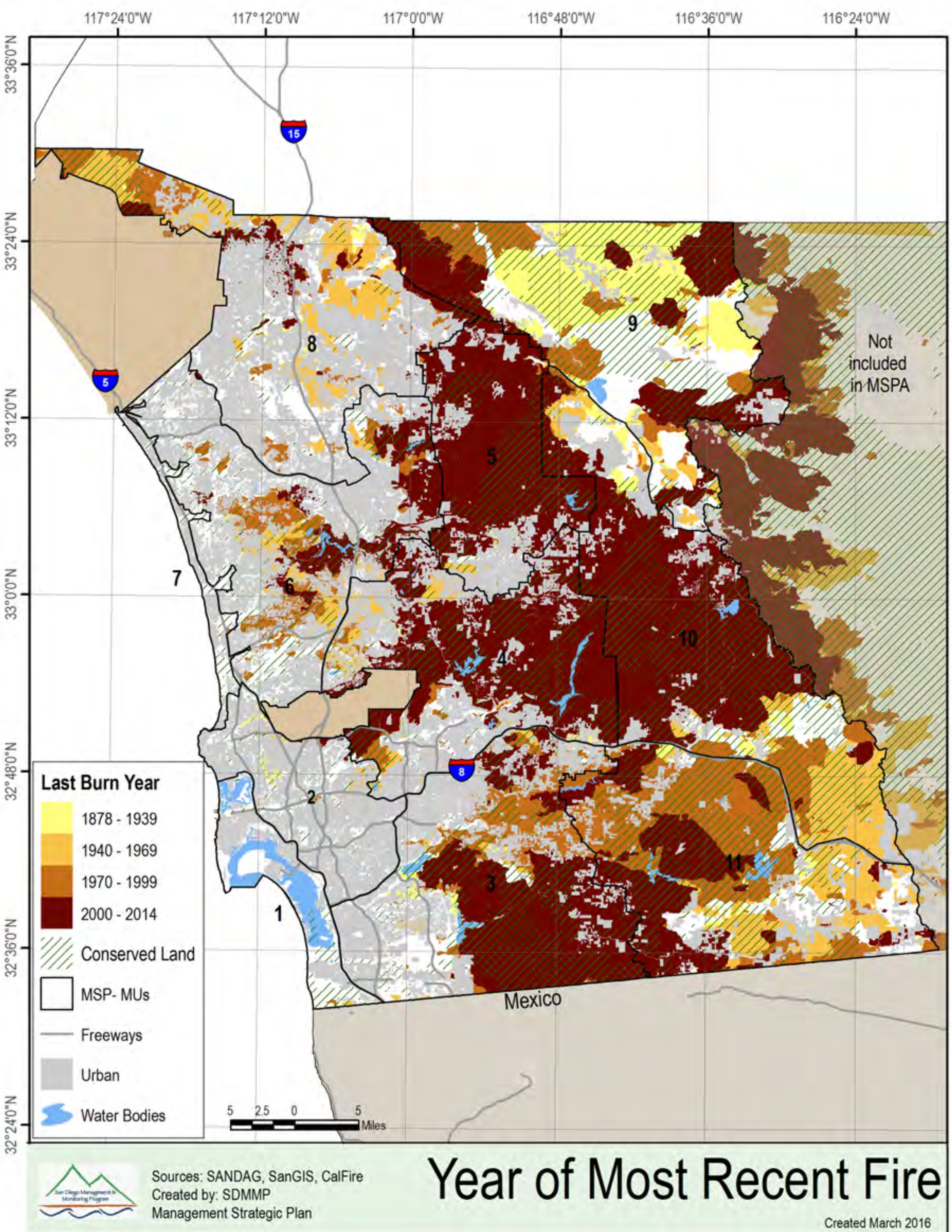

Figure V2B.1-1. Categories of time since most recent fire for Conserved Lands in the MSPA.

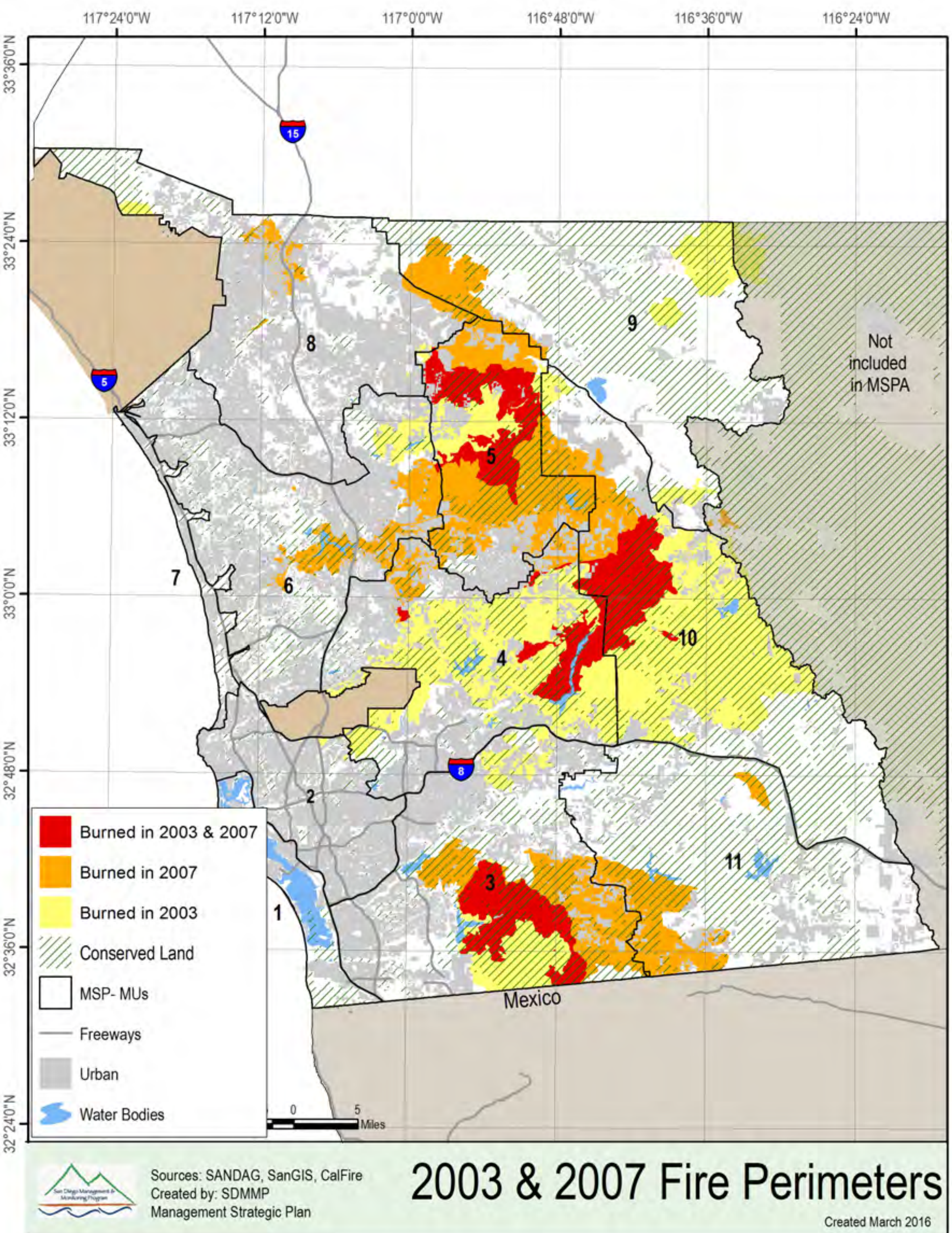

Figure V2B.1-2. Conserved Lands burned in the large-scale 2003 and 2007 wildfires in the MSPA.

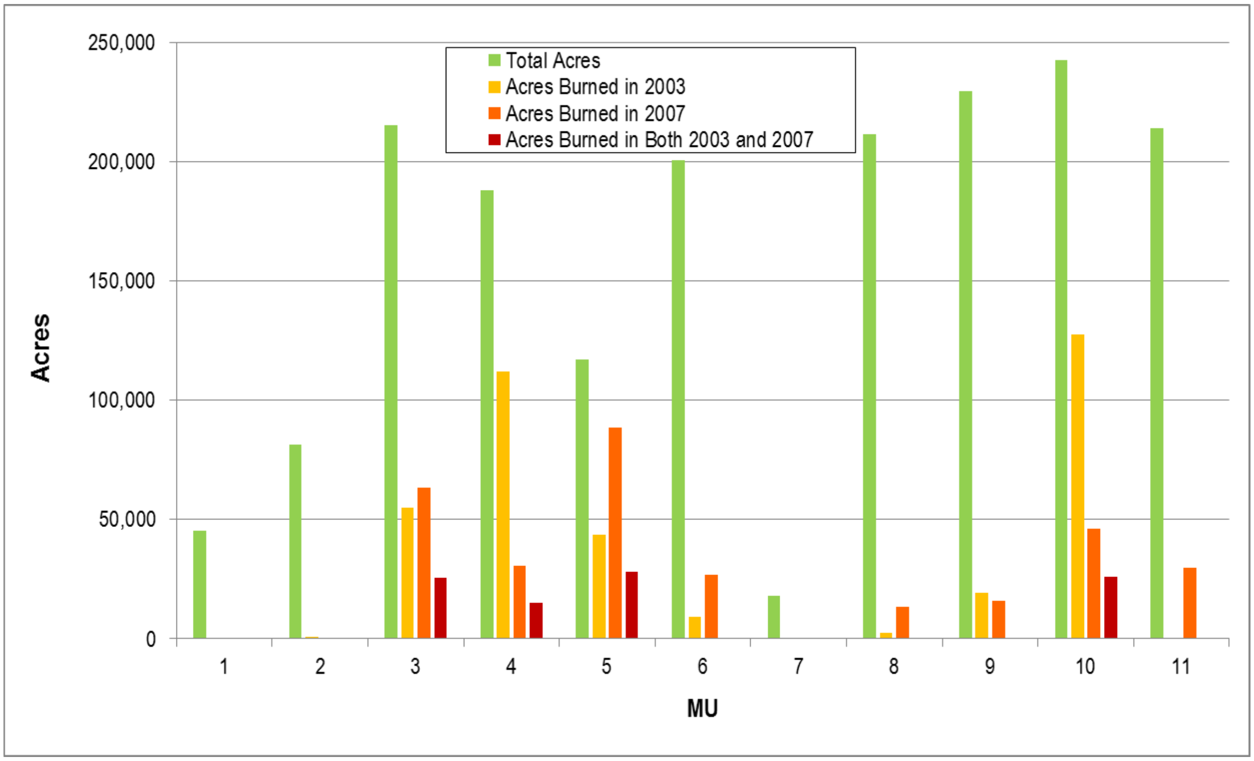

Figure V2B.1-3a. Acres of land by MU and that burned in 2003, 2007, and in both 2003 and 2007.

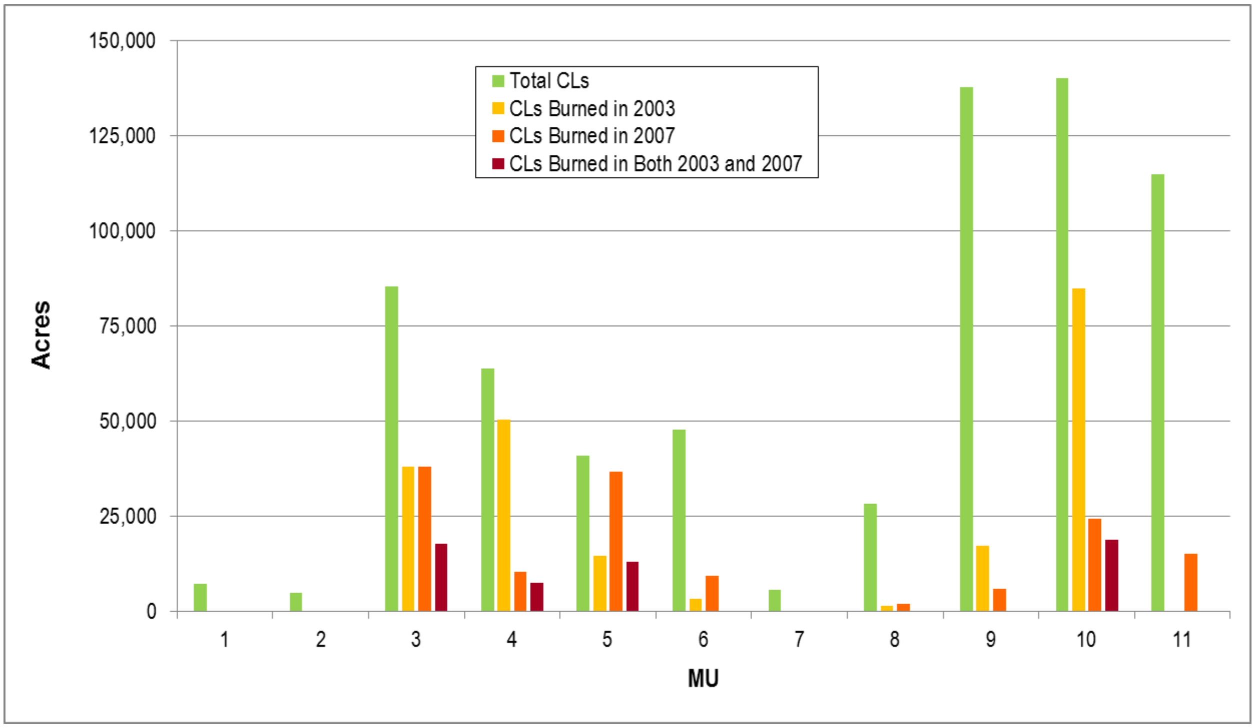

Figure V2B.1-3b. Acres of Conserved Lands (CLs) by MU and that burned in 2003, 2007, and in both 2003 and 2007.

In 2014, several relatively small Santa Ana wind-driven fires burned atypically in May, west of Interstate (I-) 15 near the coast in the Carlsbad, San Marcos, and Fairbanks Ranch areas (MUs 4, 6, and 8). Drought and extremely low fuel moisture, accumulation of dead shrubs causing high dead fuel loads, and Santa Ana wind events have been associated with the 2003 and 2007 wildfires (Keeley et al. 2004; Keeley et al. 2009; Moritz et al. 2010) and contributed to the unusual 2014 May fires.

Conserved Lands with no burn record are situated near the coast in MUs 1 and 7, while most inland areas have burned at least once since fire perimeter mapping began in San Diego County in 1910 (Figure V2B.1-4). Some areas have burned as many as 5 to 11 times, primarily in the central and southern foothill regions and the northwest corner of the MSPA. More recently, 84% of the total area burned between 2000 and 2014 burned once, while 15% burned twice, and less than 1% burned 3 or 4 times (Table V2B.1-1).

Table V2B.1-1. Acres of land and acres of Conserved Lands by MU that burned 1 to 4 times between 2000 and 2014 (CAL FIRE 2014). For each MU, the value for "Acres Burned in MU" is equal to the sum of "Acres Burned in MU by Fire Frequency Class."

MU	Total Acres in MU	Acres Burned in MU	% MU Burned	Acres of Conserved Lands in MU	Acres of Conserved Lands Burned in MU	% Conserved Lands Burned in MU	Fire Frequency in MU	Acres Burned in MU by Fire Frequency Class	% of Area Burned in MU by Fire Frequency Class
1	45,357	0	0	7,164	0	0	0	0	0
2	81,576	864	1	4,791	115	2	1	864	100
3	215,567	97,190	45	85,375	61,348	72	1	68,983	71
							2	27,294	28
							3	913	1
4	188,192	126,313	67	63,742	52,171	82	1	110,231	87
							2	15,015	12
							3	932	<1
							4	135	<1
5	117,275	104,379	89	40,991	38,328	94	1	76,046	73
							2	28,333	27
6	200,813	37,201	19	47,723	12,977	27	1	37,043	100
							2	158	<1
7	18,170	0	0	5,689	0	0	0	0	0
8	211,719	20,309	10	28,408	4,565	16	1	20,110	99
							2	199	1

MU	Total Acres in MU	Acres Burned in MU	% MU Burned	Acres of Conserved Lands in MU	Acres of Conserved Lands Burned in MU	% Conserved Lands Burned in MU	Fire Frequency in MU	Acres Burned in MU by Fire Frequency Class	% of Area Burned in MU by Fire Frequency Class
9	229,778	62,095	27	137,999	40,675	29	1	61,330	99
							2	765	1
10	242,560	150,419	62	140,355	90,878	65	1	123,149	82
							2	27,182	18
							3	88	<1
11	214,140	62,779	29	115,085	38,170	33	1	59,823	95
							2	2956	5
MSPA	1,765,148	661,550	37	677,322	339,228	50	1	557,579	84
							2	101,902	15
							3	1,933	<1
							4	136	<1

