7 Monitoring Plan

7.1 Executive Summary of Monitoring Plan

The Monitoring Plan is an important component of the Program. This Monitoring Plan requires monitoring of site conditions before, during, and after treatments or fire events to determine if Program objectives are being met, and if and how vegetation treatment methods should be refined to reach those objectives. Monitoring requirements will vary depending on the activity undertaken and the conditions in the area where the activity is to occur. Monitoring and reporting may also be required as part of the mitigation adopted with the Final EIR for the Program or any permits obtained to perform specific work activities under the Program. Individual monitoring protocols will be determined on a case-by-case basis for each project at the discretion of professional Midpen employees ~~staff~~ and/or as required by mitigation. Midpen currently conducts ongoing monitoring of Midpen lands to detect changes over time and establish baseline conditions for a myriad of programs and projects. Appendix F provides an overview of major monitoring areas and data collection Midpen employees use in fulfilling the responsibility of caring for a diverse mix of ecosystems across Midpen lands.

The Monitoring Plan includes the following components and sequencing:

- **Monitoring Scales and Monitoring Parameters**: The Monitoring Plan first describes scales of monitoring and the monitoring parameters that apply to the PFP, the VMP, and post-fire events. Monitoring parameters include biodiversity, habitat, fuel loads, disease presence, invasive species, animal mortality, presence of special-status species, fire intensity and severity, ignitions, water quality, soils, and weather.
- **Methods of Monitoring/Monitoring Protocols**: The Monitoring Plan also describes the monitoring methods for obtaining data to assess the condition of each monitoring parameter. The protocols are based on best practices used by adjacent or regionally based land management agencies (e.g., Federal Geographic Data Committee, National Park Service [NPS], California State Parks) and supported by published research. The protocols address aspects of current condition, trend analysis, and pre-/post-treatment monitoring.
- **Monitoring Prescriptions:** The section describes the objectives for each plan within the Program to be monitored, including identification of the desired conditions as a result of vegetation management treatments, and the monitoring objectives. Monitoring prescriptions are described for each plan or event (e.g., PFP, VMP, post-fire events), the parameters to be monitored, the methods that apply to each monitoring parameter, the monitoring scale, and timing.

- **Reporting and Adaptive Management**: The Monitoring Plan, finally, provides the specifications for reporting and the adaptive management procedures that should be employed to refine future treatments to meet Program objectives, based on monitoring results. Templates and forms to develop project-specific monitoring implementation plans and conduct annual reporting is provided in Appendix G ~~F~~.

7.2 Scales of Monitoring

7.2.1 Geographic Scales Considered for Monitoring

Monitoring the various indicators described in this Monitoring Plan is possible at multiple scales. The appropriate scale of monitoring should be determined by the information needs. Based on those needs, the geographic scale of monitoring (Section 7.2), the temporal scale of monitoring (Section 7.3), and the indicators to be monitored (Section 7.4) can be defined.

The general geographic scales of monitoring are defined in Table 7-1.

Table 7-1 Geographic Scales of Monitoring for Different Program Elements

Monitoring Unit	Description
By Natural Resource Classifications	
Individual Herbaceous Plants, Trees, Shrubs, Grasses	Individual plants, trees, and grasses that comprise a single organism of a specific taxon down to the species or infraspecific species level (subspecies or variety).
Wildlife Presence and Abundance	Identified down to the species or infraspecific species level (subspecies or variety).
Communities of Herbaceous Plants, Trees, Shrubs, Grasses	A community (or stand) of vegetation that is homogeneous in species composition and structure, and in a uniform habitat (Sawyer et al. 2009). The size of a community will vary by the vegetation type (shrubs, trees, grasses, herbaceous plants).
Animal Population	Usually a population estimate of one or more species to measure abundance pre- and post-treatment(s) and/or to measure if a treatment is having population level impacts (negative or positive).
Natural Vegetation Community	In the context of vegetation science, natural vegetation is defined as vegetation where ecological processes primarily determine species and site characteristics; that is, vegetation comprised of a largely spontaneously growing set of plant species that are shaped by both site and biotic processes (Küchler 1969, Westhoff and van der Maarel 1976). Natural vegetation forms recognizable physiognomic and floristic groupings that can be related to ecological site features (FDGC 2008). The natural vegetation hierarchy consists of eight levels, however, two levels (i.e. Alliance or Association) (FGCD 2008) are the most commonly used classification levels in California for mapping and regulatory purposes.

Monitoring Unit	Description
By Treatment Unit	
Treatment Unit (Planned)	The treatment unit is considered the continuous area contained within exterior boundaries of an intentionally planned and implemented project. This area can include both shaded and non-shaded fuelbreaks, ingress/egress routes, defensible space areas, fuel reduction areas, and other vegetation management actions. For linear features such as disclines, the treatment unit may be considered the disturbed area contained within that discline.
Disturbed Area (Unplanned)	A disturbance is an unplanned (natural) event, which can modify aboveground vegetation, belowground vegetation, soils, human built structures, and potentially topography. Disturbances can include events such as a wildland fire, landslide, flood, and high wind event (leading to windthrow). The disturbed area is considered the area contained within the exterior boundaries of the disturbance event. This area may be continuous for events such as a wildland fire, or discontinuous or patchy, for events such as windthrow. A disturbance may have measurable indirect effects outside of the immediately disturbed area. The geographic scale of monitoring for disturbances is expanded for those indicators that assess areas outside the disturbed area.
By Land Ownership or Jurisdictional Areas	
Individual OSP	An individual OSP includes the land and resources contained within the legal parcel boundaries of that OSP. For the purposes of monitoring, an OSP may be divided into subunits by vegetation type, management type, or other division, with monitoring occurring within that division.
Groups of OSPs	Groups of OSPs may be monitored for specific indicators such as vegetation or aquatic resources that cross adjacent or multiple OSP boundaries.
All OSPs	Monitoring for certain indicators such as vegetation type, vegetation cover, or water quality may occur over all OSPs.
Areas Outside of OSPs	Areas outside of OSPs that may be interest in monitoring include fuel treatments or disturbances on adjacent or nearby, non-Midpen lands or land managed, but not owned by Midpen.
County-Level Monitoring	Monitoring for certain indicators such as vegetation type, vegetation cover, or water quality may occur over entire individual counties or multiple counties as part of larger local and regional monitoring efforts.
By Hydrologic Areas	
Stream (Perennial or Intermittent)	Monitoring for certain indicators over the length of a stream.
Human-Made Watercourse (Irrigation or Drainage Ditch)	Monitoring for certain indicators over the length of an irrigation or drainage ditch.

Monitoring Unit	Description
Hydrologic Unit (HUC-various levels)	Monitoring for certain indicators over an area that identifies a hydrological feature like a river, river reach, lake, drainage basin, or catchment. Hydrologic units of varying types and scales are defined by the United States Geological Survey (https://water.usgs.gov/GIS/huc.html).
Water Body (Lakes or Ponds)	Monitoring for certain indicators in body of water, such as a lake or pond.
Watershed	Monitoring for certain indicators over the area of a watershed.
Other	
Statewide or Other Comparisons	Where available and of interest, conducting monitoring to compare with other local, county, statewide, or reference conditions may be useful to determine quantity or quality of various indicators and/or how they compare with similar indicators measured on other non-Midpen lands.

7.2.2 Temporal Scales Considered for Monitoring

Overview

Lands owned and managed by Midpen are not static. The land has been constantly changing over time under management and cultural influences that span the period of pre-European Contact to the growth of Silicon Valley as a global hub for some of the largest technology companies in existence. Understanding the influence of each of these time periods is important to understanding the conditions on the landscape today, and how these conditions will change in the future. A short summary of each of these time periods and associated vegetation conditions is provided here. This section also identifies the temporal scales of monitoring.

