

Forest Assessment

For Paradise Irrigation District (PID) Lands

Butte County, California

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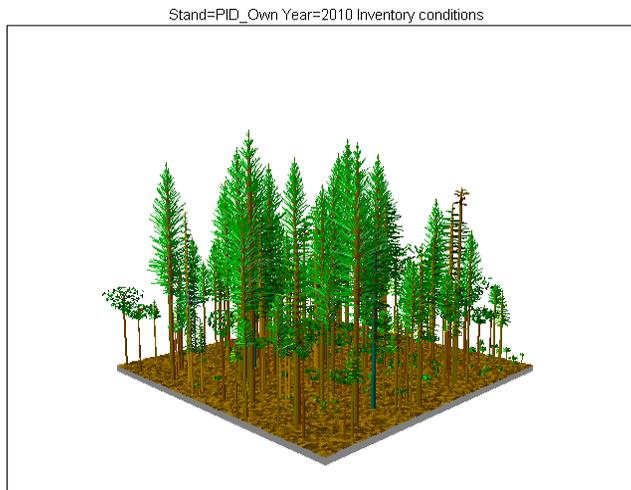
Appendix A

This appendix includes a series of projections from existing stand conditions as modeled in FVS. The red trees in the projection outputs represent tree mortality (dying) as a result of stand conditions. The captions describe what is being projected.

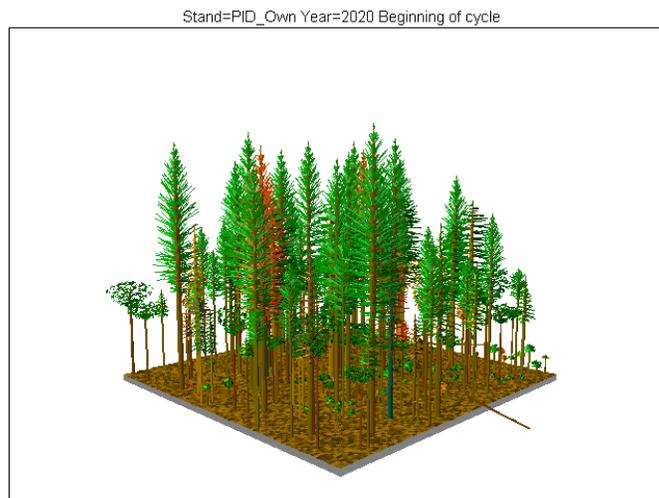
All images are direct outputs from the Stand Visualization System (SVS) component of the Forest Vegetation Simulator (FVS).