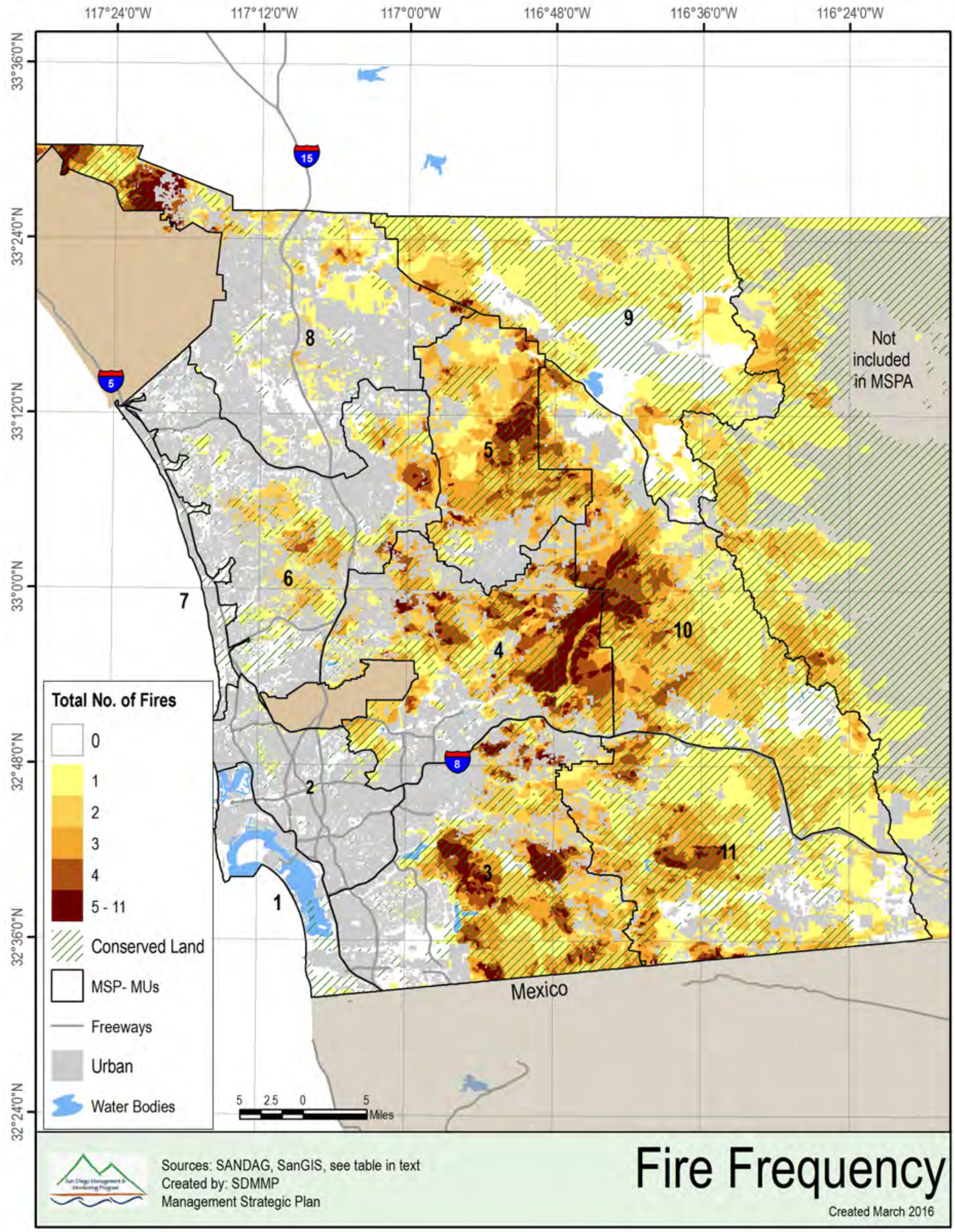

Figure V2B.1-4. Fire frequency on Conserved Lands in the MSPA between 1910 and 2014.

Coastal sage scrub and chaparral are the 2 dominant vegetation communities in the MSPA and are prone to wildfires. Coastal sage scrub is a focus of regional conservation planning and was heavily impacted by wildfires in 2003 and 2007, with over 124,152 of 221,798 acres (56%) burned at least once. MUs 3 and 4 support the greatest amount of coastal sage scrub and were most impacted by these fires (Figure V2B.1-5a). A total of 34,442 acres (51%) of coastal sage scrub that burned in 2003 also burned in 2007. MU3 had 14,538 acres of coastal sage scrub burn in both 2003 and 2007, followed by MU10 with 10,950 acres and MU10 with 7,686 acres. There are 107,042 acres of coastal sage scrub on Conserved Lands and 67,112 acres (30%) burned at least once in the 2003 and 2007 wildfires. MUs 3, 4, and 11 have the most conserved coastal sage scrub (Figure V2B.1-5b). Coastal sage scrub in MUs 3 and 4 was most affected by these fires. A total of 23,681 acres of coastal sage scrub on Conserved Lands burned in both 2003 and 2007.

Chaparral vegetation comprises 709,021 acres of habitat in the MSPA, with 291,880 acres (41%) burned at least once in 2003 and 2007. In 2003, 203,570 acres of chaparral burned and in 2007, 129,084 acres of this vegetation community burned. MUs 9, 10, and 11 each have over 120,000 acres of chaparral (Figure V2B.1-6a), with MUs 9 and 11 having only smaller amounts of chaparral burned in 2003 or 2007. MU10 had over 60,000 acres of chaparral burn in 2003 and MU5 had the most chaparral (46,000 acres) burned in 2007. Over 41,000 acres (20%) of chaparral burned in 2003 and also burned in 2007. MUs 9, 10 and 11 each have over 80,000 acres of conserved chaparral (Figure V2B.1-6b). MU10 had the most chaparral burned on Conserved Lands in 2003, while MU5 had the most chaparral on Conserved Lands burned in 2007. A total of 25,156 acres of chaparral on Conserved Lands burned in both 2003 and 2007.

Figure V2B.1-7 shows departures from historical median fire return intervals across the MSPA (also see Vol. 3, App. 4), with negative values indicating areas burning more frequently than the historical regime and positive values less frequently. Most of the County has burned too frequently, especially in the inland valleys and foothills. Areas that have burned less frequently than the historical record include higher mountain slopes at the east edge of the MSPA in MUs 10 and 11, areas of MUs 6 and 8, and fragments within the urban matrix in MUs 2, 3, and 6.

The ignition probability for fires is based upon modeling by Syphard and Keeley (2015) and shows the classes from ±1 to ±2.5 standard deviations (std dev) from the mean and is greatest (+2.5 std dev) along roads throughout the MSPA, at the margins of urban areas where there is undeveloped land and semi-rural development (Figure V2B.1-8). Risk of ignition is especially high in MU3 followed by MUs 4, 6, 8, and 9. According to the Fire and Resource Assessment Program's (FRAP) GIS database (CAL FIRE 2012), the risk of fire is greatest along the eastern edge of MU3, throughout MU11, the southeastern and northern portions of MU5, in central and northern MU8, and over much of MU9 (Figure V2B.1-9).

1.2.1 Effects of Fire on Southern California Ecosystems

Fire is a natural part of shrubland and forest ecosystems in the mediterranean climate region of southern California. In general, many plant species have evolved adaptations to fire that allow them to recover in place through soil seed banks and vegetative resprouting (Barro and Conrad 1991; Keeley et al. 2005a). In contrast, animal species may be more vulnerable to fire intensity and size and, if they do not survive within a fire perimeter, will need to recolonize from surrounding unburned areas (van Mantgem et al. 2015). Anthropogenic disturbances to the natural fire regime can alter ecosystem processes and have a negative impact on even fire-adapted plant and animal species and natural communities.

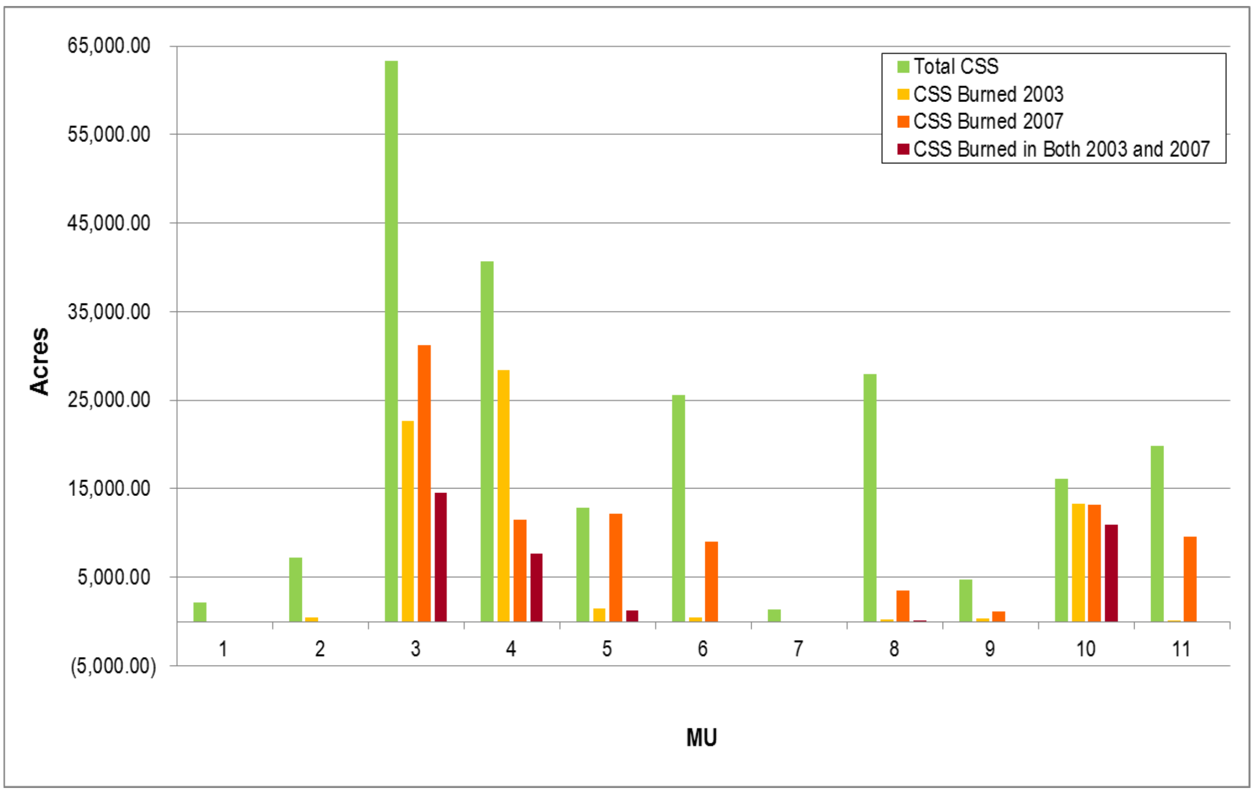

Figure V2B.1-5a. Acres of coastal sage scrub by MU and that burned in 2003, 2007, and 2003 and 2007.

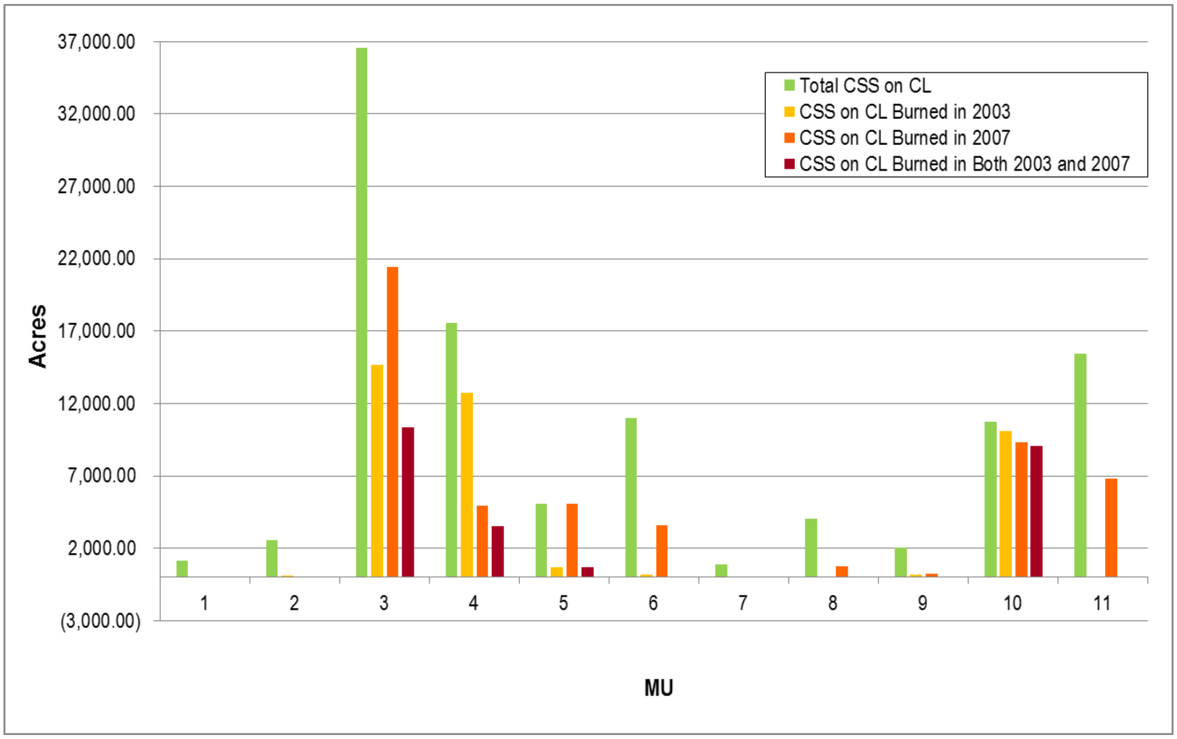

Figure V2B.1-5b. Acres of coastal sage scrub on Conserved Lands by MU and that burned in 2003, 2007, and in both 2003 and 2007.

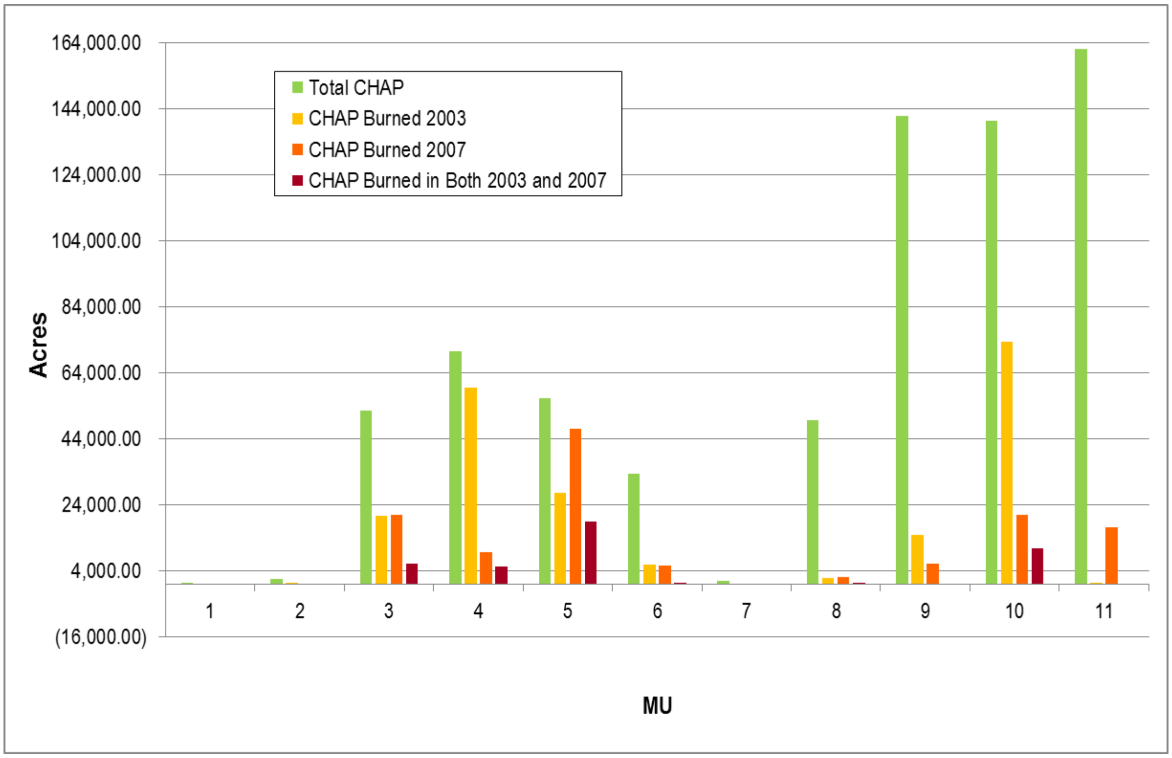

Figure V2B.1-6a. Acres of chaparral by MU and that burned in 2003, 2007, and in both 2003 and 2007.

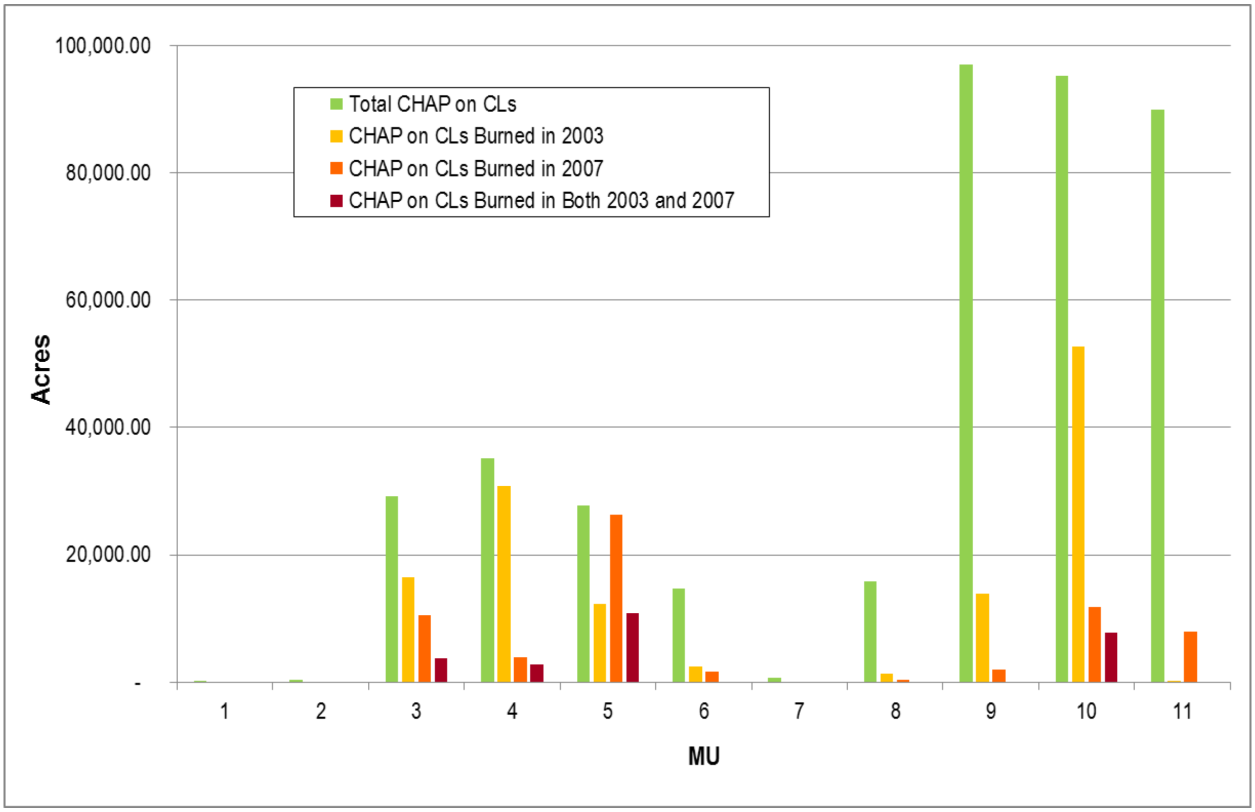

Figure V2B.1-6b. Acres of chaparral on Conserved Lands by MU and that burned in 2003, 2007, and in both 2003 and 2007.