Summary of Historic Conditions in the Region

Understanding the historic condition of various indicators is important in understanding current conditions, trends in conditions, and how those vary from the Historic Range of Variability (HRV) of vegetation cover. For the purposes of this monitoring plan, the periods of history are defined further to align with major changes in human occupation and land use culture occurring prior to the formation of Midpen. The major historical periods include:

- **Pre-Spanish/European Contact Period (Up to 1768):** The first documented exploration of the area by Europeans is in 1769 by Gaspar de Portolá ~~DePortola~~, which is assumed to be the first contact between local indigenous persons and Europeans (Portola 1770).
- **Contact through The Mission Era (1769- ~1833):** Father Junípero ~~Junipero~~ Sera was documented as traveling with General Portola on his expedition to the region.
- **Post Mission "Ranchero Era" (~1821-1844):** Mexico gained independence from Spain in 1821. Following this independence there was an effort to remove control of the Missions from the Franciscans and distribute land to local indigenous families who lived on those lands. "Although each [indigenous] family was to receive a small allotment from the former mission lands, the few who tried to make

a living from these plots gave up after [a] few years…..Most of the missions' lands were disposed of in large grants to white Californians or recently-arrived, well-connected immigrants from Mexico. In the ten years before the missions were dismantled, the Mexican government had issued only 50 grants for large ranchos. In the dozen years after the missions were secularized, 600 new grants were made." (Library of Congress 2019). Detailed descriptions of the Mexican ranching industry can be found in Richard Henry Danas' journal "Two Years Before the Mast" of his experience along the California Coast on a two-year leather trading expedition (Dana 2009).

- **Early United States Exploration and the Gold Rush and Comstock Silver Mining Era (1844-1874):** Early exploration of California followed by the Gold Rush and Comstock Era Silver mining in Nevada brought thousands of people into the San Francisco Bay Area, creating many of the towns that became the major cities seen today.
- **Agricultural/Timber Era (1769 - ~1960s)**: Western agricultural practices arrived with the missions, and the region was an important area for food and timber production into the 20th century. The area was simultaneously growing as a technology hub with the foundation of the Ames Research Center in 1939, followed by major growth during the 1970s with the addition of companies such as Atari, Apple, and Oracle. Today, the region is known less for food production and more for being the home of many established technology companies and startups (Stuart et al. 2017).
- **Midpen Establishment (1972):** Midpen was established in 1972.
- **Since Midpen Acquisition of Individual OSPs (Varies): The** OSPs were acquired at different years. New OSP lands ~~may~~ will continue to be acquired in the future. As of 2020, Midpen has preserved nearly 65,000 acres on the peninsula.
- **Recent Past Condition (Since 1984):** 1984 is the first year that 30-meter (m) resolution LANDSAT satellite data was available. Using Google Earth Engine (See Section 7.5.1) this imagery can be processed to look at trends in cover by vegetation type from 1984 to the present.

Images that demonstrate the appearance of the landscape through each of these periods is shown in the following graphics in Figure 7-1.

Figure 7-1 Images of the Landscape at Different Historic Time Periods

Pre-Spanish/European Contact Period (Up to 1768)

Depiction of Pruristac, a Ramaytush village in what is now Pacifica in 1769.

Source: Hosa and Yamane 2019

European contact through The Mission Era (1769-~1833) and Post Mission "Ranchero Era" (~1821-1844)

Source: Deppe 1832

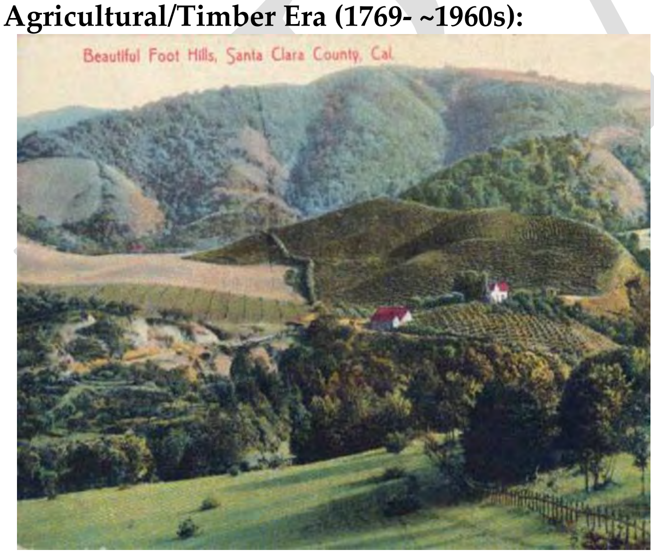
Source: Walker 1885

Early United States Exploration and the Gold Rush and Comstock Silver Mining Era (1844-1874)

San Francisco ~1850

Source: Burgess 1878

Agricultural/Timber Era (1769- ~1960s):



Santa Clara Agricultural Landscape

Source: San José Public Library nd.

San Vicente Redwoods near Davenport at the turn of the 20th century.

Source: *Environmental Science Associates 2001*

Temporal Considerations
Temporal considerations used in this Monitoring Plan are described in Table 7-2.

Table 7-2 Temporal Consideration

Time Period	Description
Historic Condition	Describes the condition of the landscape at a particular timeframe in the past.
Current Condition	Describes the condition at the time a baseline monitoring effort is started.
Changes in Condition from Historic to Present or Recent Past to Current	Includes longer term assessments of changes over time.
Changes in Condition Resulting from Planned Treatment	Includes assessments of changes before and/or after treatments, where pre-treatment baseline information is available.
Changes in Condition Resulting from Unplanned Disturbance (fire, landslide, wind throw, mortality)	Includes assessments of changes before and/or after treatments, where pre-disturbance baseline information is available.

7.3 Monitoring Parameters

7.3.1 Overview

This section describes the various monitoring parameters, the indicators that comprise each parameter, why each parameter is important, and the useful input that the parameter provides to assess Program effectiveness and overall ecosystem management and health. Some parameters are specific to certain components of the Program, or specific to a post-fire event. Methods for monitoring these parameters are presented in Section 7.4. The application of each monitoring parameter to each Program component is provided in Section 7.5.

7.3.2 Biodiversity and Wildlife Presence

This monitoring parameter includes wildlife indicator species that can be used to monitor the changes in wildlife presence and overall biodiversity resulting from planned treatments or disturbances, including positive and negative outcomes. The indicators selected for monitoring should be consistent with the scale of the treatment and desired information needs resulting from the monitoring effort.

The key indicator animals for monitoring include woodrats, badgers, avian species, butterfly species, and reptiles and amphibians, which are the most likely species to experience impacts from various vegetation treatments and that can be readily observed either directly or indirectly in the field. Indicator animals should typically be monitored for:

- Species presence and abundance (both pre-, during, and post-treatment);
- Conservation status (understand the need for special permitting or reporting); and

- Species distribution and density.

Monitoring can evaluate presence of the species through middens, droppings, nesting/denning structures, and recording of animal sightings. Existing wildlife camera arrays can also be used to collect this data or can be set up pre- and post-treatment. In some instances, monitoring can be performed through specific surveys, such as for songbirds or woodrats.

This parameter should also include any species of wildlife that begins utilizing an area after treatment or a fire event that may not have been there before or when a whole population has increased after treatments or events.

7.3.3 Wildlife Mortality

This parameter includes identifying any dead wildlife by species and potential cause of mortality, if identifiable, while monitoring areas during Program activities as well as pre- and post-treatments or events. If patterns in mortality emerge for listed species, closer examination and modification of treatment methods will be necessary.

7.3.4 Special-Status Species

Monitoring of special-status species is important by virtue of the fact that these populations are vulnerable. Potential impacts to these species often require additional permitting requirements. Special-status species include:

- Designated (rare, threatened, or endangered) and candidate species for listing by the CDFW.
- Designated (threatened or endangered) and candidate species for listing by the USFWS.
- Species considered to be rare or endangered under the conditions of Section 15380 of the CEQA Guidelines, such as those identified on lists 1A, 1B, and 2 in the 2001 Inventory of Rare and Endangered Plants of California by the CNPS.
- And possibly other species, which are considered sensitive or of special concern due to limited distribution or lack of adequate information to permit listing or rejection for state or federal status, such as those included on list 3 in the CNPS Inventory or identified as animal "California Special Concern" (CSC) species by the CDFW. Species designated as CSC have no legal protective status under the California Endangered Species Act but are of concern to the CDFW.