A-1 Untreated Stand Projections

SVS Image #1-2010 Stand Inventory Conditions



SVS Image #2-2020 projected conditions with no treatment



SVS Image #3-2030 projected conditions with no treatment

Stand=PID_Own Year=2030 Beginning of cycle



Image #4-2040 projected conditions with no treatment

Stand=PID_Own Year=2040 Beginning of cycle

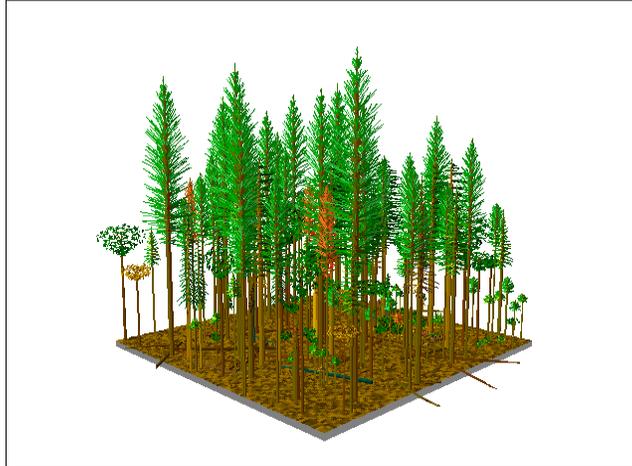


Image #5-2050 projected conditions with no treatment

Stand=PID_Own Year=2050 Beginning of cycle

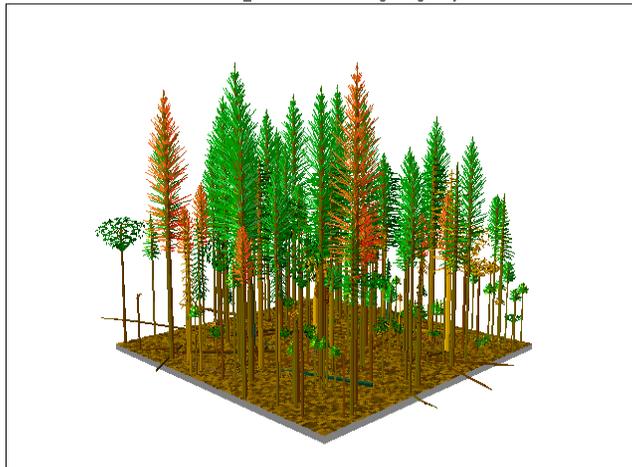
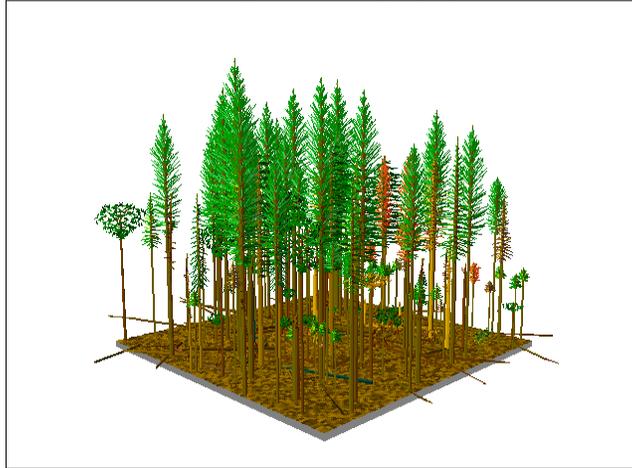


Image #6-2060 projected conditions with no treatment

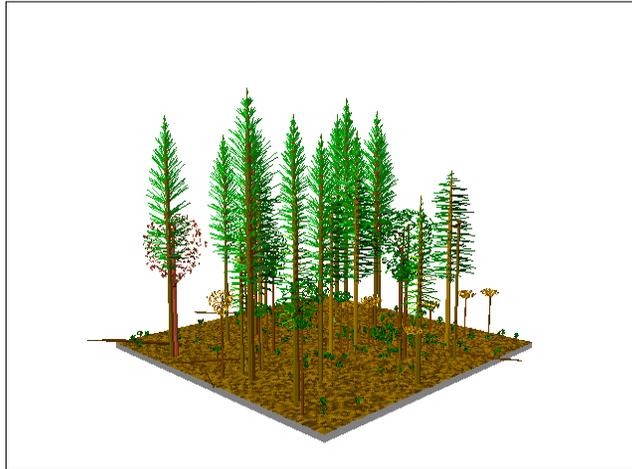
Stand=PID_Own Year=2060 Beginning of cycle



A-2 Mechanical Thinning Projections

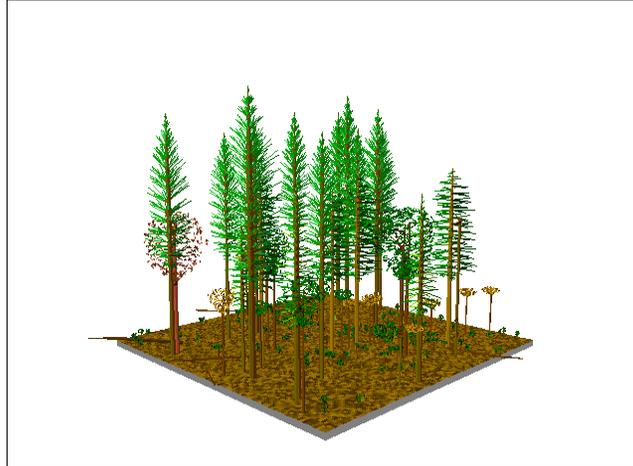
SVS Image #7-Post Treatment

Stand=PID_Own Year=2020 Beginning of cycle



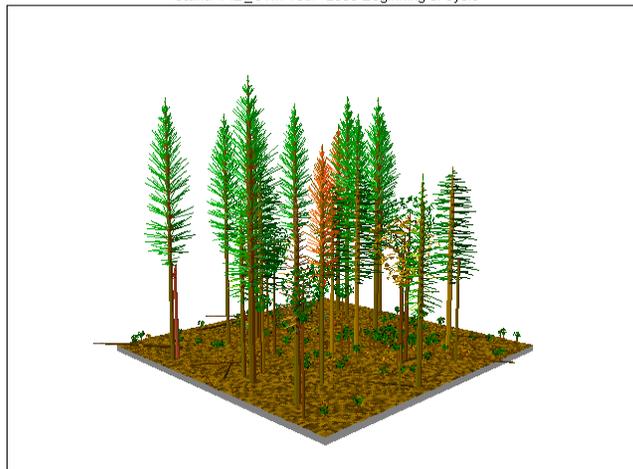
SVS Image #8-10 years later, projected project conditions post mechanical thinning