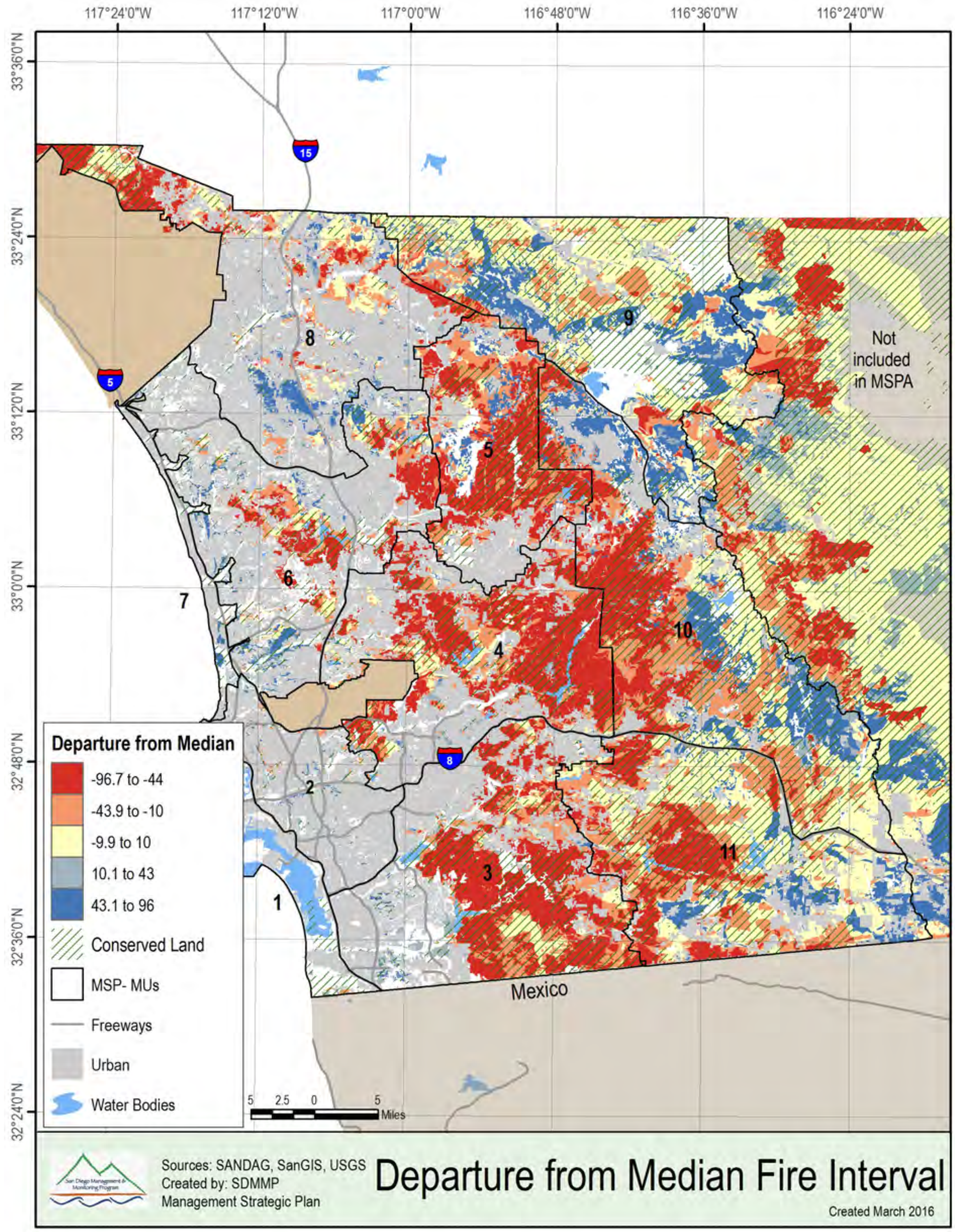

Figure V2B.1-7. Departure from median fire return intervals on Conserved Lands in the MSPA.

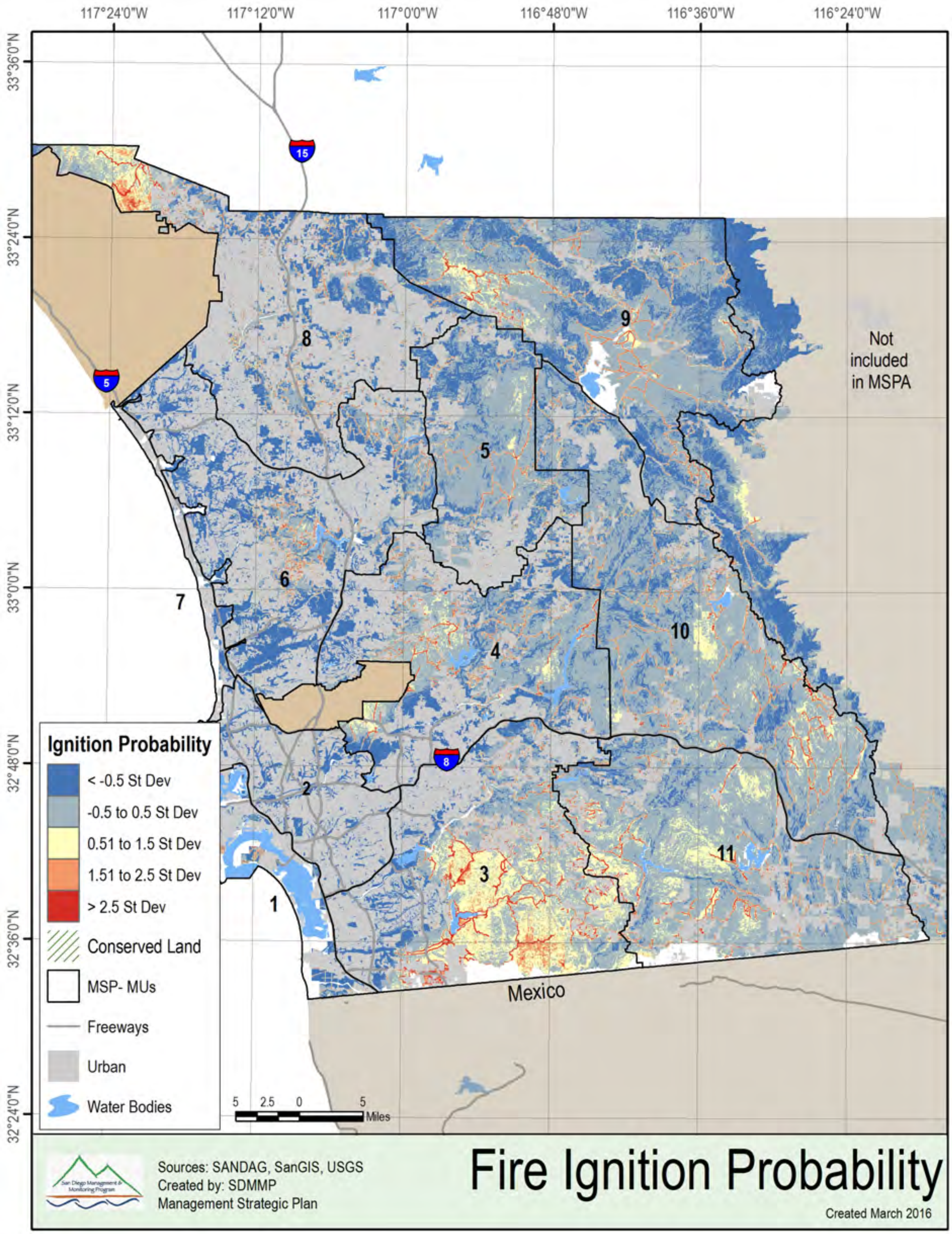

Figure V2B.1-8. Probability of wildfire ignition for Conserved Lands in the MSPA.

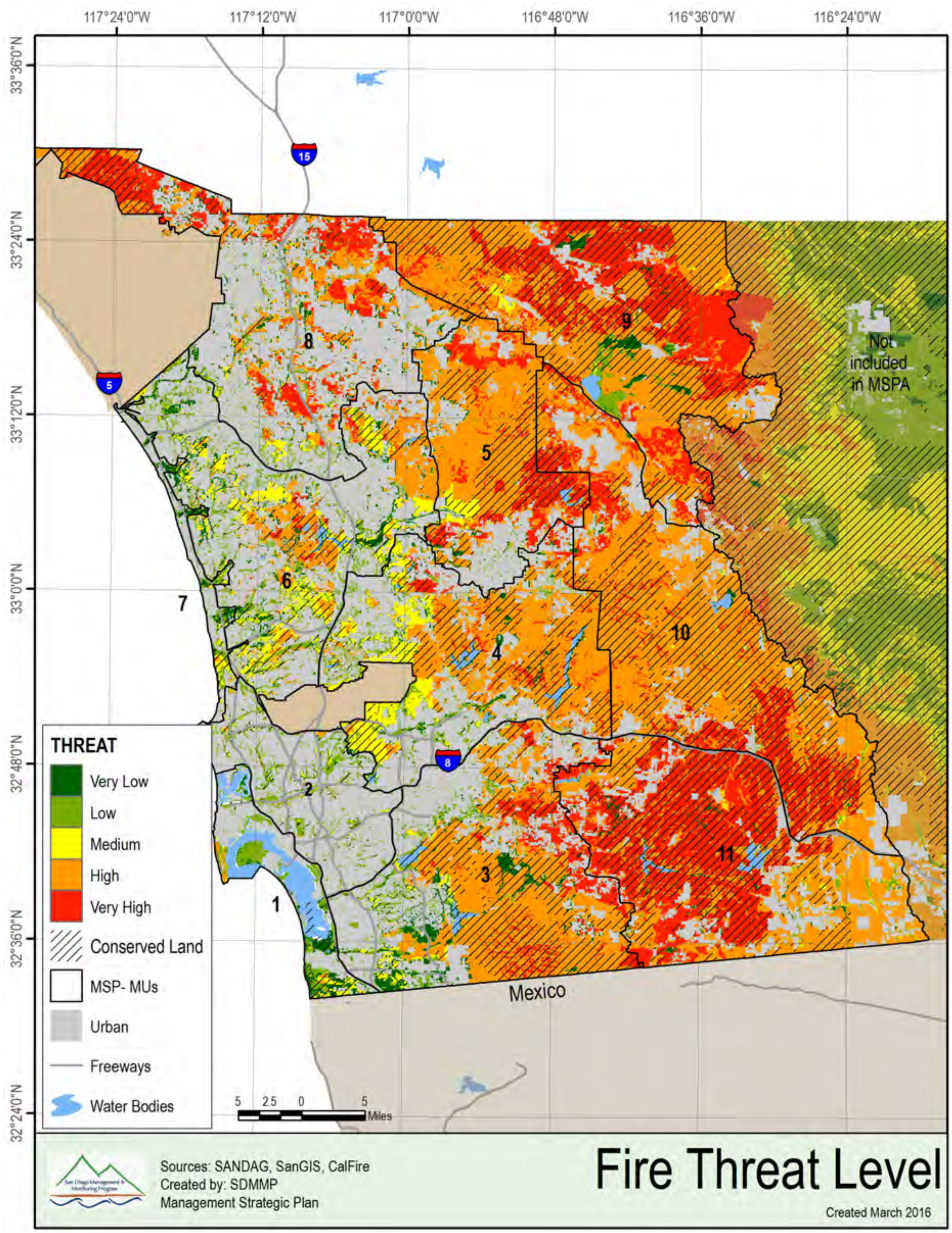

Figure V2B.1-9. Fire threat on Conserved Lands in the MSPA (CAL FIRE 2012).

Effects of Fire on Erosion

Post-fire debris flows and transport of sediment, trace metals, and pollutants can significantly impact aquatic ecosystems in southern California. Wildfires often remove vegetation and destabilize soils, which can result in debris flows, especially following rainfall events (Cannon et al. 2008; Gartner et al. 2008). In southern California, debris flows can occur with little or no moisture, with most flows occurring during low intensity storms that last 5 to 33 hours (Cannon et al. 2008). In the western United States, debris flow volumes are dependent on the area of the basin with slopes greater than or equal to 30%, burn severity, and total storm rainfall amount (Gartner et al. 2008). During the first rainy season following a wildfire, large amounts of sediment, nutrients, heavy metals, and other contaminants can be discharged into aquatic ecosystems (Stein et al. 2012; Warrick et al. 2012; Bladon et al. 2014). In southern California, water discharge can be an order of magnitude greater and sediment export 10 times greater in burned watersheds compared with unburned (Coombs and Melack 2013). Post-fire concentrations of trace metals, including lead, cadmium, copper and zinc, can be orders of magnitude greater in burned watersheds (Stein et al. 2012; Burke et al. 2013). Precipitation during the first rainfall season following fire is positively associated with sediment loads due to increased erosion processes such as rilling and mass movements of soil (Warrick et al. 2012). Within the MSPA, post-fire erosion potential is greatest in the foothills and mountains of MUs 3, 5, 8, 9, 10, and 11 (Figure V2B.1-10).

Effects of Fire on Southern California Plant Communities

Plant species in fire-prone areas are adapted to specific fire regimes that influence the evolution of plant traits and can shape biodiversity patterns (Keeley and Fotheringham 2003; Keeley et al. 2011; Pausus and Keeley 2014b). Changes to the fire regime, such as changes in fire frequency, can pose a threat to species persistence (Pausas et al. 2004; Keeley 2005; Syphard, Clarke, et al. 2007; Keeley et al. 2011).

Post-fire succession in southern California chaparral and coastal sage scrub is largely determined by species that survived the fire via vegetative structures or soil-stored seed banks, by fire severity, and by post-fire precipitation (Keeley et al. 2005a,b; Pausas and Keeley 2014b). There is greater pre- and post-fire similarity in chaparral communities that are dominated by resprouting shrubs, whereas communities dominated by obligate and facultative seeding shrubs are initially

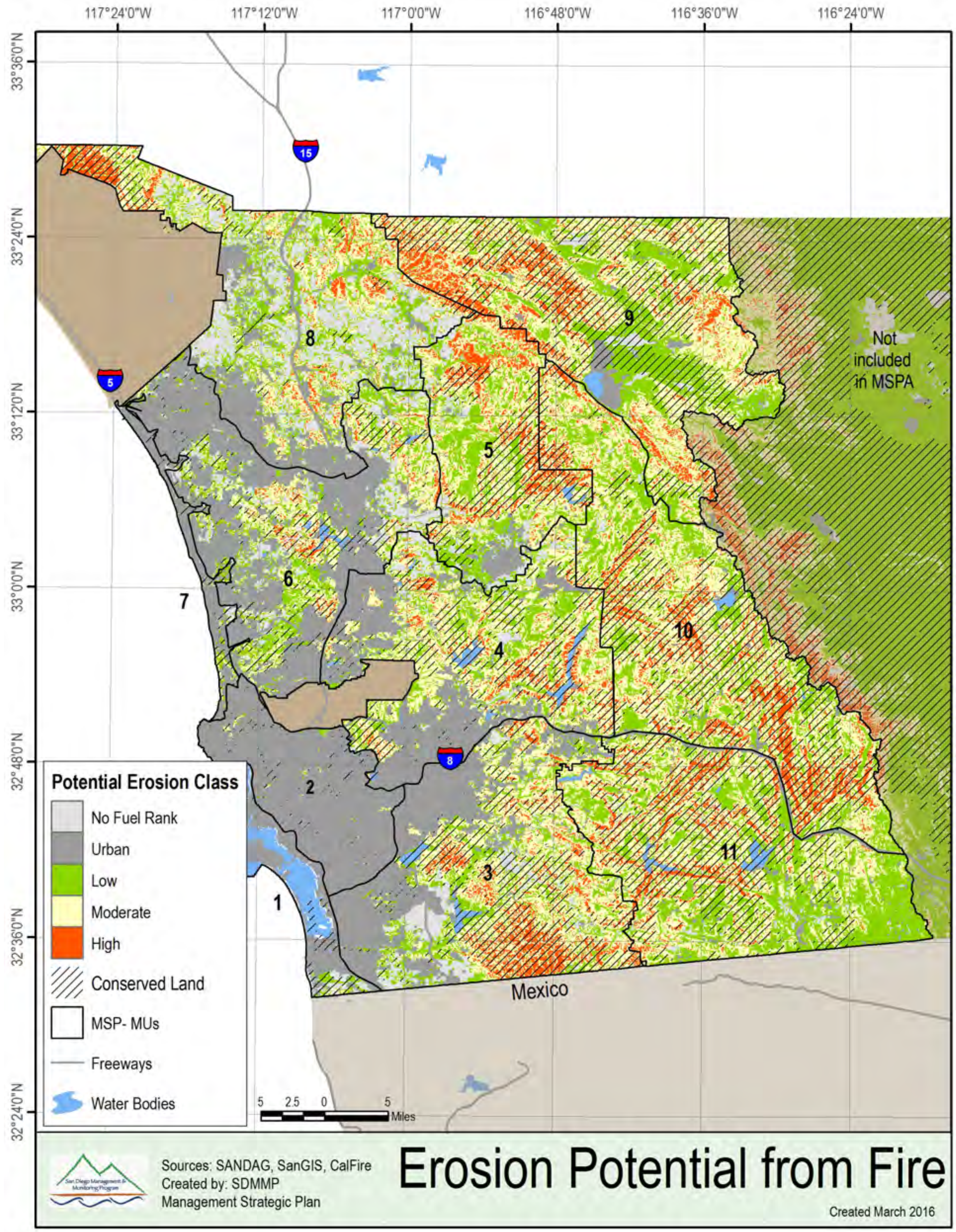

Figure V2B.1-10. Erosion potential following fire for Conserved Lands in the MSPA.

different in density and composition until years later in succession when canopy closure thins out shrubs and the community is more similar to pre-fire conditions. Coastal sage scrub dominated by resprouting subshrubs shows a different pattern in that the subshrubs grow quickly and there is extensive seedling recruitment the second year post-fire, so that pre- and post-fire densities can be much different (Keeley et al. 2005a). Inland sage scrub vegetation dominated by seeders recovers more slowly than coastal associations dominated by resprouters (e.g., California brittlebush [*Encelia californica*], Sawtooth goldenbush [*Hazardia squarrosa*]) (Keeley et al. 2005a). Post-fire diversity is also determined by precipitation, especially for annuals, including those fire endemics that are dormant in the soil seedbank until triggered to germinate by fire (Keeley et al. 2005b). Chaparral species differ in their sensitivity to fire intensity and subsequent seedling production, which can influence post-fire composition and diversity (Moreno and Oechel 1991; Keeley et al. 2005b). Post-fire herb communities are also influenced by aspect, soil characteristics; and elevation (O'Leary 1988).