Special-status species should typically be monitored for:

- Species presence and abundance (both pre-, during, and post-treatment),
- Conservation status (understand the need for special permitting or reporting), and
- Species distribution and density.

Special-status species to be monitored include species such as San Francisco garter snake. Similar to other wildlife, signs and observance of species may be used, but also specific protocol surveys could be conducted, depending on the special-status species to be monitored.

7.3.5 Vegetation and Habitat, and Rare Plants

Monitoring changes in plant cover and diversity is important to understand how treatments or fire events are changing diversity and health of plant populations or of rare plant populations. Some changes may be acceptable. Monitoring can occur through botanical surveys performed before and after treatments or fire events. The indicators described below can be used to monitor the cover, condition, extent, or change in vegetation.

- **Species:** The common name, genus, species, and if applicable sub-species of the herbaceous plant, grass, shrub, or tree(s) being monitored.
- **Conservation Status:** The individual plant taxa as well as certain vegetation communities may have changing conservation status. Individual plant taxa may have been given conservation status by the federal or State Endangered Species Acts, Native Plant Protection Act, by the CNPS, the California Coastal Act, or through various CEQA Guidelines. These taxa may not only be considered rare at a statewide scale, but also locally. The CDFW also assigns conservation status to specific vegetation communities, at the alliance or association level, based on their rarity and endangerment. Midpen also treats specific natural communities as Biologically-Highly Significant.
- **Pyrophytic Plants:** Most often referred to as fire followers, these are early successional plant species that are fire adapted to the point where fire-related effects (smoke, heat, charate, etc.) are required to complete their life cycle. In some vegetation types, fire followers are short-lived on the landscape and often includes species that are considered rare, either locally or statewide. Of the vegetation types in California, fire followers are most often associated with chaparral. Various categories of these species have been defined (i.e., Native Postfire Endemics, Native Postfire Specialists, and Native Postfire Opportunities) (Keeley and Davis 2007). Most often, native plants that meet this criterion are included on county-level locally rare plants lists.

7.3.6 Soils and Erosion

Soils are the substrate for plant growth. Understanding changes to soils can help understand how treatments or fire events may affect vegetation communities and/or create indirect impacts related to erosion. The indicators described below can be used to monitor a range of soil characteristics.

- **Soil Temperature:** The temperature of soil at the surface soil or varying depths of the soil profile.
- **Soil Moisture:** The amount of water stored in the soil. The moisture content can be affected by several variables, including soil type, aspect, slope, vegetative cover, compaction, and disturbance.
- **Compaction (Bulk Density):** Bulk density is an indicator of soil compaction and is the weight of soil in a given volume. Typically, bulk density is reported in units of kilograms per meter cubed (kg/m^3).
- **Sedimentation:** See "Turbidity and Total Suspended Solids" in Section 7.4.4.

- **Infiltration:** The process by which water on the ground surface enters the soil, typically measured in inches per hour or millimeters per hour.

7.3.7 Water-Related Indicators

Impacts to water quality can have effects on plants and animals that populate an area or region. Water quality should also be monitored for the potential to impact human health and safety, and the potential for causing regulatory impairment of waters. It should be noted that some of the water-related indicators listed below may only merit monitoring under certain circumstances.

- **Stream Flow (Hydrology):** Defined as the volume of water moving past a cross-section of a stream over a set time period. Removal of foliage from woody plants and grassland vegetation decreases interception and storage capacity of the watershed along with hydrophobic soils. Reduction in soil permeability can increase runoff and stream flow (Aregai Tecle and Daniel Neary 2015).
- **Water Temperature:** The primary way fire impacts water temperature is via vegetation removal both in the surrounding watershed and in the stream corridor. The exact magnitude of increased water temperature due to fire depends on a multitude of factors, including pre-fire vegetation density, fire intensity and extent, proximity to the water body, volume of water affected, and the degree of mixing with unaffected drainages (Cilimburg, A. C., and K. C. Short 2005).
- **Dissolved Oxygen:** Defined as the amount of oxygen that is present in water. Fire can reduce dissolved oxygen in local drainages in a couple of ways. First, increased nutrients and reduced shade can increase algal blooms, depleting the supply of dissolved oxygen as they decay and are consumed by bacteria. Secondly, the amount of dissolved oxygen may also drop as a result of increased water temperatures as cold water generally holds more oxygen than warm water (as dictated by the laws of thermodynamics).
- **pH:** A measure of the acidity or alkalinity of a solution as determined from the hydrogen ion concentration.
- **Turbidity and Total Suspended Solids:** Turbidity and total suspended solids (TSS) are both used to measure particles suspended in the water column, including organic and inorganic matter. Turbidity uses light scattering as a proxy, while TSS is a direct laboratory measurement of suspended solids. Increased erosion of fine sediments, organic matter, ash, and increased algal blooms following a fire have the potential to increase these values.
- **Metals:** The concentration of total and dissolved metals in solution. The Southern California Coastal Water Research Project (2009) guidance for post-fire water quality monitoring recommends testing of Aluminum (Al), Iron (Fe), Cadmium (Cd), Copper (Cu), Lead (Pb), Manganese (Mn), Nickel (Ni), and Zinc (Zn).
- **Polyaromatic Hydrocarbons:** Organic compounds containing only carbon and hydrogen composed of multiple aromatic rings. Formed by the incomplete combustion of wood and biomass. The Southern California Coastal Water Research

Project (2009) guidance for post-fire water quality monitoring recommends testing for polyaromatic hydrocarbons as part of a successful regional monitoring program.

7.3.8 Fuel Loads

Fuel loads should be monitored to ensure that the desired final conditions of reduced loads are reached from treatments and to better understand growth patterns of fuel loads. The indicators that can be monitored under this parameter include:

- **Status of Vegetation:** Categorize if the individual vegetation specimen being monitored is alive or dead.
- **Surface Fuels:** Includes downed woody material, such as dead twigs, branches, stems, and boles of trees and shrubs that have fallen and lie on or above the ground (Brown et al 1982). These fuels are broken into the categories below and typically reported on a tons per acre basis.
  - ***1-hour fuels:*** very fine fuels (such as needles and leaves) that are easily ignited and burn quickly. Less than 0.25 inch in diameter.
  - ***10-hour fuels:*** larger, less combustible fuels (such as small branches and woody stems). These can readily carry fire when moisture is low. From 0.25 to 1.0 inch in diameter.
  - ***100-hour fuels:*** typically twig and branch material from 1.0 to 3.0 inches in diameter.
  - ***1,000-hour fuels:*** larger limbs and tree boles that are greater than 3.0 inches in diameter and classified as "sound" or "rotten".
- **Litter:** The top layer of the forest, shrubland, or grassland floor, directly above the duff layer, including freshly fallen leaves, needles, bark flakes, cone scales, fruits (including acorns and cones), dead matted grass and other vegetative parts that are little altered in structure by decomposition. Does not include twigs and larger stems (NPS 2011).
- **Duff:** The fermentation and humus layer of the forest floor material lying below the litter and above mineral soil; consisting of partially decomposed organic matter whose origins can still be visually determined, as well as the fully decomposed humus layer. Does not include the freshly cast material in the litter layer, nor in the postburn environment and ash (NPS 2011).
- **Coarse Woody Debris**: Defined as dead woody debris (limbs, trunks, or stems) detached from the originating trunk or stem. Previous definitions have included material greater than 15 centimeters (cm) in diameter and at least 1 meter in length (Stephens and Moghaddas 2005).
- **Cover**: The area or percent of a fixed area occupied by a vegetation type or species.
- **Height**: The height of an individual tree, shrub, herbaceous plant, or grass.
- **Diameter:** The tree bole diameter at a height of 4.5 feet aboveground; if on a slope, the diameter is measured at 4.5 feet aboveground on the uphill side of the tree. On shrubs, the stem diameter is measured at the stem base.