Stand=PID_Own Year=2020 Beginning of cycle



SVS Image #9-20 years later, projected project conditions post mechanical thinning.

Stand=PID_Own Year=2030 Beginning of cycle



Appendix B-Glossary

Aspect-The direction in which a slope faces (Agee 1993).

Community Fuelbreak area-a shaded fuelbreak approved by a public fire agency as part of a fire prevention plan for fire protection, ignition management, prefire management or other fire defense improvements. Within a shaded fuelbreak, vegetation is managed to reduce the potential for wildfire damage and provides a direct benefit to defensible space as defined in 14 CCR 1271. Community fuelbreak areas include defensible space areas within 200 feet of approved and legally permitted structures, as defined in 14 CCR 895.1, and those areas comprising a system of fuelbreaks that are designed or approved by a public fire agency as part of a fire prevention plan (CA Forest Practice Rules 2011).

Crown fire-A fire burning into the crowns of the vegetation, generally associated with an intense understory fire (Agee 1993).

Diameter (syn. with Diameter at Breast Height-DBH)-The diameter of a tree measured outside the bark, at breast height, a point 4.5 feet (1.37m)) above the average ground level (CA Forest Practice Rules 2011).

Dominant (s) – means trees with well-developed crowns extending above the general level of the forest canopy and receiving full light from above and partly from the sides (CA Forest Practice Rules 2011).

Domestic Water Use-the use of water in homes, resorts, motels, organization camps, developed campgrounds, including the incidental watering of domestic livestock for family sustenance or enjoyment and the irrigation of not more than one half acre in lawn, ornamental shrubbery, or gardens at any single establishment. The use of water at a developed campground or resort for human consumption, cooking or sanitary purposes is domestic water use (CA Forest Practice Rules 2011).

Effects-means effects and impacts as defined in 14 CCR 15358 (CA Forest Practice Rules 2011).

Feasible-capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social and technical factors. With regard to economic feasibility, the issue shall be whether the plan as revised could be conducted on a commercial basis within 3 years of the submission of the plan and not solely on the basis of whether extra cost is required to carry out all the alternatives (CA Forest Practice Rules 2011).

Feller-buncher- a type of [harvester](#) used in [logging](#). It is a motorized vehicle with an attachment that can rapidly cut and gather several trees before felling them. A feller buncher consists of a standard [heavy equipment](#) base with a tree-grabbing device furnished with a chain-saw, [circular saw](#) or a [shear](#) - a pinching device designed to cut small trees off at the base. The machine then places the cut tree on a stack suitable for a skidder or forwarder, or other means of transport (yarding) for further processing (e.g., [delimiting](#), bucking, loading, or chipping) There are also wheeled feller bunchers with no articulated arm. Instead this type of vehicle drives close and grabs the tree.

Falling-

Hand falling-cutting trees by use of a chainsaw.

Mechanical falling-cutting trees by use of a feller buncher or other logging tool with implements (attachments) for cutting trees.

Fire frequency-The return interval of fire (Agee 1993).

Fire regime-The combination of fire frequency, predictability, intensity, seasonality and extent characteristic of fire in an ecosystem (Agee 1993).

Fire resilient vegetation-vegetation which can recover from fire events. Recovery means that cover is retained, and plant can re-grow. This includes basal sprouting. The original individual plant recovers from burning.

Fire resistant vegetation (Fire resistance)-vegetation which can resist damage from burning during fire events.

Fire severity-The effect of fire on plants. For trees, severity is often measured as percentage of basal area removed (Agee 1993).