Short fire return intervals as a result of anthropogenic ignitions are affecting native coastal sage scrub and chaparral vegetation in southern California and causing type conversion to nonnative annual grassland (Minnich and Dezanni 1998; Syphard et al. 2006, Syphard, Clarke, et al. 2007; Diffendorfer et al. 2007; Keeley and Brennan 2012). Obligate seeding shrubs are more vulnerable to local extinction under short fire return intervals than obligate resprouting species or facultative seeders that can employ both modes of post-fire regeneration (Syphard et al. 2006; Keeley and Brennan 2012; Enright et al. 2014). Drought can enhance this vulnerability and, under a warming and drying climate with more frequent fire, could pose a threat to persistence of obligate seeders (Lawson et al. 2010; Enright et al. 2014). Drought and nitrogen deposition have been shown to significantly slow post-fire recovery in coastal sage scrub and to facilitate type conversion to nonnative grassland (Kimball et al. 2014). Wildfire and nonnative plant invasion can also have significant impacts on soils (Dickens and Allen 2014). In chaparral vegetation, invasive grasses increased soil C/N ratio, pH, and N cycling rates and reduced NO_3N availability before fire. After fire, invasive nonnative plants slowed succession above and below ground.

Sensitive plant species can respond to fire in different ways based upon their ecological and life history attributes and to the response of introduced invasive weeds (see Rochester and Fisher 2014). Specific post-fire responses of rare plants within the MSPA are provided in the species goals and objectives (use links found in Table V2B.1-4).

Effects of Fire on Southern California Animal Communities

Animal species can survive fire by remaining in the fire area in a diapause state (e.g., invertebrates); by using refugia such as burrows, rock outcrops, riparian areas, or unburned patches to shelter in place during the fire; or by escaping the fire to unburned areas and then recolonizing burned sites during the post-fire recovery period. Direct effects of fire include animal behavioral responses to the fire (e.g., sheltering in place in refugia or escaping and recolonizing) and whether an individual survives, whereas indirect effects involve post-fire recovery in burned areas over time (Van Mantgem et al. 2015). Fire severity and size affect individual survival and post-fire recolonization, with differential effects depending on the animal species.

A meta-analysis of vertebrate species responses to fire worldwide showed that the effect of fire on species richness and community composition was largely due to the type of fire (Pastro et al. 2014). Prescribed fires tended to increase species richness, whereas wildfires did not show this effect. Prescribed fires had lower species turnover between pre- and post-fire communities compared with wildfires, which enhanced diversity in assemblages. This meta-analysis did not support the idea that there is greater species diversity with intermediate levels of disturbance or with a patch mosaic pattern of burning.

Information on the effects of fire on invertebrate, amphibian, reptile, bird, and mammal communities within the MSPA is presented below. More detailed information on the effects of fire on MSP species is provided within the Species-Specific Approach discussion in Sec. 1.5.2 (below) and in corresponding species goals and objectives (use links found in Table V2B.1-4).

1.3 RESULTS OF FIRE STUDIES IN THE MSPA

Following the 2003 and 2007 wildfires, a number of studies were conducted within the MSPA to evaluate the effect of these fires on animal communities and individual species. A summary of the effects of fire on animal communities is presented here with more detailed information and reports in Vol. 3, App.4. Specific information on the response of individual MSP species to fires is provided in the corresponding species sections.

Vegetation

The size of the 2003 and 2007 wildfires had little impact on post-fire recovery of vegetation as regeneration has been through in situ resprouting and dormant seed banks (see Rochester and Fisher 2014). Vegetation communities in the MSPA are also tolerant of a wide range of fire severities. However, too frequent fire can facilitate the invasion of nonnative annual grasses that can inhibit post-fire recovery of native vegetation (Keeley and Brennan 2012). Studies were conducted after the 2007 wildfires in the MSPA that compared recovery of chaparral with pre-fire stand ages of 3 and 24 years and of sites that burned once in a 4-year period compared with sites that burned twice. Chamise populations were substantially reduced after fire in stands of 3-year-old shrubs compared to 24 years old and there was significantly higher nonnative plant cover and lower plant diversity at the younger age sites. Sites that burned twice in 4 years had significant increases in annual plants with nonnative annuals much more abundant than native species. Nonnative annuals were negatively associated with woody plant cover. While woody plants recovered well after the first fire, they declined after burning a second time 4 years later. An altered fire regime of too frequent fire led to a loss of native diversity and, in some locations, communities began to change from woody shrublands to nonnative herbaceous dominated systems.

Pre- (1995–2002) and post-fire (2005–2012) studies of coastal sage scrub, chaparral, woodlands, and grasslands in the MSPA (MUs 3, ,4 and 9) found that chaparral and coastal sage scrub had reduced shrub and tree canopy cover 9 years after fire and had changed in overall community structure (Rochester, Mitrovich, et al. 2010; see Rochester and Fisher 2014). Post-fire community structure was more similar to that found in grasslands. There were no differences in species richness or community composition in grasslands or woodland/riparian. Nonnative grass was abundant across all plots before and after fire. California sagebrush and California buckwheat declined substantially in burned coastal sage scrub with little to no signs of recovery. Chamise, Tecate cypress, and pines also declined, although they showed some post-fire recovery. An altered fire regime with short fire return intervals is simplifying shrublands in the MSPA and could convert them to nonnative grassland.

Fire facilitates the rapid spread and widespread establishment of the invasive giant reed (*Arundo donax*) into MSPA riparian habitats and can require management in order for native vegetation to recover (see Rochester and Fisher 2014). In the absence of invasive plants, riparian systems can recover rapidly, although precipitation and fire severity can influence this process. Within 5 years post-fire, there is recovery of native understory and mid-canopy vegetation but the upper-canopy requires more time to reestablish.

Invertebrates

The rare Hermes copper butterfly is found in coastal sage scrub habitats supporting the host plant, spiny redberry (*Rhamnus crocea*), in southern and central San Diego County (Marschalek and Deutschman 2008). The range of this species has been reduced as a result of urban development (Marschalek and Klein 2010). Significant portions of Hermes copper habitat burned in 2003 and 2007, causing the loss of 13 populations and further restriction of the species range. Hermes copper butterfly larvae occur in spiny redberry and are killed by fires that burn through the vegetation. Only 2 sites that burned in 2003 have been colonized by the butterfly; 1 site was occupied prior to the fires and the other is a newly discovered population whose pre-fire status is unknown (Marschalek et al. 2016). Genetic analyses indicate that, historically, movement was possible across the landscape. Current dispersal appears limited, particularly in peripheral areas, as a result of landscape fragmentation from urban development and wildfire. Large fires can cause the loss of multiple populations, while it is suggested that small fires that reduce fuel buildup can create refugia (T. Oberbauer, pers. comm.). The bulk of the remaining populations in the southeastern portion of the range are highly vulnerable to extirpation from another large wildfire event.

Ant species diversity declined slightly 2 to 3 years after the 2003 wildfires (Matsuda et al. 2011). Ant community structure varied among coastal sage scrub, chaparral, woodland, and grassland vegetation communities, with coastal sage scrub showing the largest difference between pre- and post-fire species composition. This difference was due to significant decline in 1 ant species and a significant increase in another. Scorpions and solifugids were largely unaffected by the fires in shrublands (Brown et al. 2010). They sheltered in place within burrows in the soil and rocks and could remain underground for long periods during the post-fire period without eating or needing shade during the day.

Amphibians and Reptiles

Herpetofaunal species diversity declined after the 2003 and 2007 wildfires in coastal sage scrub and chaparral and there were significant shifts in overall community structure (Rochester, Brehme, et al. 2010). Shrub and tree cover showed an average decrease of 53% in chaparral and 75% in coastal sage scrub after 2 and 3 years post-fire. Post-fire herpetofauna community structure at burned sites was more similar to that of grasslands. There was no change in herpetofaunal diversity or community composition in woodlands or grasslands. At the species level, western fence lizard was the most abundant reptile before and after fire, with increases in western whiptail, Blainville's horned lizard, and side-blotched lizard in burned chaparral and orange-throated whiptail, and side-blotched lizards in coastal sage scrub. Western toad was detected at significantly fewer burned plots in chaparral. There were also declines in garden slender salamanders, southern alligator lizards, racers, common kingsnakes, gopher snakes, and striped racers in chaparral and coastal sage scrub. Continued monitoring through 2012 (9 years post-fire) showed that changes in post-fire community structure persisted, with specific taxa such as salamanders and small snakes not recovering in burned areas (see Rochester and Fisher 2014). It is hypothesized that this decline was to a post-fire loss of organic material on the ground that resulted in a continued loss of soil moisture. A continued fire regime of unnaturally short fire return intervals will result in simplification of reptile and amphibian communities (Rochester, Brehme, et al. 2010).

<u>Birds</u>

Bird species diversity in chaparral, oak woodland, riparian, and grassland vegetation was monitored 2 years before and 2 years after the 2003 wildfires at a high and a low elevation site in San Diego County (Mendelsohn et al. 2008). Bird species diversity remained unchanged after the fire, except at the low elevation coastal sage scrub site where it was greater. Post-fire cover of trees and shrubs was significantly reduced in coastal sage scrub and chaparral at the low elevation site but not at the high elevation site. There were significant differences in post-fire bird community assemblages in low-elevation chaparral and coastal sage scrub and in high-elevation grassland. Changes in bird community assemblages were associated with changes in vegetation due to the fire. The relative abundance of some species (e.g., lazuli bunting, horned lark) significantly increased after the fire, while other species decreased (e.g., Anna's hummingbird, wrentit, bushtit). Spotted towhee increased in burned chaparral but declined in burned coastal sage scrub at the low elevation site. The ability of bird species to recover from fire is attributed to the availability of unburned refugia, post-fire vegetation characteristics, and the ability to disperse and recolonize burned areas.

Bird communities surveyed from 2002 through 2008 in burned and unburned chaparral and forest habitats in southern California showed substantial variation in species responses to fire (Hargrove and Unitt, in prep.). Overall, breeding bird communities consisted of 16 "fire follower" species, 30 neutral or "fire resilient" species, and 33 "fire fugitive" species. During the nonbreeding season, this changed to 8 "fire followers," 23 "fire resilient," and 33 "fire fugitives." Fire followers included lazuli bunting, Costa's hummingbird, and rock wren. Those species that were fire fugitives included year-round territorial residents such as wrentits and California thrashers or those in forest habitat that converted to chaparral such as mountain chickadee, pygmy nuthatch, Steller's jay, and western tanager. Those species most impacted by fire were in restricted coniferous forest habitat, which takes a long time to recover, were patchily distributed, or also faced other threats.

Significant declines have been documented in coastal cactus wren populations following large wildfires in southern California. Wren populations suffer direct mortality from fire and loss of cactus scrub habitat that can take many years to grow back and often does not fully recover to support wrens. In Orange County, the 1994 Laguna fire caused an 87% decline from an estimated 1,473 to 187 occupied acres, even after 12 years of post-fire recovery (Mitrovich and Hamilton 2007). Similarly, the 2007 Santiago fire resulted in an estimated 82% reduction from an estimated 374 to 67 territories in the year following the fire (Leatherman BioConsulting Inc. 2009). In San Diego County, the 2007 Witch Creek Fire burned through the San Dieguito River Valley and impacted more than 60% of the San Dieguito River Park (Hamilton 2009). A survey in 2008 found 33 territories, a 63% decline from the 90 territories estimated in the 1980s and early 1990s. The population east of I-15 in the San Pasqual Valley recovered rapidly, with at least 65 territories documented by USGS 4 years after the fire during a study of cactus wren genetics (Barr et al. 2015). However, wrens west of I-15 largely disappeared and remained only at Bernardo Mountain in small numbers with 2 pairs in 2012 and 3 pairs in 2014 (Mahrdt and Weaver 2015). The 2007 Harris Fire resulted in the disappearance of several wren territories on the San Diego National Wildlife Refuge, in the vicinity of Sweetwater Reservoir and San Miguel Mountain. Cactus wrens are poor dispersers in a fragmented landscape (Atwood et al. 1998; Preston and Kamada 2012; Kamada and Preston 2013; Barr et al. 2015) and frequent wildfires are associated with genetic bottlenecks (Barr et al. 2015).

Coastal California gnatcatcher monitoring from 2004 through 2009 in the MSPA found slow rates of recolonization at sites burned in 2003 wildfires and indications that colonization was more likely near high-quality and very high-quality habitats (Winchell and Doherty 2014). A larger, more comprehensive study of gnatcatcher and coastal sage scrub post-fire recovery following 2003, 2007, and 2014 wildfires is ongoing with monitoring conducted in 2015 and 2016 (USGS unpub. data).

Small Mammals

Small mammal communities in the MSPA showed a more simplified community structure 2 and 3 years after the 2003 wildfires due to a reduction in shrub and tree cover in chaparral and coastal sage scrub plots (Brehme et al. 2011). Small mammal community recovery in woodlands and grasslands was not affected by tree or shrub cover, as these differences were smaller between pre- and post-burned sites and was hypothesized to be influenced by interspecific competition. There were significant increases in the relative abundance of deer mouse and Dulzura kangaroo rat and significant decreases in California mouse, San Diego pocket mouse, desert woodrat, and brush mouse. Continued monitoring of small mammal communities for 9 years post-fire showed some species increased with time, although woodrats remained low in burned areas (see Rochester and Fisher 2014).

Another study of post-fire recovery of small mammal communities in the MSPA was conducted from 13 to 39 months after the 2003 wildfires (Diffendorfer et al. 2012). Small mammal recovery was not influenced by fire severity or distance from unburned habitat; rather, vegetation characteristics, distance to riparian, and rocky substrates were important in species recovery, with different responses depending on species. Small mammal communities differed between burned and unburned sites with a slow increase in similarity over time since fire. Similar to the Brehme et al. (2011) study, California mouse dominated unburned sites but was rare in burned sites while deer mice and kangaroo rats were initially abundant in burned sites with kangaroo rats increasing over time. Species also showed differential responses to annual precipitation. Both studies indicate that too frequent fire will increase invasion of nonnative grasses into shrublands and cause a simplification of the small mammal community, with loss of shrub specialists.

Carnivores

Using track surveys with baited scent stations and remotely triggered camera stations Turschak et al. (2010) investigated the role of the 2003 wildfires on the relative abundance of carnivores in 2 study areas within San Diego. Data were collected during the 2 years preceding the fire and then 3 to 4 years after the fire. Fifteen medium to large mammal species were detected at the 2 sites including mountain lion, mule deer, coyote, bobcat, badger, gray fox, raccoon, striped skunk, spotted skunk, opossum, and long-tailed weasel. There was little evidence that 2003 fires affected relative abundance of carnivore species for which there were sufficient data. Most of the species seemed capable of persisting in the patchwork of burned and unburned habitats. Indirect effects of wildfires such as changes in habitat suitability and predator-prey dynamics were likely responsible for minor changes in the abundance and distribution of carnivore species.

Schuette et al. (2014) also used motion sensor cameras and track plots to measure carnivore occupancy patterns in burned and unburned habitat in the MSPA 3 to 4 years after the 2003 wildfires. Focal species included coyote, gray fox, bobcat, and striped skunk. Gray fox occupancies were highest overall followed by striped skunk, coyote, and bobcat. The 3 species considered as habitat and foraging generalists (gray fox, coyote, and striped skunk) were common in burned and unburned habitats. Occupancy patterns were consistent over time for all species except for coyote, whose occupancies increased with time. Environmental and anthropogenic variables had weak effects on all 4 species and these effects were species-specific. Gray fox occurred at slightly higher rates in burned interior areas and this could be related to competitive displacement and avoidance of coyotes and bobcats.