- **Canopy Cover (Foliar Cover):** The percentage of ground covered by the vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings in the canopy are included (Glossary Revision Special Committee 1989).
- **Canopy Closure:** The proportion of the sky hemisphere obscured by vegetation when viewed from a single point.
- **Density:** The number of individuals over a fixed area (per acre, per square meter).
- **Structure (Physiognomy):** For vegetation, (1) the spatial pattern of growth forms in a plant community, especially with regard to their height, abundance, or coverage within the individual layers (Gabriel and Talbot 1984), and (2) the spatial arrangement of the components of vegetation resulting from plant size and height, vertical stratification into layers, and horizontal spacing of plants (Lincoln et al, 1998, Mueller-Dombois and Ellenberg 1974).
- **Age:** The age of an individual or stand in years. Where age cannot be determined by tree rings, it may be estimated by time since past disturbance
- **Above and Belowground Carbon:** The amount of live or dead above and/or belowground carbon in a given area or per acre basis.
- **Presence or Absence by Location(s)**: The presence or absence of a target species within an area, OSP, or other fixed location.

7.3.9 Disease Presence and Invasive Species

The extent and spread of forest diseases and invasive species can greatly impact fuel loads and flammability and have negative impacts on native vegetation and ecosystem health. Monitoring of invasive species and forest disease conditions is important to understand where to focus treatments and to design effective treatments. Disease presence and invasive species parameters should also be monitored to ensure that vegetation treatments are not increasing or exacerbating existing issues or creating new problems.

In conjunction with monitoring as part of the Midpen's Integrated Pest Management Program (IPMP), monitoring of these parameters in areas of vegetation managed under the Program includes:

- Identifying the pest or diseases that are occurring and understanding the life cycle (invasive species) or mode of spread (disease)
- Determining the extent of the problem or infestation
- Evaluating the site conditions and susceptibility to invasive species or forests disease spread

7.3.10 Intensity and Severity of Fire

The indicators described below can be used to assess disturbances such as wildland fire, landslides, or flooding and should also be monitored during prescribed fire to ensure that methods to reduce intensity are effective.

- **Geographic Location and Extent:** The basic geographic location and extent (acres) of a disturbance can be used to determine several potential effects at course scale.
- **Vegetation Burn Severity:** Typically assessed as the percentage of live vegetation or live vegetation canopy cover directly killed by fire.
- **Soil Burn Severity:** The effect of a fire on ground surface characteristics, including char depth, organic matter loss, altered color and structure, and reduced infiltration. The classification of post-fire soil condition is based on fire-induced changes in physical and biological soil properties (Parsons et al. 2010).
- **Frequency:** The number of times a disturbance event happens in a given time period, both in terms of average, historical, and current frequency.

7.3.11 Ignition Sources

Understanding the source and locations of wildland fire ignitions (human, intentional, accidental, or lighting caused) is an important part of mitigating potential future ignitions. This parameter includes identifying and understanding the ignition source and where else on Midpen lands similar ignition sources are found. Understanding these areas of additional risk for wildland fire can help Midpen plan and prioritize fuel treatments that reduce risks. Quality of historical ignition sources can vary but generally human and lighting-caused ignitions since 1970 are available statewide for further analysis.

7.3.12 Weather and Fuel Moisture

The indicators described below can be used to assess weather and fuel moisture typically at multiple time scales (hourly, daily, yearly, point in time). Weather monitoring may be important to better understand when conditions could result in a higher fire threat or when planning post fire erosion control treatments, that may merit taking additional precautions and implementing high fire threat or danger procedures. Weather is also important to monitor during prescribed fires.

- **Temperature**: Air temperature, which can be expressed as a point in time measurement, hourly average, daily average, maximum, or minimum.
- **Relative Humidity:** The amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.
- **Windspeed:** The speed of wind at a selected point or over an area. Remote Access Weather Stations typically provide windspeeds at a height of 20 feet averaged over 10 minutes. Windspeeds may also be measured at point in time or lower or higher heights as appropriate.
- **Wind Direction:** The direction the wind is originating from.

- **Precipitation:** The hourly, daily, monthly, or annual amount of fog or rainfall at a given measured point or extrapolated over an area. Precipitation can be reported as a rate (inches/hour) or total.
- **Dead Fuel Moisture:** The moisture content of dead organic fuels, expressed as a percentage of the oven dry weight of the sample, that is controlled entirely by exposure to environmental conditions.
- **Live Fuel Moisture:** Fuel moisture is a measure of the amount of water in a fuel (vegetation) and is expressed as a percent of the dry weight of that specific fuel.

7.4 Methods of Monitoring and Monitoring Protocols

This section describes the methods and protocols that may be applied to monitor the parameters and indicators identified in Section 7.3. These methods and protocols are summarized in Table 7-3. The detailed methods are included in Appendix H ~~G~~. The order of methods described in the table and in Appendix H ~~G~~ generally follows the order of the parameters as presented in Section 7.3.

Prior to undertaking any of these protocols, it is essential to first identify the monitoring or research question, the appropriate time and geographic scale(s) for that question, and the indicators that may most efficiently be assessed to provide the desired information. How these monitoring methods are applied to each Program components (e.g., PFP, Vegetation Management Plan, or fire event) is provided in Section 7.5.

Table 7-3 Monitoring Methods and Protocols

Monitoring Parameter		Monitoring Methods and/or Protocols	Sources
Biodiversity and Wildlife Presence	Avian	Point Count	Ralph et al. 1993, Ralph et al 1995, Fancy et al. 2009, Coonan et al. 2011, Coonan and Dye 2016, Hall et al. 2018
		Area Search	Ralph et al. 1993, Loges et al. 2017, Stephens et al. 2010
		Regional Landbird Monitoring	NPS 2018
	Butterfly	Transect Identification	Kadlec et al. 2012
	American Badger	Trapping and radiotelemetry Camera traps and identification	Gould and Harrison 2018, Brehme et al. 2014
	Dusky-footed woodrat	Locating woodrat houses, trapping, and identification	Innes et al. 2007, Sakai and Noon 1993
	Reptile and Amphibians	Time-constrained searches Surveys of coarse woody debris Pitfall trapping	USFS 1990
	Mammals	Trail cameras	--
Wildlife Mortality	--	Mapping using GIS	--
Special-Status Wildlife Species	Numerous	Numerous	CDFW 2018, Kim et al. 2017, USFWS 2005b, Seltenrich and Pool 2002, USFWS 2003, USGS 2006a, USGS 2006b, Gorresen et al. 2008, Weller and Lee 2007, etc.
Vegetation and Habitat, Rare Plants, and Soils	Vegetation and Habitats	Vegetation (Species and Guild) Cover by Plot	Keeley and Davis 2007, Bartosh and Peterson 2014, Corelli and Bartosh 2019, Neubauer 2013, CNPS 2001
		Relevé Vegetation (Alliances and Associations) Sampling	FDGC 2008, Sawyer et al. 2009, CNPS and CDFW 2019