A suite of analyses of carnivore movement and camera studies indicate that increasing fire frequency and conversion of shrubland to nonnative grassland could lead to a simplification of the carnivore community (Jennings 2012), similar to other taxa described above. A study tracking mountain lion movements in southern California used global positioning system (GPS) collars and found lions had a moderate preference for burned areas over unburned areas, although this varied by individuals (Jennings et al. 2016). Prey kills were inferred from repeated visits to an area over several nights and while more prey was killed in unburned habitats there was a higher than expected proportion of kills in burned habitats. Mountain lions avoided grasslands and areas with low cover and suitable habitat could be lost through repeated fire and vegetation type conversion to nonnative annual grassland. A similar long-term telemetry study of bobcats and coyotes found that landscape connectivity, particularly for bobcats, was substantially constrained when the effects of fire return intervals were factored in (Jennings 2012). An analysis of remote camera data collected over 14 years in southern California suggests that bobcats avoided urban areas and recently burned areas and were a good indicator of the condition of the landscape (Jennings 2012). Gray fox and mountain lions were most sensitive to conversion of shrublands to grassland and mesopredators such as striped skunk, raccoon, and opossum could benefit from type conversion to grassland (Jennings 2012).

1.4 IMPORTANT AREAS TO MANAGE FIRE RISK

To help prioritize areas for general fire management, overall fire risk was calculated across San Diego County (see Vol. 3, App. 4) based upon fire frequency

(Figure V2B.1-4), the departure from median fire return interval (Figure V2B.1-7), and probability of large fire ignition (Figure V2B.1-8). Preserves were identified that fell into high fire risk categories (see Vol. 3, App. 4). MUs 3, 4, 5, 8, 10, and 11 had preserves at high risk of too much fire. All but MU7 had preserves with a high probability of ignition somewhere within their boundaries. MUs 4 and 5 were the only MUs without preserves or parts of preserves that burned less than the median fire return interval.

Fire risk was also evaluated relative to species diversity, to genetic diversity and to combined species and genetic diversity to identify those areas most important for management of those elements (see Vol. 3, App. 4). A Pareto ranking algorithm was used to spatially prioritize areas for monitoring and management based upon fire risk to species diversity, genetic diversity, and to combined species and genetic diversity (Figures V2B.1-11, V2B.1-12, and V2B.1-13). MUs 3, 4, 5, 6, 8, 9, 10, and 11 had preserves that were ranked ≤25th percentile and were considered highest priority to manage fire risk for species diversity and genetic diversity (see Vol. 3, App. 4).

These analyses were refined to identify important management areas (IMAs) for general reduction of fire frequency (Figure V2B.1-14) and fire ignition probability (Figure V2B.1-15). The fire ignition probability IMA based upon the Syphard and Keeley 2015 model, identifies areas that have the highest probability (mean + 2 standard deviations) for ignitions. The fire frequency IMA is based on a cumulative overlay of highest departure from median fire return interval IMAs for SL, SS, and SO species. IMAs for reducing fire risk to individual MSP species are presented in the goals and objectives sections for those species prioritized at risk from fire (see Species-Specific Approach discussion in Sec. 1.5.2).

1.5 MANAGEMENT AND MONITORING APPROACH

The fire management goal for the MSPA is to maintain the long-term integrity and viability of ecosystems, MSP species, and vegetation communities on Conserved Lands in a cost-effective manner by managing the current human altered fire regime to promote a fire regime with lower fire frequency and reduced impacts (direct and indirect) to natural resources.

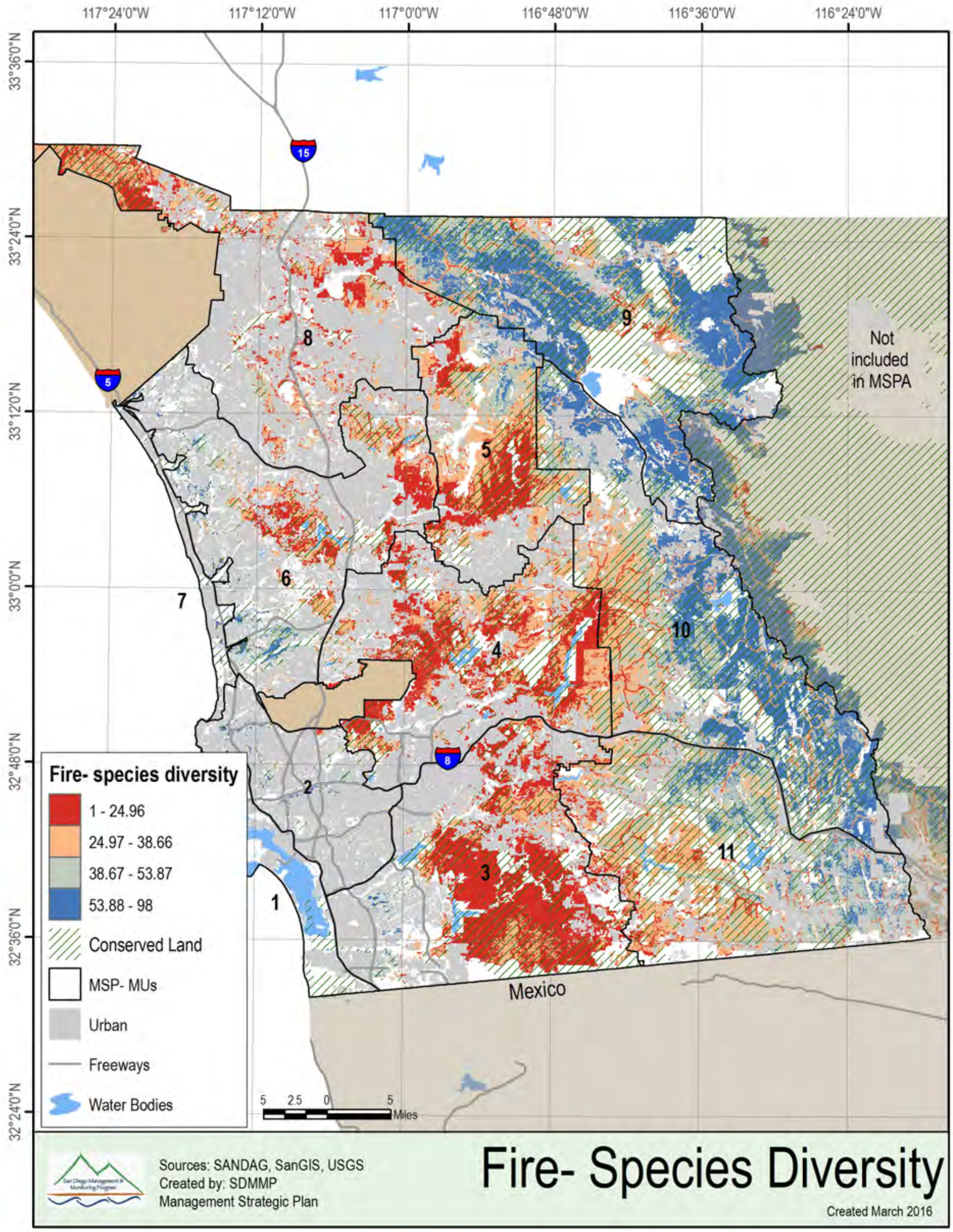

Figure V2B.1-11. Fire and species diversity risk analysis to identify priority areas for management based upon Pareto rankings, the lower the number the higher the priority.

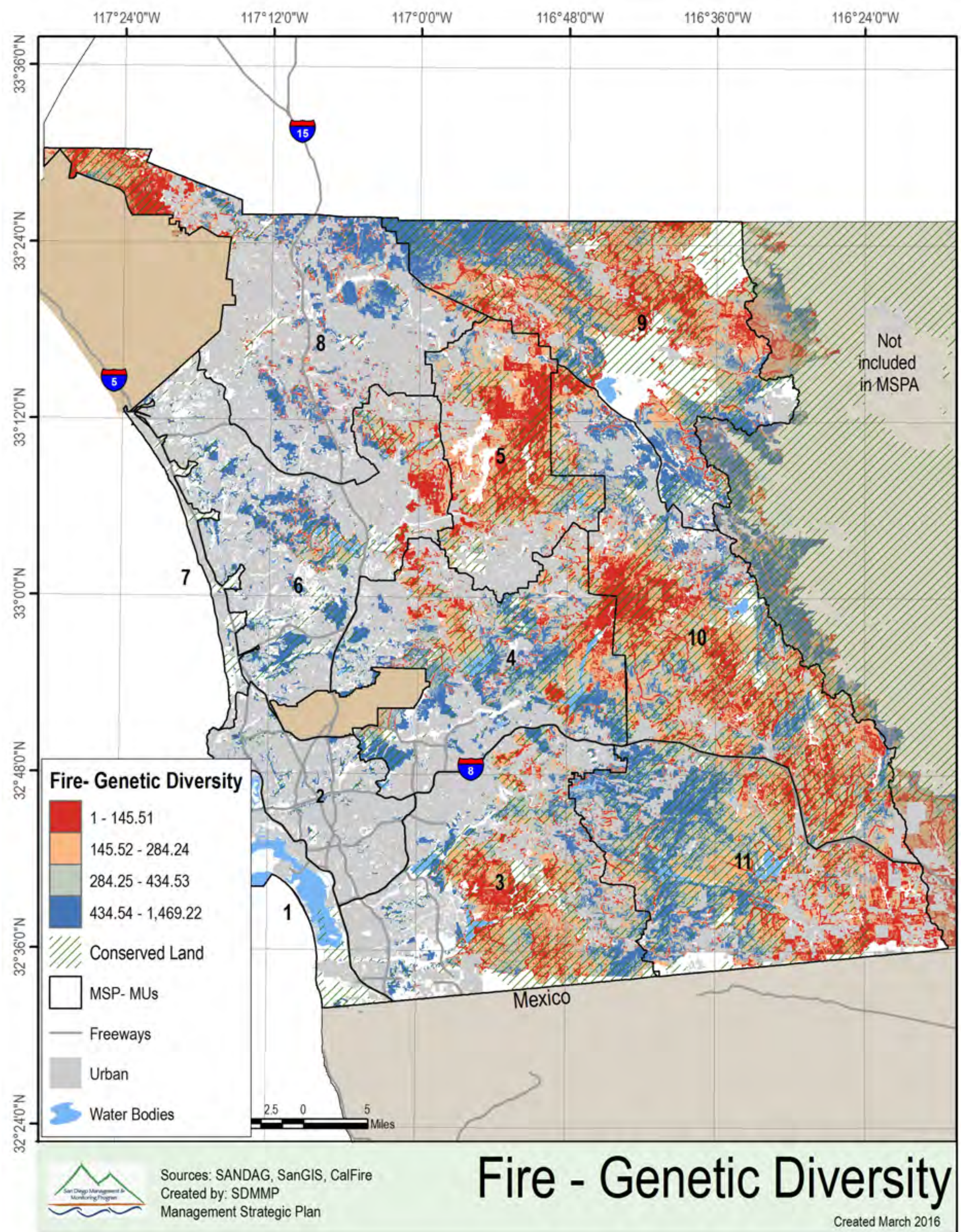

Figure V2B.1-12. Fire and genetic diversity risk analysis to identify priority areas for management based upon Pareto rankings, the lower the number the higher the priority.

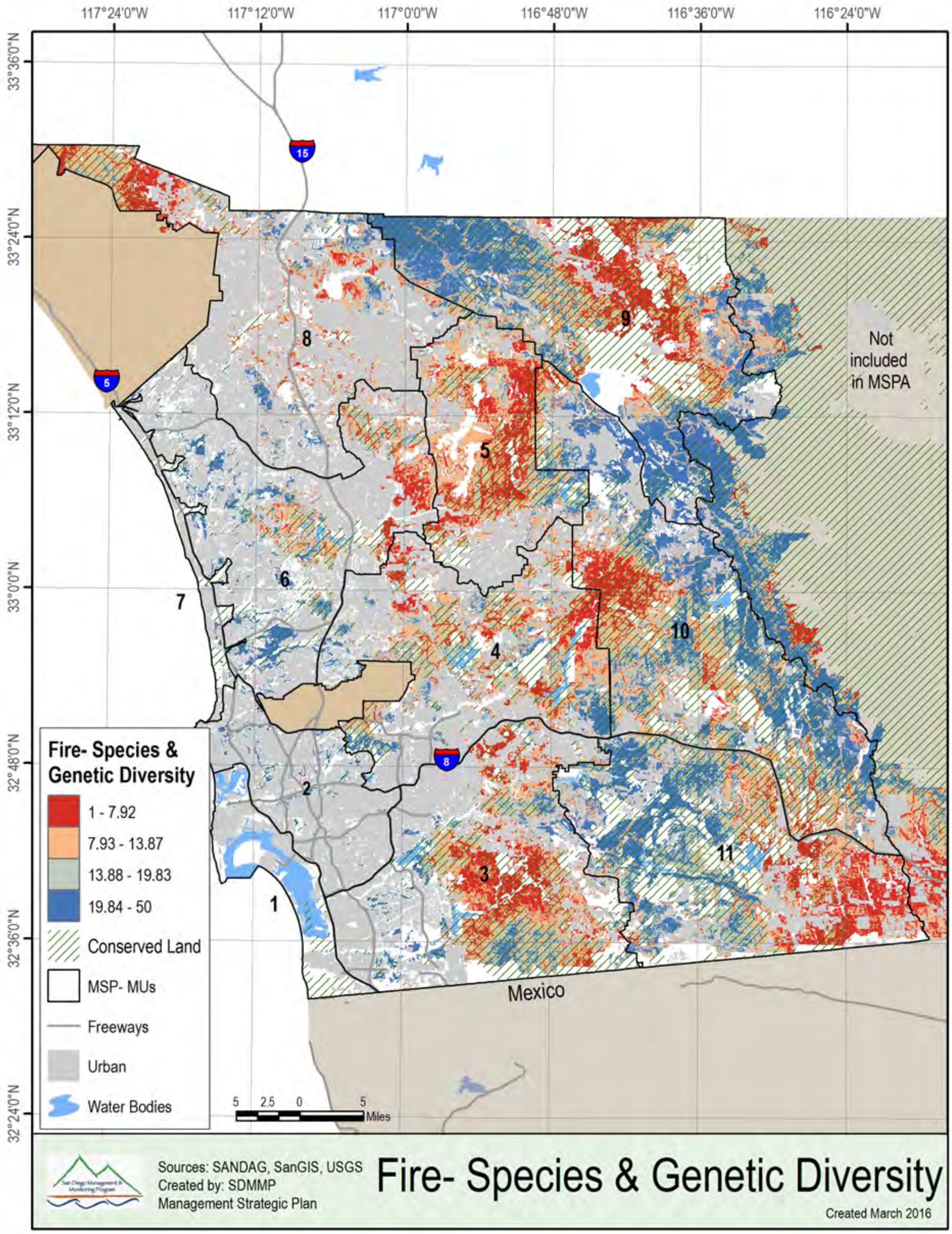

Figure V2B.1-13. Fire, species diversity, and genetic diversity risk analysis to identify priority areas for management based upon Pareto rankings, the lower the number the higher the priority.

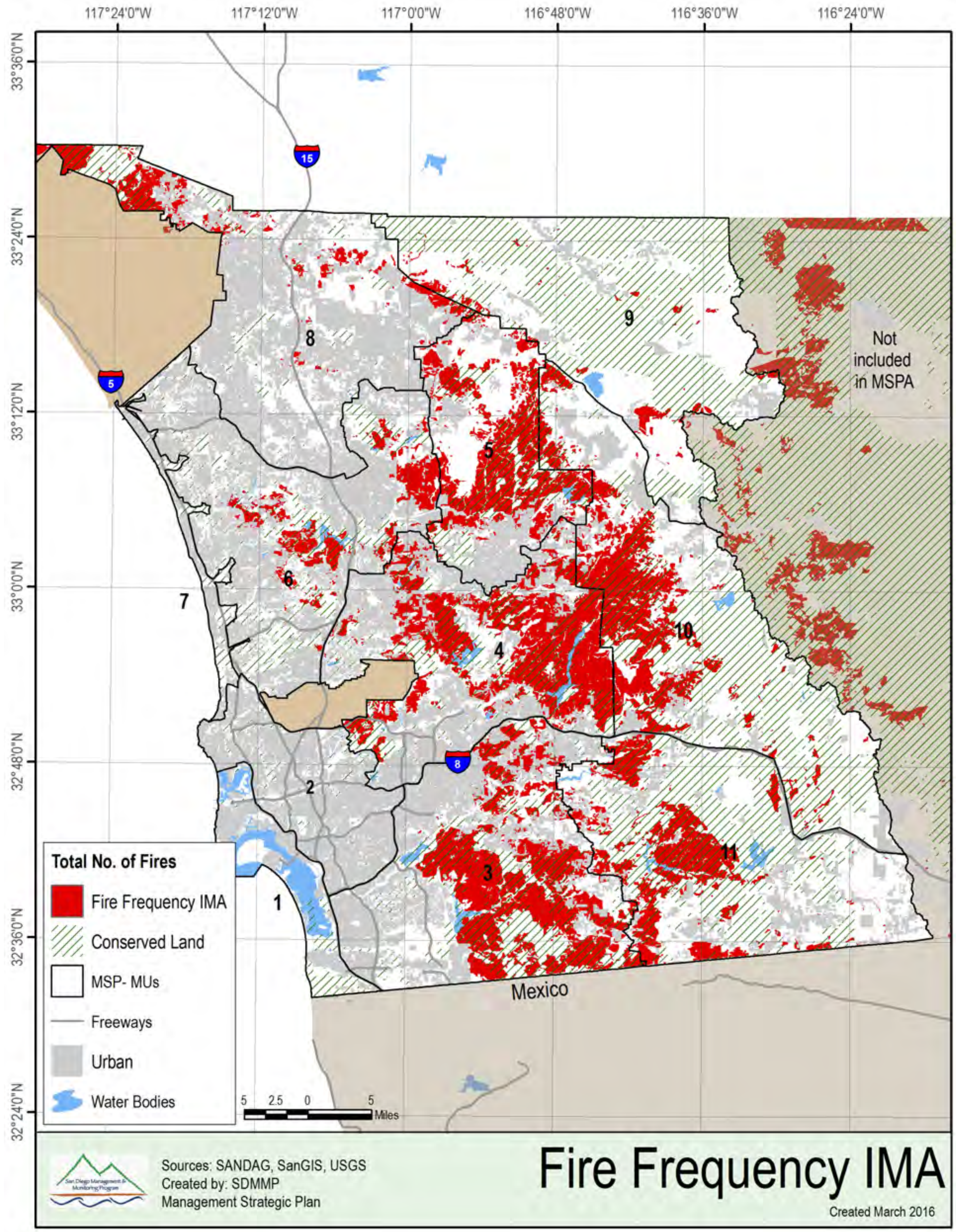

Figure V2B.1-14. Important Management Areas (IMAs) for reducing fire frequency on Conserved Lands in the MSPA.

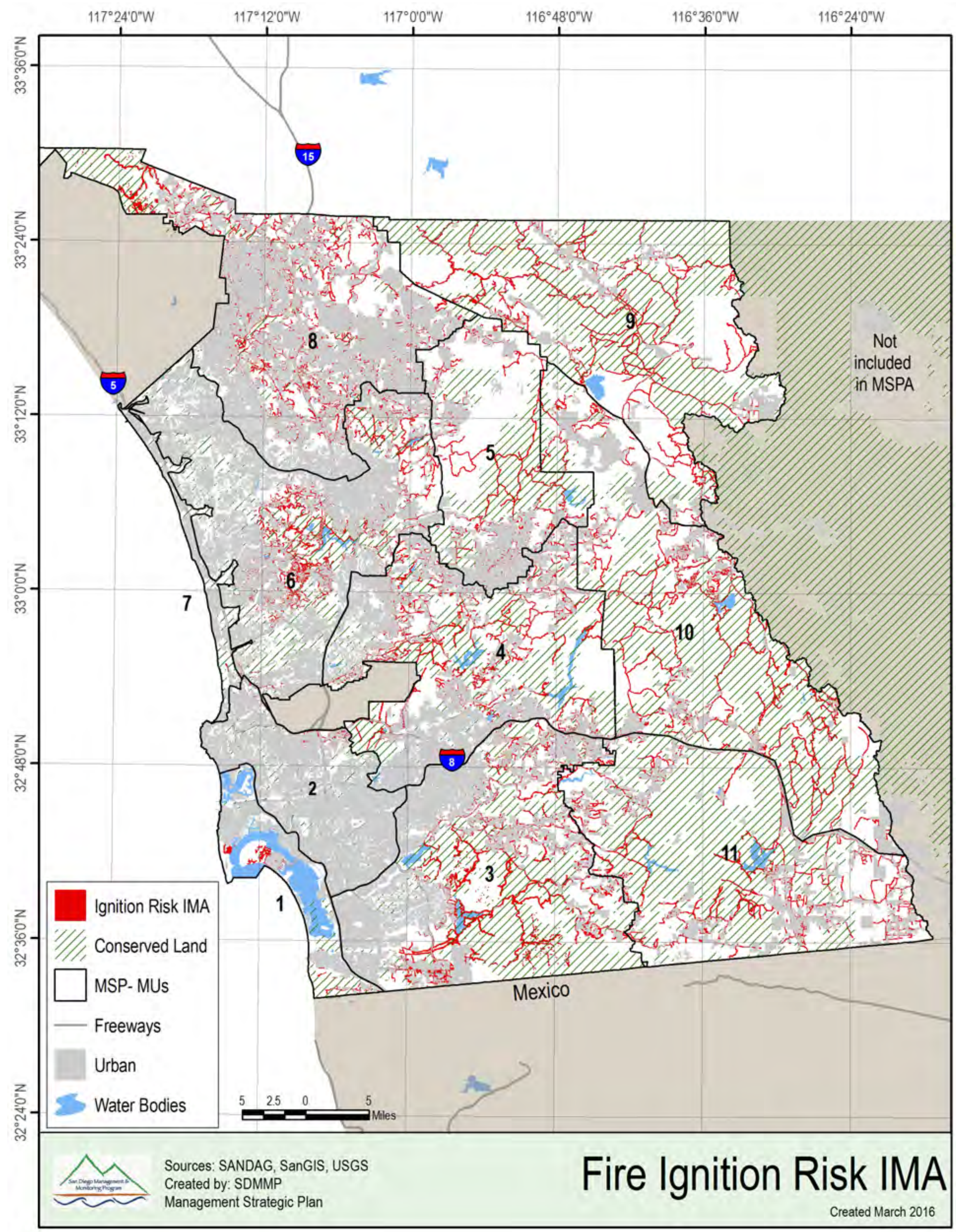

Figure V2B.1-15. Important Management Areas (IMAs) for reducing fire ignition probability in the MSPA.

1.5.1 Reducing Fire Risk to Natural Resources

Early fire detection and sufficient firefighting resources devoted to early suppression are important to reduce the risk of large and catastrophic wildfires, especially during severe fire weather (Fried et al. 2008; Cary et al. 2009; Peterson et al. 2011; Calkin et al. 2013, Penman et al. 2015). Managing fire ignitions is a method to reduce fire frequency to more natural, historical levels in a region where 95% of ignitions are human-caused (Syphard and Keeley 2015).

Fuel management to reduce fire risk to natural resources is complicated and challenging in southern California shrublands and often ineffective for Santa Ana wind-driven fires, when the majority of Conserved Lands burn. Pre-fire fuel management is most effectively targeted at the WUI interface to reduce the destruction of human life and property (Price and Bradstock 2012; Calkin et al. 2013; Syphard et al. 2014). Especially important in southern California shrublands is the creation of defensible space immediately adjacent to homes and other structures in the WUI (Calkin et al. 2013; Syphard et al. 2014). Managing Santa Ana wind-driven fires through reduction of shrubland fuel loads in the interior of preserves, away from the WUI, is more problematic and less successful. Unlike in many forest ecosystems, there is not a strong relationship between fuel age and fire probability in California shrublands (Price et al. 2012; Moritz et al. 2014). Prescribed fire to reduce fuel loads has not been shown to be effective in a number of biomes worldwide, including southern California shrublands (Price et al. 2012; Price et al. 2015). Fuel reduction across large areas of the landscape intended to reduce wildfire intensity, severity, and spread has not stopped wildfires under extreme weather conditions (Keane et al. 2008; Blodgett et al. 2010; Price and Bradstock 2012; Price et al. 2012). As an example, the 2007 wildfires in San Diego County burned through more than 95,000 acres (25%) of land that burned 4 years previously in the 2003 wildfires (see Sec. 1.2, Fire Regime, in the MSPA; Keane et al. 2008; Blodgett et al. 2010).

A study of the 2003 Cedar fire in San Diego County by Blodgett et al. (2010) used very fine spatial resolution imagery to compare burn patterns in areas within the burn perimeter subjected to Santa Ana wind conditions and to areas that burned under non-Santa Ana weather conditions. Pre-fire stands older than 6 years for Santa Ana wind portions of the burn and more than 10 years in the non-Santa Ana wind burn areas had little effect on the pattern of remaining unburned vegetation. This indicates that the mosaic of different age classes did not prevent fire from burning in either the Santa Ana or non-Santa Ana wind conditions. However, Blodgett et al. (2010) found that pre-fire shrub structure and composition did affect localized fire behavior, with chamise chaparral having the least amount of remaining unburned vegetation irrespective of fire weather. Fire severity did not differ between Santa Ana and non-Santa Ana wind portions of the burn as fire may have burned longer but at a lower intensity within the non-Santa Ana wind burn areas. The authors concluded that Santa Ana wind-driven fires would be difficult to control with traditional fuel management techniques of fire breaks and prescribed burning.

Fuel breaks are more effective in managing fires that are not driven by strong winds blowing embers ahead of the fire and where it is safer for fire management personnel to implement fire suppression. Fuel breaks to stop the spread of fire were effective 46% of the time in fires over a 28-year period in shrublands of the Las Padres National Forest in California (Syphard et al. 2011a). Fuel breaks were most effective when they enabled firefighter access to conduct suppression activities (Syphard et al. 2011a,b). Fuel breaks were also more effective in small fires and when the fuel breaks were longer in length. Other important factors in the success of fuel breaks in stopping fires were fire weather and fuel break maintenance that allowed firefighters to access the fires (Syphard et al. 2011b). Environmental conditions vary making the strategic location of fuel breaks important in their usefulness and proximity for access near communities is important for fire protection.

Fuel management to control fire risk is often associated with an increase in the spread and abundance of invasive, nonnative plants, particularly grasses and forbs. Nonnative plant abundance was 200% greater along fuel breaks in the Los Padres National Forest than in nearby untreated areas (Merriam et al. 2006). Fuel breaks made by bulldozers had greater impacts with greater nonnative cover, more bare ground and less canopy cover, litter, and duff. Mechanical fuel treatments in southern California chaparral to reduce shrub biomass and decrease fire hazard were found to be short term in effect as shrubs rapidly regrew and resulted in a 5-fold increase in herbaceous fuels (Brennan and Keeley 2015). This increase in native and nonnative highly flammable herbaceous fuels, especially nonnative invasive annual grasses, increases chances of fire ignition. A comparison of fuel reduction methods in northern California chaparral found that mastication had 34% greater nonnative annual grass cover than prescribed fire (Potts and Stephens 2009). Winter and spring prescribed fire were more resistant to grass invasion than fall fires or fall or spring mastication treatments.

In the MSPA, land owners and managers will determine the type of fuel management actions to implement to reduce risk to lives, property and natural resources and to ensure compliance with state and local laws. They may find targeted fuel management most effective at the WUI and the use of fuel breaks at strategic locations where active fire management can reduce fire risks to human life, property, and sensitive resources.

1.5.2 General and Species-Specific Fire Management Approaches

The approach for managing an altered fire regime is divided into 2 parts: general and species-specific. General fire management objectives focus on management actions that benefit natural resources across the MSPA and that are not targeted to particular species. Species-specific fire management objectives are developed for MSP species identified as at risk from fire, in which significant occurrences or even the species themselves could be lost from the MSPA as a result of an altered fire regime.

The general approach is based upon input from a 2-day Fire and Wildlife Strategic Plan Workshop convened by USGS in March 2013. This workshop brought together researchers, fire management personnel, and land managers to review and discuss wildfire impacts to at-risk natural resources and fire management planning (Rochester and Fisher 2014). A summary document was prepared and then reviewed by a Scientific Advisory Panel and it describes the workshop presentations, discussions, and resulting recommendations (Rochester and Fisher 2014). The workshop provided guidance for development of general fire management objectives and actions that identify at-risk resources with implementable management actions falling into 3 categories: pre-fire, suppression, and post-fire. The general goals, objectives, and actions for fire management on Conserved Lands provided in this Fire and Wildlife Element of the MSP include the recommendations from the workshop and are described below and listed on the MSP Portal under the Altered Fire Regime summary page (https://portal.sdmmp.com/view_threat.php?threatid=TID_20160304_1448).

Further details on recommended management actions are provided in the 2013 Fire and Wildlife Strategic Plan Workshop summary (Rochester and Fisher 2014).

The species-specific approach for managing and monitoring an altered fire regime is based on follow-up workshops held in October 2015. Although the initial Fire and Wildlife Strategic Plan Workshop in March 2013 provided information on the effects of fire on several MSP species (Rochester and Fisher 2014), there were several MSP species that still needed to be addressed. The workshops in October 2015 focused on prioritizing species by fire risk and developing management recommendations to reduce impacts to plants and animals. See the 2013 Fire and Wildlife Strategic Plan Workshop summary (Rochester and Fisher 2014) for workshop information and summaries. Fire risk prioritizations for plant species are provided in Table V2B.1-2 and for animals in Table V2B.1-3. Fire management approach, rationale, objectives, and actions for at- risk MSP species are presented in the corresponding species sections with goals and objectives on the MSP Portal.

General Approach Objectives

Below is a summary of the management and monitoring objectives for the threat of altered fire regime. For the most up-to-date goals, objectives, and actions, go to the MSP Portal Altered Fire Regime summary page: https://portal.sdmmp.com/view_threat.php?threatid=TID_20160304_1448.

Pre-Fire Objectives: Prepare and Implement a Fire Ignition Reduction Plan

USFS, Bureau of Land Management (BLM), and California Department of Forestry and Fire Protection (CAL FIRE) have focused over the years on reducing ignitions through public education and outreach to inform people about fire dangers in risk areas and about measures to prevent ignitions (see Rochester and Fisher 2014). Firefighting agencies have also been effective at early suppression, as most fires are immediately put out and only a small fraction become large, catastrophic fires. Fire management officials suggest that it may not be possible to suppress and contain the remaining 3–5% of fires that grow beyond 10–150 acres. It is this remaining 5% of ignitions that has caused 95% of the impacts to natural resources in San Diego County, and even a small reduction in these large fires would benefit sensitive plant and animal species and their habitats.

To address other sources of wildfire ignition in the MSPA, a Fire Ignition Reduction Plan should be developed that evaluates ignition sources and the spatial distribution and timing of ignitions (see Rochester and Fisher 2014; Syphard and Keeley 2015). A Fire Ignition Reduction Plan for the MSPA should focus on ignition sources on and near Conserved Lands that have the potential to cause catastrophic fires and that do not overly duplicate the efforts of other organizations. The plan should prioritize areas for management that have high risk of ignition and the greatest potential for impact to at-risk MSP species and vegetation communities.

Table V2B.1-2. Fire risk prioritizations for MSP plant species.

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Management Category[3]	Overall Fire Risk Category[4]	Categorization Rationale
Acanthomintha ilicifolia	San Diego thorn-mint	MSCP, MHCP, NCP	FT/CE	SO	High	High risk of loss of individual populations (especially small ones) due to secondary fire effects of invasive nonnative plant species.
Acmispon prostratus	Nuttall's acmispon	MSCP, MHCP	--/--	SO	Low	
Adolphia californica	California adolphia	NCP	--/--	VG	Low	
Agave shawii var. *shawii*	Shaw's agave	MSCP	--/--	SL	Medium	Low risk of fire but few small populations with only 1 thought to be native.
Ambrosia pumila	San Diego ambrosia	MSCP, MHCP, NCP	FE/--	SO	Medium	Few populations, high risk from invasive plant species puts species at risk of extirpation due to too frequent fire.
Aphanisma blitoides	Aphanisma	MSCP	--/--	SL	Low	
Arctostaphylos glandulosa ssp. *crassifolia*	Del Mar manzanita	MSCP, MHCP, NCP	FE/--	VF	Medium	Resprouts/reseeds after fire. Altered fire regime does not appear to be a threat currently, but should be monitored. Insufficient fire at coastal locations could pose eventual threat from senescence and lack of reproduction.
Arctostaphylos otayensis	Otay manzanita	MSCP	--/--	VF	High	Fire adapted but restricted range with shortened fire return intervals puts species at risk.
Arctostaphylos rainbowensis	Rainbow manzanita	NCP	--/--	VF	Medium	Fire increases germination and this species may require fire to maintain vigorous populations. Too frequent fire poses a risk given the limited distribution.
Atriplex coulteri	Coulter's saltbush	NCP	--/--	VF	Low	
Atriplex parishii	Parish brittlescale	NCP	--/--	VF	Low	

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Management Category[3]	Overall Fire Risk Category[4]	Categorization Rationale
Baccharis vanessae	Encinitas baccharis	MSCP, MHCP, NCP	FT/CE	SO	High	Known fire follower; however shortened fire intervals put some populations at risk of extirpation due to weed competition/conversion.
Bloomeria clevelandii	San Diego goldenstar	MSCP, NCP	--/--	SS	Medium	Bulb life form life form facilitates protection/recovery from fire; too frequent fire may lead to population reduction due to secondary effects such as invasive grass/forb invasion.
Brodiaea filifolia	Thread-leaved brodiaea	MSCP, NCP	FT/CE	SS	Medium	Populations found in areas with little fire history; corm life form facilitates protection/ recovery from fire; however, fire may lead to secondary effects such as invasive grass/forb invasion.
Brodiaea orcuttii	Orcutt's brodiaea	MSCP, NCP	--/--	SO	Low	
Brodiaea santarosae	Santa Rosa brodiaea	NCP	--/--	SS	Low	Bulb life form life form facilitates protection/recovery from fire; fire may lead to secondary impacts such as invasive nonnative grasse and forbs.
Calochortus dunnii	Dunn's mariposa lily	MSCP	--/--	VG	Medium	Bulb life form life form facilitates protection/recovery from fire; fire may lead to secondary impacts such as invasive nonnative grasses and forbs.
Ceanothus cyaneus	Lakeside ceanothus	MSCP	--/--	VF	High	Restricted range/few occurrences; shortened fire return interval puts species at high risk of local population extirpation due to fire.
Ceanothus verrucosus	Wart-stemmed ceanothus	MSCP, MHCP, NCP	--/--	VF	Medium	Reseeds after fire. Altered fire regime does not appear to be a threat currently in coastal locations but should be monitored for populations along 1-5 that have burned since 2000.
Centromadia parryi ssp. *australis*	Southern tarplant	NCP	--/--	VF	Low	

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Management Category[3]	Overall Fire Risk Category[4]	Categorization Rationale
Chloropyron maritimum ssp. *maritimum*	Salt marsh bird's-beak	MSCP	FE/CE	SL	Low	
Chorizanthe orcuttiana	Orcutt's spineflower	MHCP, NCP	FE/CE	SL	Low	
Clinopodium chandleri	San Miguel savory	MSCP, NCP	--/--	SL	High	Low population numbers, shortened fire return intervals, few occurrences puts at high risk of extirpation due to too frequent fire.
Comarostaphylis diversifolia ssp. *diversifolia*	Summer-holly	MHCP, NCP	--/--	VG	Low	
Cylindropuntia californica var. *californica*	Snake cholla	MSCP	--/--	VF	Medium	Too frequent fires (< 10 years) could threaten this species, which is restricted in distribution in the MSPA.
Deinandra conjugens	Otay tarplant	MSCP	FT/CE	SS	High	Few occurrences and shortened fire return intervals may pose a risk of reduction/loss for some occurrences. Fire may lead to population declines due to secondary effects such as nonnative grass/forb invasion that should trigger active management/invasive control post-fire.
Dicranostegia orcuttiana	Orcutt's birds-beak	MSCP	--/--	SL	Low	
Dudleya blochmaniae	Blochman's dudleya	MHCP	--/--	SL	Low	
Dudleya brevifolia	Short-leaved dudleya	MSCP, NCP	--/CE	SL	Low	
Dudleya variegata	Variegated dudleya	MSCP	--/--	SS	High	Corm life form facilitates protection/recovery from fire; shortened fire return intervals at some locations may lead to secondary effects such as invasive nonnative grasses and forbs.
Dudleya viscida	Sticky dudleya	MSCP, NCP	--/--	SS	Medium	Corm life form facilitates protection/recovery from fire; shortened fire return intervals at some locations may lead to secondary effects such as invasive nonnative grasses and forbs.