Monitoring Parameter		Monitoring Methods and/or Protocols	Sources
		Belt Transects for Measuring Fire Severity, Species Richness, and Vegetative (Pyrophtic) Cover	Bartosh and Peterson 2014
	Rare Plants and Communities: Rare Annual Plants	Ground or Field-Based Methods	ICF 2012
		Direct Count (Small Area of Occupancy)	--
		Simple Random Coordinate Method (Moderate Sized Area of Occupancy)	Elzinga et al. 1998
		Grid Cell Method (Large Area of Occupancy)	Elzinga et al. 1998
		Remote Sensing Method Using Multispectral Imagery Analysis (Landscape-scale Area of Occupancy)	Nomad 2017
	Rare Plants and Communities: Rare Geophyte	Geophyte Population Monitoring	Elzinga et al. 1998
	Rare Plants and Communities: Rare Herbaceous Perennial	Rhizomatous Herbaceous Perennial Monitoring	Nomad 2017
		Biennial Monitoring	Elzinga et al. 1998, Nomad 2017
	Rare Plants and Communities: Rare Shrub	Aerial Imagery Supported Monitoring	Nomad 2016
		Seedling and Stump Sprout Monitoring	Elzinga et al. 1998
	Rare Plants and Communities: Rare Tree	Seedling and Stump Sprout Monitoring	Elzinga et al. 1998
Soils and Erosion	Hydrology	Stage measurement at gaging stations	Sauer, V.B., and Turnipseed, D.P., 2010

Monitoring Parameter	Monitoring Methods and/or Protocols	Sources
	Discharge measurements at gaging stations	Turnipseed, D.P., and Sauer, V.B., 2010
	V-notch weirs	Rantz, S.E., and others. 1982
	Water Erosion Prediction Project (WEPP)	Elliot et al 2000–2002
	Models	Foltz et al 2009, USDA 2016, Kinoshita et al 2013
Soil Infiltration	Soil Hydrophobic Conditions	USDA 2016
	Single-ring infiltrometer	Herrick et al. 2005
Sedimentation	Visual indicators of erosion	Ypsilantis, W.G. 2011
	Erosion bridge	Ypsilantis, W.G. 2011
	Erosion plots	Ypsilantis, W.G. 2011
	Close-range photogrammetry	Ypsilantis, W.G. 2011
	Silt fence catchments	Robichaud, P. R. and R. E. Brown. 2002, Robichaud, P. R. 2005
	Water Erosion Prediction Project (WEPP) Erosion Risk Management Tool (ERMT)	Elliot et al. 2000–2002
	Erosion Risk Management Tool (ERMT)	Robichaud et al. 2006
Soil Temperature	Surface and Subsurface Monitoring Using Infrared Thermometer or Soil Thermometer	
Soil Moisture	Equipment	--
	Soil Moisture Active Passive (SMAP) satellite	--

Monitoring Parameter		Monitoring Methods and/or Protocols	Sources
	Compaction (Bulk Density)	Soil Core Sampler and Weighed	--
		Soil Penetrometer and Statistical Analysis	Moghaddas and Stephens 2008, Moghaddas and Stephens 2007
Water-Related Indicators		Create a water quality sampling plan	OWEB 2000
		Collect water quality data	OWEB 2000, USGS 2019, NRCS 2003 (part 614)
		Post-fire water quality monitoring	SCCWRP 2009
		Data quality, storage, and analysis	OWEB 2000, NRCS 2003 (part 615)
Fuel Loads		Ground-based or Terrestrial Light Detection and Ranging (LiDAR) Systems	-
		Photo Points Monitoring	Hall 2001
	Forest Inventory	Common Stand Exam (CSE) Protocols and Forest Visualization Simulator (FVS)	USDA 2019a, USDA 2019b
	Surface Fuel	Plot-Level Assessments	Brown 1974, Brown and Johnston 1982
	Large Woody Debris	Plot-Level Assessments	Stephens and Moghaddas 2005
	Forest Carbon	--	Climate Action Reserve 2019
Disease Presence and Invasive Species	Forest Disease	Data Review of Tree Mortality or Aerial Surveys	CAL FIRE 2018
	Invasive and Non-native Species	Early Detection Rapid Response and IPMP	Midpen 2014
Intensity and Severity of Fire	Flame Length	Cameras or Passive Flame Height Sensors	Ryan 1981, Kobziar and Moghaddas 2007
	Fire Detections	Moderate Resolution Imaging Spectroradiometer (MODIS)	NASA 2019

Monitoring Parameter		Monitoring Methods and/or Protocols	Sources
Ignition Sources		Historical Patterns	Keeley and Syphard 2018
		Historical and Recent Ignition Data	FAM 2019
Weather and Fuel Moisture	Weather	Equipment Monitoring	--
		Remote Access Weather Stations (RAWS)	Main et al. 1990, NOAA 2019a
		Windspeeds and Directions	Earth 2019, Windmap 2019
		Fire Danger	USFS 2019b, NOAA 2019b
	Fuel Moistures (Live and Dead)	Field Measurements and Satellite Imagery	USFS 2019a, USFS 2019b, NOAA 2019a

7.5 Monitoring Prescriptions

The following tables provide guidance on how monitoring parameters, and methods and protocols, are applied to each component plan of the Program as follows.

- **Table 7-4. Vegetation Management Plan – Fire Management**: The actions under the Monitoring Plan include vegetation management actions for fire management. These actions include creation and maintenance of shaded and non-shaded fuelbreaks, ingress/egress/evacuation routes, disclines, defensible space, and emergency staging areas and ~~emergency~~ landing zones.
- **Table 7-5. Vegetation Management Plan – Ecosystem Resiliency**: The actions under the Monitoring Plan includes vegetation management and the creation of fuel reduction areas for ecosystem health.
- **Table 7-6. Prescribed Fire Plan:** The Monitoring Plan includes the actions for prescribed fire. Prescribed fire is performed to reduce fuel loads in areas away from roads and structures, and to improve ecosystem health and resiliency.
- **Table 7-7. Unplanned Wildland Fire Event**: The last table is not directly correlated to a plan but describes monitoring actions following an unplanned fire event.

The tables identify how the desired conditions and the monitoring objectives should be established for each relevant monitoring parameter. The monitoring prescriptions include the scales of monitoring, method and protocol to use in monitoring when it should be used, and the timing of monitoring (i.e., before, during, or post activity). It should be noted that additional specific criteria should also be established at the time of monitoring, depending on specific activities and site conditions, and in accordance with the reporting requirements outlined in Section 7.6.

Table 7-4 Vegetation Management Plan – Fire Management Monitoring Prescriptions by Relevant Parameter