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Management Category[3]	Overall Fire Risk Category[4]	Categorization Rationale
Ericameria palmeri ssp. *palmeri*	Palmer's goldenbush	MSCP	--/--	VF	Low	
Eryngium aristulatum var. *parishii*	San Diego button-celery	MSCP, NCP	FE/CE	VF	Low	
Erysimum ammophilum	Coast wallflower	MSCP	--/--	SL	Low	
Euphorbia misera	Cliff spurge	MHCP	--/--	VF	Low	
Ferocactus viridescens	San Diego barrel cactus	MSCP, MHCP, NCP	--/--	VF	Medium	Occurrences in grasslands may have hard time recovering post-fire.
Fremontodendron mexicanum	Mexican flannelbush	None	FE/--	SL	High	Restricted range/few occurrences (4) with low population numbers put species at high risk of extirpation due to fire.
Hazardia orcuttii	Orcutt's hazardia	MHCP	--/CT	SL	High	Likely fire adapted, but only 1 natural occurrence puts species at high risk of extinction due to fire (e.g., invasive plants, suppression actions).
Hesperocyparis forbesii	Tecate cypress	MSCP	--/--	VF	High	Restricted range/few occurrences with decreasing population size due to shortened fire intervals puts species at high risk.
Iva hayesiana	San Diego marsh-elder	MHCP	--/--	VG	Low	
Lepechinia cardiophylla	Heart-leaved pitcher sage	MSCP	--/--	SL	High	Fire follower; however, single occurrence with low numbers is at risk from too frequent fire.
Lepechinia ganderi	Gander's pitcher sage	MSCP	--/--	VG	High	Fire follower; however, distribution is restricted and shortened fire return intervals puts species at risk.

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Management Category[3]	Overall Fire Risk Category[4]	Categorization Rationale
Monardella hypoleuca ssp. *lanata*	Felt-leaved monardella	MSCP, NCP	--/--	VF	Medium	Fire could be a problem at some sites due to invasive nonnative plant species.
Monardella stoneana	Jennifer's monardella	None	--/--	SL	High	Restricted range/few occurrences with low population numbers and shortened fire intervals puts species at high fire risk.
Monardella viminea	Willowy monardella	MSCP	FE/CE	SL	High	Restricted range/few occurrences with low population numbers and some occurrences with shortened fire intervals puts species at high risk from secondary effects of erosion and invasion of nonnative grasses and forbs.
Navarretia fossalis	Spreading navarretia	MSCP, MHCP, NCP	FT/--	VF	Low	
Nolina cismontana	Chaparral nolina	NCP	--/--	SL	High	Resprouts/reseeds after fire, but species at risk of loss/extirpation at sites that burn frequently.
Nolina interrata	Dehesa nolina	MSCP	--/CE	SO	High	Resprouts/reseeds after fire, but species at risk of loss/extirpation at sites that burn frequently.
Orcuttia californica	California orcutt grass	MSCP, MHCP	FE/CE	SL & VF	Low	
Packera ganderi	Gander's ragwort	NCP, MSCP	--/--	SO	High	Restricted range/few populations puts species at risk of extirpation/degradation if too frequent fires causes invasion of nonnative plants.
Pinus torreyana ssp. *torreyana*	Torrey pine	MSCP, MHCP	--/--	VF	High	Few natural occurrences put species at high risk due to fire, especially given recent mortality from drought and bark beetles.
Pogogyne abramsii	San Diego mesa mint	MSCP	FE/CE	VF	Low	
Pogogyne nudiuscula	Otay mesa mint	MSCP	FE/CE	SL & VF	Low	
Quercus dumosa	Nuttall's scrub oak	MHCP, NCP	--/--	VF	Low	

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Management Category[3]	Overall Fire Risk Category[4]	Categorization Rationale
Quercus engelmannii	Engelmann Oak	MHCP, NCP	--/--	VF	Medium	Risk of fire dependent on age of tree: Poor fire response for seedlings < 3 years; while older large trees subject to increased mortality probability with repeat fires.
Rosa minutifolia	Small-leaved rose	MSCP	--/CE	SS	Low	
Tetracoccus dioicus	Parry's tetracoccus	MSCP, MHCP, NCP	--/--	SS	Medium	Dioecious; regenerates readily post fire, initially; but shortened fire return interval at some locations may cause extirpation due to competition with invasive nonnative plants.

[1] Species covered in a Natural Community Conservation Plan does not denote a priority management area. MHCP = Multiple Habitat Conservation Plan; MSCP = Multiple Species Conservation Plan; NCP = North County Plan

[2] Federal State Designation: FE = Federally Endangered; FT = Federally Threatened; BESA = Federally Protected under the Bald Eagle Protection Act of 1940, as amended; CE = California State Endangered; CT = California State Threatened; CSP = California Specially Protected; CSC = California Species of Special Concern; FP = California Fully Protected Species.

[3] MSP Management Categories are described in detail in Vol. 1, Sec. 2.0. Codes are as follows: SL = Species at risk of loss from MSPA; SO = Significant occurrence(s) at risk of loss from MSPA; SS = Species more stable but still requires species-specific management to persist in MSPA; VF = Species with limited distribution in MSPA or needing specific vegetation characteristics requiring management; VG = Species not specifically managed for, but may benefit from vegetation management for VF species.

[4] Overall Fire Risk Categories: Low, Medium or High risk of impact from fire based on 1st Order, 2nd Order Short Term and 2nd Order Long Term risk evaluations.

Table V2.B1-3. Fire risk prioritizations for MSP animal species.

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Mgmt Cat[3]	1st Order Fire Risk Cat[4]	2nd Order - ST Fire Risk Cat[5]	2nd Order – LT Fire Risk Cat[6]	Overall Fire Risk Cat[7]	Fire Risk Categorization Rationale
INVERTEBRATES									
Branchinecta sandiegonensis	San Diego fairy shrimp	MSCP, NCP	FE/--	SO & VF	Low	Low	Low	Low	
Euphyes vestris harbisoni	Harbison's dun skipper	MHCP, NCP	--/--	SL	Medium	Medium	Low	High	Moderate potential for direct loss of individuals and host plants during extreme fire events. Loss of oak canopy would reduce potential habitat. Longer term, concern is combined impact of drought, fire and invasive plants on the overall quality of habitat.
Euphydryas editha quino	Quino checkerspot butterfly	NCP	FE/--	SL	Medium-High	Medium	Medium	High	Direct loss of larvae and habitat can occur in an extreme fire event but studies also indicate known locations will support QCB following wildfire (2003-2005 USFWS study). Short term possible moderate positive benefit (0-5 years) canopy opens and provides potential sites for larval plants and allows for easier dispersal of adults across the landscape. Long term concern would be invasion of nonnative grasses and filaree. Disturbance could displace cryptogrammic crusts and allow invasive species to outcompete native plant species.
Lycaena hermes	Hermes copper	NCP	--/--	SL	High	High	Medium	High	Impacted by direct mortality and short term habitat loss. Moderate long term risk due to low recolonization after fire. Mature spiny redberry is not a requirement for eggs/larvae. Long term concern is habitat type conversion and

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Mgmt Cat[3]	1st Order Fire Risk Cat[4]	2nd Order - ST Fire Risk Cat[5]	2nd Order – LT Fire Risk Cat[6]	Overall Fire Risk Cat[7]	Fire Risk Categorization Rationale
									loss of spiny redberry/California buckwheat association.
Callophrys thornei	Thorne's hairstreak butterfly	MSCP	--/--	VF	High	High	Low	High	Potential for high mortality during extreme fire events. Short term loss of habitat, but decreases as Tecate cypress recovers. Longer term threat depends on recovery of Tecate cypress, which is hampered by short fire return intervals. Fire can benefit by germination of host plants and expansion of occupied habitat if source populations are not extirpated.
Panoquina errans	Wandering skipper	MSCP, MH	--/--	VF	Low	Low	Low	Low	
Streptocephalus wootoni	Riverside fairy shrimp	MSCP, MH NCP	FE/--	VF	Low	Low	Low	Low	
FISH									
Gila orcuttii	Arroyo Chub	NCP	--/CSC	SL	Low	Medium-High	High	High	Does not seem to suffocate with ash during fire. Short term there could be significant mud or sediment flows that fill in ponds. Benefits from invasive plant removal by fire. Long term, invasive plant species return and population contracts.
AMPHIBIANS									
Anaxyrus californicus	Arroyo toad	MSCP, NCP	FE/CSC	SO	Low	Low	High	High	Species is underground during fall fires. A spring fire may cause direct mortality. Short term, invasive plants are cleared and species responds positively. Long term, invasive plants return and populations contract.

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Mgmt Cat[3]	1st Order Fire Risk Cat[4]	2nd Order - ST Fire Risk Cat[5]	2nd Order – LT Fire Risk Cat[6]	Overall Fire Risk Cat[7]	Fire Risk Categorization Rationale
Spea hammondii	Western spadefoot toad	MHCP, NCP	--/CSC	VF	Low	Medium	Medium-High	High	Species is underground during fall fires. A spring fire may cause direct mortality. Some impacts from fire suppression have been observed. Long term, species will suffer from sedimentation of vernal pools.
Taricha torosa	California newt	NCP	--/CSC	VF	Low	High	Medium-High	High	Species lives in very shallow ponds. Debris flow immediately flowing fire could fill in pond. Long term, some occurrences will likely have no real effect but problems with siltation and invasive plants could arise for others.
REPTILES									
Aspidoscelis hyperythra	Orange-throated whiptail	MSCP, MHCP, NCP	--/CSC	VG	Low	Low	Low	Low	
Crotalus ruber	Red diamond rattlesnake	NCP	--/CSC	VG	High (Spring) ; Low (Fall)	Low	Medium-High	High	Risk of mortality is low in a fall fire and high in a spring fire. Snakes are seen immediately after a fire hunting and most likely benefit from an increase in prey. Suppression activities do pose risk to individuals.
Emys pallida	Southwestern pond turtle	MSCP, MHCP, NCP	--/CSC	SL	High	High	High	High	During the fall, species moves away from ponds so fire will result in direct mortality. Short term, there is a risk of siltation and burial of habitat. Long term the species is so limited in distribution that a single fire could elimate all viable populations.
Phrynosoma blainvillii	Blainville's horned lizard	MSCP, NCP	--/CSC	VF coastal & VG inland	Low	Low	Low	Low	
Thamnophis hammondii	Two-striped garter snake	NCP	--/CSC	VG	Low	Low	Low	Low	

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Mgmt Cat[3]	1st Order Fire Risk Cat[4]	2nd Order - ST Fire Risk Cat[5]	2nd Order – LT Fire Risk Cat[6]	Overall Fire Risk Cat[7]	Fire Risk Categorization Rationale
BIRDS									
Accipiter cooperii	Cooper's hawk	MSCP, MHCP	--/--	VG	Low	Low	Low	Low	
Agelaius tricolor	Tricolored blackbird	MSCP, NCP	--/CSC	SL	Low	Low to Medium	Low	High	Likely only low adult mortality during a fire, although a spring fire could cause nestling mortality. Fire beneficial in creating early successional marsh habitat favored for breeding and open habitat for foraging. Negative short-term impacts could include siltation of breeding ponds and attraction of competitors and predators. During the breeding season pulling water from ponds for firefighting aircraft could impact nesting blackbirds. Not sure long-term indirect impacts on food availability (grasshoppers) or the best fire return interval for maintaining early successional habitat.
Aimophila ruficeps canescens	Southern California rufous-crowned sparrow	MSCP, MHCP, NCP	--/--	VG	Low	Low	Low	Low	
Ammodramus savannarum perpallidus	Grasshopper sparrow	NCP	--/CSC	VF	Low	Low	Low	Low	
Artemisiospiza belli belli	Bell's sparrow	MHCP, NCP	--/--	VF	High	High	Low	High	Mortality is likely high during fire events. Species is declining in coastal San Diego County so fire-related mortality is an issue. Short term, during the first 2 years following fire habitat is degraded (Hargrove and Unitt 2015). As habitat recovers then species increases. Natural fire regime likely benefits this

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Mgmt Cat[3]	1st Order Fire Risk Cat[4]	2nd Order - ST Fire Risk Cat[5]	2nd Order – LT Fire Risk Cat[6]	Overall Fire Risk Cat[7]	Fire Risk Categorization Rationale
									species by opening up dense shrub canopy.
Aquila chrysaetos canadensis	Golden eagle	MSCP, MHCP, NCP	BEPA/FP	SO	Low	Low	Low	Low	
Athene cunicularia hypugaea	Western burrowing owl	MSCP, NCP	--/CSC	SL	Low	Low	Low	Low	
Branta canadensis	Canada goose	MSCP	--/--	VG	Low	Low	Low	Low	
Buteo regalis	Ferruginous hawk	MSCP	--/--	VG	Low	Low	Low	Low	
Buteo swainsoni	Swainson's hawk	MSCP	--/CT	VG	Low	Low	Low	Low	
Campylorhynchus brunneicapillus sandiegensis	Coastal cactus wren	MSCP, MHCP, NCP	--/CSC	SO	High	High	High	High	One of the more fire sensitive bird species in southern California (Hargrove and Unitt, in prep.). Occurrences have declined substantially following fire both from mortality and loss of habitat. Cactus can burn severely and may not recover or else take a long time to grow back. Invasive annual plants can degrade habitat, particularly after multiple fires.
Charadrius nivosus nivosus	Western snowy plover	MSCP, MHCP	FT/CSC	SL	Low	Low	Low	Low	
Circus cyaneus	Northern harrier	MSCP, NCP	--/CSC	SO	Low	Low	Low	Low	
Egretta rufescens	Reddish egret	MSCP	--/--	VG	Low	Low	Low	Low	
Empidonax traillii extimus	Southwestern willow flycatcher	MSCP, MHCP, NCP	FE/CE	SL	Low	High	Medium	High	Mortality unlikely unless late spring or early summer fire. Fire at any time of year could destroy nesting habitat along upper San Luis Rey River where most of population occurs. This could

Scientific Name	Common Name	Plans Covered By[1]	Fed/State Desig[2]	MSP Mgmt Cat[3]	1st Order Fire Risk Cat[4]	2nd Order - ST Fire Risk Cat[5]	2nd Order – LT Fire Risk Cat[6]	Overall Fire Risk Cat[7]	Fire Risk Categorization Rationale
									have a devastating short term effect on persistence in southern California, since there are few other pairs elsewhere. Longer term effects could include slow habitat recovery dependent on available water flow and invasion by nonnative plants such as *Arundo donax.*
Falco peregrinus anatum	American peregrine falcon	MSCP, MHCP	--/ FP	VG	Low	Low	Low	Low	
Haliaeetus leucocephalus	Bald eagle	MSCP	--/CE, FP	VG	Low	Low	Low	Low	
Icteria virens	Yellow-breasted chat	MHCP, NCP	--/CSC	VG	Low	Low	Low	Low	
Numenius americanus	Long-billed curlew	MSCP	--/--	VG	Low	Low	Low	Low	
Pandion haliaetus	Osprey	MHCP	--/--	VG	Low	Low	Low	Low	
Passerculus sandwichensis beldingi	Belding's savannah sparrow	MSCP, MHCP	--/CE	VF	Low	Low	Low	Low	
Passerculus sandwichensis rostratus	Large-billed savannah sparrow	MSCP, MHCP	--/CSC	VG	Low	Low	Low	Low	
Pelecanus occidentalis californicus	California brown pelican	MSCP, MHCP	--/FP	VG	Low	Low	Low	Low	
Plegadis chihi	White-faced ibis	MSCP, MHCP, NCP	--/CSC	VG	Low	Low	Low	Low	
Polioptila californica californica	Coastal California gnatcatcher	MSCP, MHCP, NCP	FT/CSC	VF	Low	Medium	Medium	Medium	Recovery of habitat and recolonization following wildfire appears relatively slow for recent large-scale wildfires in San Diego County. Potential long term

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									effects of fire, particularly repeated fire, include degradation of coastal sage scrub and type conversion to nonnative grassland.
Rallus obsoletus levipes	Ridgway's rail	MSCP, MHCP, NCP	FE/CE, FP	SO	Low	Low to Medium	Low	Medium	Main threat is run-off during rainy period that could transport heavy metals from burned areas downstream into the salt marsh.
Sialia mexicana	Western bluebird	MSCP, MHCP	--/--	VG	Low	Low	Low	Low	
Sternula antillarum browni	California least tern	MSCP, MHCP	FE/CE, FP	SO	Low	Low	Low	Low	
Thalesseus elegans	Elegant tern	MSCP, MHCP	--/--	VG	Low	Low	Low	Low	
Vireo bellii pusillus	Least Bell's vireo	MSCP, MHCP, NCP	FE/CE	VF	Low	Low	Low	Low	
MAMMALS									
Antrozous pallidus	Pallid bat	NCP	--/CSC	SL	Low	Low	Medium	Medium	Bats can escape fire and in short term fire opens up habitat for insect foraging. long term, fire can result in loss of roost sites and degradation of foraging habitat by invasive nonnative plants.
Chaetodipus fallax fallax	Northwestern San Diego pocket mouse	MHCP	--/CSC	VG	Low	Low	Low	Low	
Dipodomys stephensi	Stephens' kangaroo rat	MHCP, NCP	FE/CT	VF	Low	Low	Low	Low	

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Lepus californicus bennettii	San Diego black-tailed jackrabbit	MHCP, NCP	--/CSC	VF	High	High	Low	High	Vulnerable to mortality from fire and to short term impacts to habitat from loss of shrub cover.
Odocoileus hemionus fuliginata	Southern mule deer	MSCP, MHCP	--/--	VG	Low	Low	Low	Low	
Plecotus townsendii pallescens	Townsend's big-eared bat	NCP	--/CSC	SO	Low	Low	Medium	Medium	Bats can escape fire and in short term fire opens up habitat for insect foraging. Long term, fire can result in loss of roost sites and degradation of foraging habitat by invasive nonnative plants.
Puma concolor	Mountain lion	MSCP, MHCP, NCP	--/--	SL	Low	Low	Medium	Medium	Initial risk of mortality is low overall but high impact to population if there is loss of even 1 lion. Short term, fire opens up habitat, possibly enhancing food availability. long term can be a moderate risk if there is type conversion of shrubland to grassland.
Taxidea taxus	American badger	MSCP, NCP	--/CSC	SL	Low	Low	Low	Low	

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[3] MSP Management Categories are described in detail in Vol. 1, Sec. 2.0. Codes are as follows: SL = Species at risk of loss from MSPA; SO = Significant occurrence(s) at risk of loss from MSPA; SS = Species more stable but still requires species-specific management to persist in MSPA; VF = Species with limited distribution in MSPA or needing specific vegetation characteristics requiring management; VG = Species not specifically managed for, but may benefit from vegetation management for VF species.

[4] 1st Order Fire Risk Categories: Low, Medium or High risk of mortality from fire.

[5] 2nd Order Short-Term Fire Risk Categories: Indirect impact from fire such as Low, Medium or High risk of short-term habitat loss or degradation.

[6] 2nd Order Long-Term Fire Risk Categories: Indirect impact from fire such as Low, Medium or High risk of long-term habitat loss or degradation.

[7] Overall Fire Risk Categories: Low, Medium or High risk of impact from fire based on 1st Order, 2nd Order Short-Term and 2nd Order Long-Term risk evaluations.

Power equipment is the most common ignition source for fires in San Diego County and the leading cause of large fires (Syphard and Keeley 2015). The Fire Ignition Reduction Plan should include measures to reduce power equipment ignitions such as public education and outreach about the risk of fire ignitions from power equipment. It should also include implementing the Project Activities Level (PAL) fire danger rating system across the MSPA to regulate use of power equipment during periods of high fire danger (see Rochester and Fisher 2014).

The second most common source of wildfire ignitions in San Diego County is powerlines (Syphard and Keeley 2015). San Diego Gas and Electric (SDG&E) already has a plan to reduce powerline ignitions and is undertaking a variety of measures, such as monitoring the likelihood of fires using a comprehensive weather network, clearing vegetation around utility poles and trimming trees near powerlines, replacing wood poles with steel poles in fire-prone areas, and temporarily depowering lines during extreme Santa Ana wind events (SDG&E 2013). As a result of SDG&E's management of powerline ignition risks, the Fire Ignition Reduction Plan can focus on other causes of wildfire ignitions.

A majority of fires in San Diego County are also started near roads (Syphard and Keeley 2015) and the Fire Ignition Reduction Plan should identify and prioritize areas to reduce roadside ignitions with actions like strategic road hardening, flashy fuel management, and public education and outreach. Ignitions are also greatest in WUIs with intermediate levels of development (Syphard, Clarke, et al.; Syphard, Radeloff, et al. 2007; Price and Bradstock 2014). The plan should also provide recommendations for reducing fire ignitions from target shooting. BLM recently identified recreational shooters using steel shot as an ignition source that could be managed during periods of high fire danger and through outreach and education to reduce accidental ignitions (see Rochester and Fisher 2014). The plan should also include provisions to increase efforts at public outreach and education about wildfire prevention and the importance of defensible space to reduce ignitions and spot fires within residential areas in the WUI.

The Fire Ignition Reduction Plan should also include specifics on developing a volunteer Fire Watch Program modeled after Orange County Fire Watch (OC Fire Watch 2016) to reduce human-caused wildfires. This program sends highly trained volunteers to specific locations with highest probabilities of ignition during periods of high fire danger. These volunteers serve as visual deterrents, report dangerous or suspicious activities to authorities, and assist with early detection and reporting of ignitions. The plan should also include specific ignition reduction measures for at-risk MSP species, as described in species-specific goals and objectives (use links found in Table V2B.1-4). Upon completion of the Fire Ignition Reduction Plan, ignition management actions should be implemented over time, starting with highest-priority actions.

Pre-Fire Objectives: Prepare a Guidebook for Preserve Fire Management Plans

Within the MSPA, there is a need to plan for fires at the preserve level and to integrate this planning into the existing fire management system. Marine Corps Installations (MCI) – West Camp Pendleton has identified the following steps of fire management planning: (1) identify resources at risk, (2) gather data, (3) prioritize those risks, and (4) develop an action plan to protect resources (see Rochester and Fisher 2014). It is important for land owners and managers to coordinate with their responding fire management agencies to develop Preserve Fire Management Plans that determine specific pre-fire, suppression, and post-fire management actions. As part of fire planning, it is critical to acknowledge that, while efforts will be made to avoid impacts to biological resources during fire suppression, the most important priority during extreme fire conditions is human safety and it takes precedence when there is a conflict between protecting natural resources and protecting human life and property (see Rochester and Fisher 2014)

A guidebook with guidelines for developing Preserve Fire Management Plans should be developed collaboratively with input from land owners, land managers, fire management agencies, scientists, and other relevant stakeholders. The purpose of the guidebook is to provide fire and natural resource management recommendations and to ensure plans are consistent with one another in terms of the type of information provided, formatting, symbology, and terminology. This will help reduce confusion when a fire is being suppressed across multiple preserves and by several fire management agencies, including those from out of the area and unfamiliar with the preserves. An inventory should be made of existing Preserve Fire Management Plans and these plans should be evaluated to determine what types of information to include in the guidebook. The guidebook should include recommendations for pre-fire fire risk reduction and post-fire monitoring and rehabilitation of conserved species and vegetation communities. The Santa Monica Mountains National Recreation Area has a fire plan that could also serve as a model in developing the guidebook (NPS 2012).

The guidebook for Preserve Fire Management Plans should include recommendations for identifying pre-approved fire suppression staging areas, identify what suppression actions are appropriate, and identify the type of areas to

Table V2B.1-4. MSP plant and animal species with specific altered fire regime management and monitoring objectives.

Scientific Name	Common Name	Management Category	Goals Objectives Actions Page Link
Acanthomintha ilicifolia	San Diego thorn-mint	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=32426&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Baccharis vanessae	Encinitas baccharis	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=183764&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Bloomeria clevelandii	San Diego goldenstar	SS	https://portal.sdmmp.com/tracker.php?Target=species&Species=509575&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Clinopodium chandleri	San Miguel savory	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=565077&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Cylindropuntia californica var. californica	Snake cholla	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=913470&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Deinandra conjugens	Otay tarplant	SS	https://portal.sdmmp.com/tracker.php?Target=species&Species=780273&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Dudleya variegata	Variegated dudleya	SS	https://portal.sdmmp.com/tracker.php?Target=species&Species=502182&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Ericameria palmeri ssp. palmeri	Palmer's goldenbush	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=527914&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Euphorbia misera	Cliff spurge	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=28104&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Ferocactus viridescens	San Diego barrel cactus	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=19801&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit

Scientific Name	Common Name	Management Category	Goals Objectives Actions Page Link
Fremontodendron mexicanum	Mexican flannelbush	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=21581&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Hazardia orcuttii	Orcutt's hazardia	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=502882&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Lepechinia cardiophylla	Heart-leaved pitcher sage	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=32553&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Monardella stoneana	Jennifer's monardella	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=832834&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Monardella viminea	Willowy monardella	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=833060&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Nolina cismontana	Chaparral nolina	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=507567&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Nolina interrata	Dehesa nolina	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=42992&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Packera ganderi	Gander's ragwort	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=565357&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Quercus engelmannii	Engelmann Oak	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=19329&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Euphydryas editha quino	Quino checkerspot butterfly	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=779299&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit

Scientific Name	Common Name	Management Category	Goals Objectives Actions Page Link
Euphyes vestris harbisoni	Harbison's dunn skipper	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=707282&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Lycaena hermes	Hermes copper	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=777791&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Anaxyrus californicus	Arroyo toad	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=773514&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Emys pallida	Southwestern pond turtle	SL	https://portal.sdmmp.com/tracker.php?Target=species&Species=668677&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Phrynosoma blainvillii	Blainville's horned lizard	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=208819&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Aquila chrysaetos canadensis	Golden eagle	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=175408&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Campylorhynchus brunneicapillus sandiegensis	Coastal cactus wren	SO	https://portal.sdmmp.com/tracker.php?Target=species&Species=917698&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit
Polioptila californica californica	Coastal California gnatcatcher	VF	https://portal.sdmmp.com/tracker.php?Target=species&Species=925072&MonMgtObjType=&ActionStatus=&ManagementUnit=&ObjectiveType=&Year=&Preserve=&Short=Long&submit=Submit

avoid or minimize fire suppression activities to protect sensitive natural resources. It should provide examples of how to evaluate sensitive resources in relation to wildfire risk and to the potential impacts from fire suppression activities. For some resources, it may be best to provide no fire management and let the resource burn as impacts from suppression are sometimes greater than impacts from fire. For other species, it may be most beneficial to employ fire suppression actions to keep the fire from burning the resource.

The guidebook should provide recommendations on pre-fire management actions, such as ignition risk reduction and fuel management to reduce fire risk to protect natural resources. Fuel management objectives should have a goal of minimizing the introduction of invasive nonnative annual plants that can increase flashy fuels and fire ignition risk and that can expand to invade and degrade native vegetation communities. The guidebook should also include recommendations for species-specific fire management actions (see Sec. 1.5.2.2, Species-Specific Approach) and post-fire monitoring and management actions to ensure recovery of conserved species and vegetation communities.

Once the guidebook is completed, Preserve Fire Management Plans should be developed for preserves that have no plans or need to update their plans. Preserves that make up Preserve Complexes that are in proximity and share many of the same resources and fire risks may choose to develop joint Fire Management Plans to coordinate fire management across their boundaries.

Pre-Fire Objective: Integrate Resource Avoidance Area Maps into Fire Management Agency GIS Wildland Decision Support Fire Systems

The "Resource Avoidance Areas Map" from Preserve Fire Management Plans should be made available to fire management agencies in a format that is compatible with their GIS Wildland Fire Decision Support Systems and that includes standardized symbology and mapping criteria adopted by these agencies. This map could also include elements of the *Border Agency Fire Council – Natural Resource Protection Guidebook for Fire Management and Law Enforcement Officers* (BAFC 2010), which has information on property ownership, access, points of contacts, and preferred suppression guidelines for preserve lands. The maps should identify preapproved fire suppression staging areas and identify what suppression actions are appropriate for a site, and areas to avoid or minimize fire suppression activities to protect sensitive resources.

Pre-Fire Objective: Establish a Wildland Fire Resource Advisors Program (WFRAP)

Wildland Fire Resource Advisors (READs) are called in for large fires to provide information to Incident Management Team (IMT), specifically the Operations Chief and Logistics Chief, on resource protection during fire suppression (see Rochester and Fisher 2014). READs are included in the fire incident management team and provide information to the Incident Command on sensitive resources that should be protected. The READs are responsible for providing GIS layers to fire management agencies if they are not already included in GIS Wildland Fire Decision Support Systems and should also have hard copy maps available as backup. The fire agencies need to know where the sensitive resources are, what resources have priority, and what actions are most appropriate to protect these resources. READs help to reduce conflicts between fire suppression and resource protection, with the consideration that human safety is of the highest priority. The READs also coordinate with local U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW) staff regarding threatened and endangered species issues. The most important role of the READ is to provide a unified, clear message about priority resource protection during fire suppression activities. After the fire, the READs often provide guidance on rehabilitation of fire suppression impacts, such as repairing dozer lines.

Most READs belong to federal or state agencies, and in large fires multiple READs will confer and coordinate to develop a unified message on resource avoidance or mitigation measures to the IMT (Rochester and Fisher 2014). There is a need to develop and coordinate READ participation by local jurisdictions and to integrate this effort into the state and federal READ structure. A group of READs should be (a) established and trained to respond to fires on non-federal and non-state lands, (b) authorized to work across lands held by multiple land owners, and (c) integrated into existing fire response programs. Local READs should be assimilated into a team to work collaboratively with the state and federal READs on fires that cross state, federal, and locally owned lands. Local jurisdiction READs will be required to meet National Wildfire Coordination Group requirements. These include red card certification in fire training, a physical exam, and a work capacity test to ensure minimum requirements for wildland firefighter access. The local READs will also require training in fire command structure and procedures; operating procedures and constraints of the GIS support team providing maps during fires; procedures for providing GIS data and incorporating recommendations for local lands with those of the federal and state READs; and the process for delivering a simple, unified message to the IMT.

An important aspect of fire planning is communication and coordination between land owners and managers, READs, and fire management agencies (Rochester and Fisher 2014). It is important to delineate roles and responsibilities beforehand and to use the wildland fire decision support system for planning, decision making, and responding to fires (see Rochester and Fisher 2014). Meetings should be held between land managers and responding fire management personnel at least annually and more often as needed to develop working relationships and coordinate fire management (Rochester and Fisher 2014). These meetings would help to clarify roles and responsibilities; inform land managers about fire management procedures; familiarize fire agency personnel with the preserve and sensitive resources; and provide guidance on areas to avoid, staging areas for suppression efforts, and areas where firefighting activities are not constrained by sensitive resources.

It is important to increase land manager and READ participation in fire safety organizations such as the California Wildland Fire Coordination Group, in order to foster coordination with fire management personnel (Rochester and Fisher 2014). Providing opportunities to develop personal relationships and learn from one another's experiences will improve collaboration and transfer of knowledge among fire and natural resource management personnel. Wildland fire management is most successful when roles and responsibilities are clearly delineated, there is coordination and communication between all parties, and there is a management strategy based upon known capabilities (see Rochester and Fisher 2014).

Pre-Fire Objectives: Identify and implement priority pre-fire monitoring and management actions for at-risk MSP species occurrences

The MSP Roadmap has species-specific monitoring objectives that are based upon determining population status (e.g., abundance, percent area occupied, distribution, areal extent, etc.) and characterizing habitat associations, and assessing the level of threats at species occurrences. This information should be evaluated to determine which species and occurrences are most at risk from a fire, including species that do not have species-specific fire objectives. Fire risks to consider include invasion of nonnative plants from nearby source populations and accumulation of dense and dead fuels that could severely impact and potentially lead to extirpation of a species' occurrence. Monitoring data should be used to develop a map of those species occurrences most at risk from potential post-fire expansion of invasive nonnative plants. Based upon the monitoring assessment, management actions should be identified and prioritized by the degree of threat invasive plants pose to the species and to individual occurrences. The evaluation should also determine whether fuels management can effectively reduce risk to particular species occurrences vulnerable to extirpation from fires of high severity or large extent. For some MSP species, there may be occurrences where targeted fuel management is warranted to reduce fire severity, although follow-up management may be required to control invasive plants.

Following the evaluation and prioritization, management recommendations should be implemented for those species and occurrences at highest risk from fire.

Suppression Objective: Implement Wildland Fire Resource Advisor Program

During significant wildfire events on local jurisdiction lands, the WFRAP should be implemented with READs representing local jurisdictions participating on the fire incident team. These READs would work with federal and state READs to provide a unified clear message about natural resource protection priorities across land ownerships.

Post-Fire Objective: Monitor and implement post-fire management to promote recovery of at-risk MSP species and vegetation communities

Post-fire recovery of at-risk MSP species and vegetation communities should be monitored over multiple years to inform best management practices (BMPs) and to provide for adaptive management as needed. This includes 3 years of post-fire surveys of MSP species occurrences to track recovery and determine management needs. The monitoring should include mapping of MSP species occurrences, especially mapping the extent of rare plant species occurrences that occur under the canopy of shrubs and are difficult to detect. The surveys will determine if post-fire management of invasive nonnative plants is warranted. Invasive plant control should be conducted for 3 years or longer until control is achieved.

Species-Specific Approach

While wildfire causes direct impacts (i.e., mortality) to MSP species, fire can also have significant effects on their post-fire recovery, both short and long term. Many MSP species and vegetation communities are fire-adapted and may depend on fire or can readily recover following fire. However, an altered fire regime is negatively impacting many MSP species and vegetation communities. In particular, increased fire frequency, size, and intensity, in concert with invasive annual grasses and forbs, is converting native shrublands to nonnative grassland (Keeley and Brennan 2012).

General pre-fire and post-fire monitoring and management objectives described above are applicable to MSP species at risk from fire. Also, there are additional species-specific pre-fire management objectives that include implementing pre-fire ignition reduction measures for at-risk occurrences establishing nurseries to grow native cacti and selected plants for immediate post-fire habitat recovery, enhancing and establishing multiple spatially distinct occurrences for a species to reduce impacts from a single fire, and pre-planning to collect and salvage individuals during a fire event. During a fire, species measures include rescuing individuals from the direct impacts of fire. Post-fire monitoring could include studies to determine mechanisms of post-fire recovery and effects of fire on species and their habitats. Post-fire management could include invasive plant and animal control, habitat enhancement and restoration, and translocations to reestablish occurrences impacted by fire. Descriptions of fire management approach and rationale and goals, objectives, and actions for at-risk MSP species are presented in the corresponding species sections. Links to species-specific fire objectives are provided in Table V2B.1-4. Use the MSP Portal for the most updated list of species with Altered Fire Regime objectives.

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