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Wildlife Presence	Creation and maintenance of VMAs will have some effects on the presence and use of the VMAs by wildlife. Woodrats may be more exposed in areas of thinner vegetation and therefore, may not nest as frequently in these areas. Ground nesting birds may experience reduced cover that could affect nesting success. The tolerance for impacts to wildlife should be established based on balancing the benefits of the VMA with potential reduced use of VMA areas by wildlife, including avian species, badgers, and woodrats.	Gather and synthesize data to allow Midpen to better understand if patterns of wildlife use and presence are affected by VMA creation and maintenance.	**Geographic:** Typically, specific to a particular managed area and specific to the treated areas within the managed areas. Monitoring across multiple managed areas and habitats to identify larger patterns would be most beneficial to understand the overall impacts of VMA creation and maintenance on wildlife presence and use of VMAs. **Temporal:** Changes in condition resulting from planned treatments.	**Avian Monitoring** can be implemented periodically or in specific testing areas. **Woodrat Assessments** may also be performed through specific surveys of VMA areas. **Trail Camera Monitoring** to understand different mammalian species' use or migration through treated areas.	Performed on a cyclical and on-going basis.
Wildlife Mortality	Direct wildlife mortality would be avoided through careful use and timing of equipment. Indirect mortality can be tracked through monitoring to determine if adaptive changes need to be made to protect wildlife.	Observe and record any mortality of wildlife during and after treatments and to identify the reason for the mortality.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Mortality data collection** to understand species killed and how it died.	During and after treatment activity.
Special-Status Wildlife and Plant Species	The tolerance for impacts to special-status wildlife and plant species is low and, generally, impacts should be avoided.	Understand the potential for presence of special-status species prior to performing treatment, ensuring that if any are present, they are not impacted during or after treatments (in accordance with permits or CEQA mitigation).	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance and in some cases Protocol Surveys** for the special-status species of concern.	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.
Habitat and Vegetation Types	Changes to vegetation composition will occur from the creation of the various types of VMAs under the Vegetation Management Plan. The desired condition established for each treatment or treatment area to be monitored should minimize loss of diversity of plant species and loss of habitat functions in the larger surrounding areas. Habitat types should remain generally the same and should not transition, except in some cases like for creation of new unshaded fuelbreaks to protect property.	Monitor the surrounding composition of vegetation before and after treatments, and to understand any changes in composition or health as a result of treatments.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance Field Surveys and Mapping** to map vegetation community-level changes and specific plant species composition changes. **Remote Sensing, Unmanned Aerial Systems (UAS), and GIS Methods for Monitoring Vegetation Condition, Distribution, and Change,** although use of these techniques would be specific to the smaller scale considerations of habitat impacts from creation of fuelbreaks, defensible space, etc.	Prior to conducting the activity and after it is completed.
Rare Plants	The tolerance for impacts to rare plants is low and, generally, impacts should be avoided.	Understand the potential for presence of rare plants prior to performing treatments, ensuring that if any are present, they are not impacted during or after treatments (in accordance with permits or CEQA mitigation).	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Ground or Field Based Methods for Monitoring Vegetation Condition, Distribution, and Change in Rare Plants**	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Soils and Erosion	The desired conditions should include minimization of soil and erosion impacts through the use of best management practices.	Verify the effectiveness of erosion control measures implemented.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Sedimentation Monitoring Methods**	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.
Fuel Loads	The desired conditions will reflect the type of fuelbreak or defensible space created and must reduce fuel loads to meet the specification of the VMA type. Desired conditions may also be established for carbon stock as a result of treatments. Generally, carbon stock losses should be neutral in VMA areas, but may take time to reach such a condition.	Understand the fuel loads before and after treatment to ensure that the specifications of the VMA are achieved and to understand the timeframe for retreatment as fuel loads regrow	**Geographic:** At the level of the activity being performed. Monitoring across multiple managed areas and habitats to identify larger patterns would be most beneficial to understand the overall impacts of VMA creation and maintenance on habitats and vegetation. **Temporal:** Changes in condition resulting from planned treatments.	**Common Stand Exam Protocols** to understand changes at a small scale. **Photo Points** **Browns Methods (Brown 1974; Brown and Johnston 1982) and ~~CDW~~ Snags and Coarse Woody Debris Methods (Stephens and Moghaddas 2005)** **Forest Carbon Inventory** to understand changes in carbon stock.	Before treatments, after treatments, and on a cyclical and on-going basis to understand trends.
Invasive Species	The desired condition should reflect control, reductions, or removal of invasive species and avoidance of expanded invasive species populations.	Understand where invasive species are found before initiating work to minimize potential for spread. To verify that work completed has not resulted in increases in invasive species over the long-term.	**Geographic:** At the level of the activity being performed if it is forested. Monitoring across multiple managed areas to identify larger patterns would be most beneficial to understand the overall impacts of VMA creation and maintenance on forest disease spread or where forest diseases are spreading. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance Field Surveys for Invasive Species** **EDRR**	Before treatments and on-going basis to understand if invasive species are spreading.
Forest Disease	The desired conditions should reflect reductions in forest diseases and restoration of diseased areas to resilient tree types.	Understand locations of forest disease to focus treatments to these areas and ensure that activities and treatments are not resulting in the spread of forest diseases.	**Geographic:** At the level of the activity being performed if it is forested. Monitoring across multiple managed areas to identify larger patterns would be most beneficial to understand the overall impacts of VMA creation and maintenance on forest disease spread or where forest diseases are spreading. **Temporal:** Changes in condition resulting from planned treatments.	**Tree mortality maps available via the California Tree Mortality Task Force** **Unmanned Aerial Vehicle (UAV) Monitoring of smaller areas (<250 acres)**	Cyclical and on-going basis to understand trends in disease spread at a larger scale.

Table 7-5 Vegetation Management Plan – Ecosystem Resiliency Monitoring Prescriptions by Relevant Parameter

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Wildlife Presence	Creation and maintenance of FRAs could have some effects on the presence and use of these areas by wildlife, but impacts are expected to be minor. FRAs include reducing fuel loads, but to a lesser degree than is performed to create other types of VMAs.	Gather and synthesize data to allow Midpen to better understand if patterns of wildlife use and presence are affected by FRA creation and maintenance.	**Geographic:** Typically, specific to a particular managed area and specific to the treated areas within the managed areas. Monitoring across multiple managed areas and habitats to identify larger patterns would be most beneficial to understand the overall impacts of FRA creation and maintenance on wildlife presence. **Temporal:** Changes in condition resulting from planned treatments.	**Avian Monitoring** can be implemented periodically or in specific testing areas. **Woodrat Assessments** may also be performed through specific surveys of VMA areas. **Trail Camera Monitoring** to understand different mammalian species' use or migration through treated areas.	Performed on a cyclical and on-going basis.
Wildlife Mortality	Direct wildlife mortality would be avoided through careful use and timing of equipment. Indirect mortality can be tracked through monitoring to determine if adaptive changes need to be made to protect wildlife.	Observe and record any mortality of wildlife during and after treatments and to identify the reason for the mortality.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Mortality data collection** to understand species killed and how it died.	During and after treatment activity.
Special-Status Wildlife and Plant Species	The tolerance for impacts to special-status wildlife and plant species is low and, generally, impacts should be avoided.	Understand the potential for presence of special-status species prior to performing treatment, ensuring that if any are present, they are not impacted during or after treatments (in accordance with permits or CEQA mitigation).	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance and in some cases Protocol Surveys** for the special-status species of concern.	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.
Habitat and Vegetation Types	Changes to broader surrounding vegetation composition are not anticipated with the creation of FRAs. Habitat types should remain generally the same and should not transition.	Monitor the composition of surrounding vegetation before and after treatments, and to understand any changes in composition or health as a result of treatments.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance Field Surveys and Mapping** to map vegetation community-level changes and specific plant species composition changes. **Remote Sensing, ~~Unmanned Aerial Systems (UAS)~~, and GIS Methods for Monitoring Vegetation Condition, Distribution, and Change,** although use of these techniques would be specific to the smaller scale considerations of habitat impacts from creation of fuelbreaks, defensible space, etc.	Prior to conducting the activity and after it is completed.
Rare Plants	The tolerance for impacts to rare plants is low and, generally, impacts should be avoided.	Understand the potential for presence of rare plants prior to performing treatments, ensuring that if any are present, they are not impacted during or after treatments (in accordance with permits or CEQA mitigation).	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments	**Ground or Field Based Methods for Monitoring Vegetation Condition, Distribution, and Change in Rare Plants**	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Fuel Loads	The desired conditions reflect a reduced fuel load, reduced forest disease, and reduced invasive species. Desired conditions may also be established for carbon stock as a result of treatments. Generally, carbon stock losses should be neutral in VMA areas, but may take time to reach such a condition.	Understand the fuel loads before and after treatment to ensure that the specifications of the FRA are achieved and to understand the timeframe for retreatment as fuel loads regrow.	**Geographic:** At the level of the activity being performed. Monitoring across multiple managed areas and habitats to identify larger patterns would be most beneficial to understand the overall impacts of FRA creation and maintenance on habitats and vegetation. **Temporal:** Changes in condition resulting from planned treatments.	**Common Stand Exam Protocols** to understand changes at a small scale. **Photo Points** **Brown Method (Brown 1974; Brown and Johnston 1982) and Snags and Coarse Woody Debris Method (Stephens and Moghaddas 2005)** ~~**Browns Methods and CDW Methods**~~ **Forest Carbon Inventory** to understand changes in carbon stock.	Before treatments, after treatments, and on a cyclical and on-going basis to understand trends.
Invasive Species	The desired condition should reflect control, reductions, or removal of invasive species and avoidance of expanded invasive species populations.	Understand where invasive species are found before initiating work to minimize potential for spread. To verify that work completed has not resulted in increases in invasive species over the long-term.	**Geographic:** At the level of the activity being performed if it is forested. Monitoring across multiple managed areas to identify larger patterns would be most beneficial to understand the overall impacts of FRA creation and maintenance on forest disease spread or where forest diseases are spreading. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance Field Surveys for Invasive Species** **EDRR**	Before treatments and on-going basis to understand if invasive species are spreading.
Forest Disease	The desired conditions should reflect reductions in forest diseases and restoration of diseased areas to resilient tree types.	Understand locations of forest disease to focus treatments to these areas and ensure that activities and treatments are not resulting in spread of forest diseases.	**Geographic:** At the level of the activity being performed if it is forested. Monitoring across multiple managed areas to identify larger patterns would be most beneficial to understand the overall impacts of VMA creation and maintenance on forest disease spread or where forest diseases are spreading. **Temporal:** Changes in condition resulting from planned treatments.	**Tree mortality maps available via the California Tree Mortality Task Force** **UAV Monitoring of smaller areas (<250 acres)**	On-going basis to understand trends in disease spread at a larger scale.

Table 7-6 Prescribed Fire Plan – Monitoring Prescriptions by Relevant Parameter

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Wildlife Presence	Prescribed fire could have some effects on the presence and use of these areas by wildlife. Areas subject to prescribed fire are expected to experience some changes in forage and cover, and some changes in usage patterns by wildlife is expected in the short term. Over the long-term usage of these areas by wildlife should increase with improvements in ecosystem health through the use of prescribed fire.	Gather and synthesize data to allow Midpen to better understand if patterns of wildlife use and presence are affected positively or negatively by areas where prescribed fire is used and to understand the duration of impacts.	**Geographic:** Typically, specific to a particular managed area and specific to the treated areas within the managed areas. Monitoring across multiple managed areas and habitats to identify larger patterns would be most beneficial to understand the overall impacts of prescribed fire on wildlife presence. **Temporal:** Changes in condition resulting from planned treatments.	**Avian Monitoring** can be implemented periodically or in specific testing areas. **Woodrat Assessments** may also be performed through specific surveys of treated areas. **Trail Camera Monitoring** to understand different mammalian species' use or migration through treated areas.	Performed on a cyclical and on-going basis.
Wildlife Mortality	Direct wildlife mortality would be avoided through careful use and timing of equipment. Indirect mortality can be tracked through monitoring to determine if adaptive changes need to be made to protect wildlife.	Observe and record any mortality of wildlife during and following prescribed fire treatments and to identify the reason for the mortality.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Mortality data collection** to understand species killed and how it died.	During treatment activity.
Special-Status Wildlife Species	The tolerance for impacts to special-status wildlife species is low and, generally, impacts should be avoided.	Understand the potential for presence of special-status species prior to performing treatment, ensuring that if any are present, they are not impacted during or after prescribed fire treatments (in accordance with permits or CEQA mitigation).	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance and in some cases Protocol Surveys** for the special-status species of concern.	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.
Vegetation and Habitat Types	Changes to vegetation densities are expected from prescribed fire and should be positive over a longer period by reducing invasive species, increasing the health of native species, and supporting the re-emergence of fire-dependent native species and rare plants.	Monitor the composition of vegetation before and after treatments, and to understand any changes in composition or health as a result of prescribed fire.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments	**Habitat Reconnaissance Field Surveys and Mapping** to map vegetation community-level changes and specific plant species composition changes. **Remote Sensing, ~~Unmanned Aerial Systems (UAS),~~ and GIS Methods for Monitoring Vegetation Condition, Distribution, and Change,** for larger-scale areas in particular. **Aerial LiDAR**	Prior to conducting the activity and after it is completed.

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Rare Plants	Impacts to some rare plants is expected to be positive, but others may have low tolerance for fire and impacts to these species should be avoided.	Understand the potential for presence of rare plants prior to performing a prescribed fire, ensuring that if any are present, they are not impacted during or after treatments (in accordance with permits or CEQA mitigation). Another component of monitoring of rare plants is to understand how prescribed fire may improve populations of fire-following species.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments	**Ground or Field Based Methods for Monitoring Vegetation Condition, Distribution, and Change in Rare Plants**	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.
Soils and Erosion	The desired conditions should include minimization of soil and erosion impacts from prescribed fire, through the use of best management practices, pre-treatments, and planning.	Verify the effectiveness of erosion control measures implemented and to determine if additional measures need to be taken to reduce erosion.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments	**Sedimentation Monitoring Methods**	Prior to conducting the activity, while the activity is being conducted, and after the activity is completed.
Water Quality	The desired condition is to have minimal impacts on water quality after prescribed fire.	Ensure that downstream waterways are not impacted by prescribed fire, including for various constituents that could impact water quality or public health.	**Geographic:** At the level of the activity being performed. **Temporal:** Changes in condition resulting from planned treatments	**Water Quality Sampling Methods**	Cyclical or on-going basis, only if other indicators suggest impacts to water quality downstream of a prescribed fire has occurred.
Fuel Loads	The desired conditions reflect a reduced fuel load, reduced forest disease, and reduced invasive species. Desired conditions may also be established for an expanded carbon stock as a result of prescribed fire.	Understand the fuel loads before and after treatment to evaluate the effectiveness of the prescribed fire. To understand the treatment interval needed to maintain desired conditions.	**Geographic:** At the level of the activity being performed. Monitoring across multiple managed areas and habitats to identify larger patterns would be most beneficial to understand the overall benefits of prescribed fire. **Temporal:** Changes in condition resulting from planned treatments but potentially also as compared with historic conditions.	**Common Stand Exam Protocols** to understand changes at a small scale. **Photo Points** **Forest Carbon Inventory** to understand changes in carbon stock. **Plot Level Vegetation Monitoring Using Terrestrial LiDAR Systems** **Common Stand Exam Protocols**	Before treatments and on a cyclical and on-going basis to understand fuel loads.

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Invasive Species	The desired condition should reflect reductions in invasive species through prescribed fire.	Understand where invasive species are found before initiating work to minimize potential for spread. To verify that the prescribed fire has not resulted in increases in invasive species over the long-term.	**Geographic:** At the level of the activity being performed if it is forested. Monitoring across multiple managed areas to identify larger patterns would be most beneficial to understand the overall impacts of prescribed burning on forest disease spread or where forest diseases are spreading. **Temporal:** Changes in condition resulting from planned treatments.	**Habitat Reconnaissance Field Surveys for Invasive Species** **EDRR**	Before treatments and on-going basis to understand if invasive species are spreading.
Forest Disease	The desired conditions should reflect reductions in forest diseases, where possible.	Understand locations of forest disease in general and how disease may be reduced through prescribed fire.	**Geographic:** At the level of the activity being performed if it is forested. Monitoring across multiple OSPs to identify larger patterns would be most beneficial to understand the overall impacts of prescribed fire on forest disease. **Temporal:** Changes in condition resulting from planned treatments.	**Tree mortality maps available via the California Tree Mortality Task Force** **UAV Monitoring of smaller areas (<250 acres)**	Cyclical and on-going basis to understand trends in disease spread at a larger scale.
Intensity and Severity of Fire	The desired condition is a controlled fire with lower intensity. Use of pre-treatments, firelines, and planning should reduce intensity of prescribed fire.	Understand and adapt in the field to prevent a fire from escaping or burning out of control.	**Geographic:** At the level of the activity being performed. **Temporal:** During event.	**Fire Severity can be monitoring using the Relative Differenced Normalized Burn Ratio (RdNBR)** **Fire intensity (flame length) can be measured using stationary cameras, passive flame height sensors, and field observations during wildland fires or prescribed fires**	During treatment activity.
Weather and Fuel Moisture	The desired condition is to only perform a prescribed fire during the appropriate weather conditions	Ensure that weather conditions are appropriate to prevent a fire from escaping or burning out of control.	**Geographic:** At the level of the activity being performed. **Temporal:** During event.	**Point in Time Measures of Weather Indicators** **Fuel Moistures (Live and Dead)** **~~Remote Access Weather Stations~~ (RAWS)** **Fire Weather Forecast** **Fire Danger and Related Metrics** **Windmap**	Before and during treatment activity.

Table 7-7 Unplanned Wildland Fire Event – Monitoring Prescriptions by Relevant Parameter

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Wildlife Presence	N/A	Understand how wildlife use burned areas.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Reconnaissance Surveys for Wildlife** **Trail Camera Monitoring** to understand different mammalian species' use or migration through treated areas.	Cyclical and on-going basis.
Wildlife Mortality	N/A	Identify the extent of wildlife mortality.	**Geographic:** In the area of the wildland fire, if forested. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Mortality data collection** to understand species/individuals killed.	After the wildland fire event.
Special-Status Wildlife Species	N/A	Understand the degree of impacts to special-status wildlife habitat or individuals.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Habitat Reconnaissance and in some cases Protocol Surveys** for the special-status species of concern.	After the wildland fire event and potentially on an on-going and cyclical basis as part of recovery efforts.
Habitat and Vegetation Types	N/A	Identify the degree of impacts to habitat and vegetation.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Habitat Reconnaissance Field Surveys and Mapping** to map vegetation community-level changes and specific plant species composition changes. **Remote Sensing, ~~Unmanned Aerial Systems (UAS)~~, and GIS Methods for Monitoring Vegetation Condition, Distribution, and Change,** for larger-scale areas in particular. **Aerial LiDAR**	After the wildland fire event.
Rare Plants	N/A	Understand how the wildland fire may improve populations of fire-following species.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Ground or Field Based Methods for Monitoring Vegetation Condition, Distribution, and Change in Rare Plants**	After the wildland fire event and potentially on an on-going and cyclical basis as part of recovery efforts.
Soils and Erosion	To reduce erosion after a wildland fire event, where possible.	Understand the potential cause and extent of erosion, to put in place erosion control measures, if feasible.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Sedimentation Monitoring Methods**	After the wildland fire event.

Parameter/Indicator	Considerations for Establishing Desired Conditions	Monitoring Objectives	Scale of Monitoring	Method/Protocol	Timing of Monitoring
Water Quality	To reduce impacts on water quality after a wildland fire event, where possible.	Understand impacts on water quality and take actions, as feasible, to reduce any impacts detected.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**Water Quality Sampling Methods**	After the wildland fire event.
Invasive Species	To prevent spread of invasive species after a wildland fire event, where possible.	Monitor recovery in burned areas to ensure that invasive species do not take hold and spread.	**Geographic:** The area of the wildland fire. **Temporal:** Changes in Condition Resulting from Unplanned Disturbance.	**EDRR**	After the wildland fire event.
Forest Disease	N/A	Understand locations of forest disease in general and how disease may spread or reduce as a result of wildland fire.	**Geographic:** The area of wildland fire impact, if forested. **Temporal:** Changes in condition resulting from planned treatments.	**Tree mortality maps available via the California Tree Mortality Task Force** **UAV Monitoring of smaller areas (<250 acres)**	Cyclical and on-going basis to understand trends in disease spread at a larger scale.
Ignition	To reduce the likelihood of a future fire elsewhere form a similar ignition source.	Understand the source of ignition.	**Geographic:** In the area of wildland fire. **Temporal:** N/A	**Investigative Methods**	After the wildland fire event.
Intensity and Severity of Fire	N/A	Understand the extent of impacts from the intensity of the wildland fire.	**Geographic:** In the area of wildland fire. **Temporal:** N/A	**Fire Severity can be monitoring using the ~~Relative Differenced Normalized Burn Ratio (RdNBR)~~** **Fire intensity (flame length)** can be measured using stationary cameras, passive flame height sensors, and field observations during wildland fires or prescribed fires	After the wildland fire event and on a cyclical and on-going basis to reduce risks of similar ignitions in other areas.
Weather and Fuel Moisture	N/A	Understand how weather affected the fire behavior.	**Geographic:** In the area of wildland fire. **Temporal:** N/A	**Point in Time Measures of Weather Indicators** **Fuel Moistures (Live and Dead)** **~~Remote Access Weather Stations (RAWS)~~** **Fire Weather Forecast** **Fire Danger and Related Metrics** **Windmap**	After an event and on an on-going and cyclical basis.

7.6 Reporting and Adaptive Management

7.6.1 Development of Monitoring Plans for Each Project/Activity

This Monitoring Plan identifies the tools needed to create a specific monitoring plan for each project or activity undertaken, as well as to define on-going and cyclical monitoring activities that will help Midpen better understand the wildland fire risks and ecosystem health of the OSPs on a larger scale. Monitoring results will be used to understand the effectiveness of the activities undertaken across multiple parameters and to refine the activities to achieve the desired conditions.

Table 7-4 through Table 7-7 should be utilized to develop an individual monitoring plan for each project or activity. Forms and templates are provided in Appendix G ~~F~~ to streamline the process for developing these monitoring plans. The individual monitoring plan should address the species, habitats, methods, and protocols specific to the area where the monitoring is to occur. The monitoring plans should also address the qualifications of the required monitors.

7.6.2 Results Reporting

Reporting will be performed ~~on a project-by-project basis and also~~ in an Annual Monitoring Report to the Board and on a project-by-project basis for larger scale projects. Individual reports should be prepared after ~~each project~~ for larger scale projects and/or activities that are completed ~~activity is complete~~. The Annual Monitoring Report will be a synthesis of all vegetation management activities ~~individual monitoring reports~~ over the calendar year, fire event monitoring (if occurred), and reporting on larger-scale, on-going, or cyclical monitoring. Adaptive management recommendations should be made in the Annual Monitoring Report. An Annual Monitoring Report template is provided in Appendix G ~~F~~.

7.6.3 Adaptive Management Based on Monitoring Results

The Monitoring Plan will identify areas where Midpen needs to proactively seek out information. Similarly, Midpen will need to be continually responsive to changes in laws and regulations pertaining to endangered species protections, noxious species quarantines, greenhouse gas emissions, and wildland fire treatments. Midpen also needs to conduct enough monitoring of both its natural resources and the effects of its actions to detect and respond to critical changes, optimize its activities, and ensure that overall goals are being met.

Adaptive management is comprised of the following actions:

- **Monitoring biological stressor indicators.** Recognizing that large-scale changes, such as SOD and global climate change, are occurring, Midpen will study these macro-processes to develop and adopt appropriate long-term management strategies.
- **Monitoring management activities and, if warranted, revise approaches or actions.** Through the reporting described in this Monitoring Plan, each individual

activity will include a monitoring component. The results of each monitoring effort will be described. At the individual and annual reporting phase, Midpen employees ~~staff~~ will identify whether the activities being undertaken are meeting the overall objectives of the work and will make recommendations to modify methods in the planning of future activities. For example, if monitoring identifies that erosion persists as a result of an activity, the recommendation may be to increase the erosion control efforts and/or to avoid certain areas that have systematically shown erosion problems after certain types of treatments. Another example is if monitoring shows reduced usage of certain treatment areas by woodrats, additional measures may be taken in how the treated areas are maintained or to move woodrat nests in these areas in the future.

- **Continuing to work with surrounding land management agencies and the public to foster education, research, and volunteer efforts**. Midpen has an active volunteer program, and coordinates with many partnering ~~sister~~ agencies and organizations regarding vegetation management and wildland fire risk reduction. Midpen will continue to improve regional ecosystem health and reduce wildland fire risks.
- **Utilizing new methods and technologies that increase efficiency, reduce costs, and reduce impacts on the environment from fuel management activities**. Midpen will adapt the Program over time through adoption of new methods and technologies.