Functional Wildlife Habitat-vegetative structure and composition which function to provide essential characteristics for wildlife feeding, reproduction, cover and movement between habitats. The habitat components must be in sufficient quantities and arrangements to support the diverse assemblage of wildlife species that are normally found on or use forestlands within that area. Within this definition the following terms mean:

Function(al): Refers to ecological relationships between both the habitat components and needs of the species which allows for the normal life cycle including, migration corridors, genetic pathways, food availability, temperature protection, moisture retention, nutrient cycling, denning, spawning, nesting, and other functions necessary to complete a life cycle.

Composition: Refers to the types, abundance, distribution, and ecological relationships of species of terrestrial and aquatic vegetation within the forest stand including dominance, richness, trophic levels and other population and community features at levels which affect the long-term survival of individual forest species.

Structure: Refers to the physical arrangement of and relationships between living and non-living terrestrial and aquatic components within the forest stand including, age, size, height and spacing of live vegetation in the forest in addition to seeps, spawning gravels, pools, springs, snags, logs, den trees, meadows, canopy coverage, levels of canopies and other physical features necessary to allow species to function (CA Forest Practice Rules 2011).

Harvesting Method-the process used to cut and remove timber. It may have as its' silvicultural objective either stand regeneration or intermediate treatments (CA Forest Practice Rules 2011).

Historic Road-an existing road, including associated landings and watercourse crossing, that is not part of the permanent road network and that has not been maintained or proactively abandoned (CA Forest Practice Rules 2011).

Intermediate Treatments-harvests conducted to modify or guide the development of an existing stand of trees, but not to replace (regenerate) the stand with a new one. The treatments involve the removal of trees to allow expansion of the crowns and root systems (CA Forest Practice Rules 2011).

Intermediates-trees with crowns below the general level of the forest canopy and receiving little light from either above or the sides. Intermediates have minimally-developed crowns and are crowded on the sides (CA Forest Practice Rules 2011).

Ladder fuels-means vegetative fuels that can spread a fire vertically between or within a fuel type (CA Forest Practice Rules 2011).

Lake-a permanent natural body of water of any size, or an artificially impounded body of water having a surface area of at least one acre, isolated from the sea and having an area of open water of sufficient depth and permanency to prevent complete coverage by rooted aquatic plants (CA Forest Practice Rules 2011).

Landing-that area where forest products are concentrated prior to loading for transportation to market (CA Forest Practice Rules 2011).

Late Succession Forest Stands-stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (CA Forest Practice Rules 2011).

Listed Species-a plant or animal species which is listed as rare, threatened or endangered under federal or state law, or a sensitive species by the Board (CA Forest Practice Rules 2011).

Long Term Significant Adverse Affect-on fish, wildlife, or listed species known to be primarily associated with late succession forest stands means an effect that creates an identifiable trend or set of conditions which provide a substantial level of scientific evidence that a population of one or more species of fish, wildlife, or listed species primarily associated with late succession forest stands will become extirpated from a significant portion of its current range in the Forest District within the planning horizon (CA Forest Practice Rules 2011).

Lopping-Severing and spreading of slash so that no part of it remains more than 30 in' above the ground (Ref. Sect. 4551.5 PRC) (CA Forest Practice Rules 2011).

Lopping for Fire Hazard Reduction severing and spreading slash so that no part of it generally remains more than 30 inches above the ground except where a specific rule provides another standard.

Manmade Watercourse-a watercourse which is constructed and maintained to facilitate man's use of water and includes, but is not limited to, ditches and canals used for domestic, hydropower, irrigation, and other beneficial uses (manmade watercourses as defined do not include roadside drainage ditches) (CA Forest Practice Rules 2011).

Meadows and wet areas-those areas which are moist on the surface throughout most of the year and/or support aquatic vegetation, grasses and forbs as their principal vegetative cover (Ref. Sec. 4563.7, PRC) (CA Forest Practice Rules 2011).

Native Americans-A person indigenous to the area. For this assessment the Concow Band of the Mountain Maidu, perhaps others. Further research needed.

Overstory-that portion of the trees, in a forest of more than one story, forming the upper canopy layers (CA Forest Practice Rules 2011).

Plant community-An assemblage of plant species that occur widely enough across the landscape to be recognized as a unit. This assemblage can be a pioneer group of species, a late successional group, or a combination of both (Agee 1993).

Predominant trees-those whose crowns are above the general level of the canopy and are significantly older than the surrounding stand (CA Forest Practice Rules 2011).

Prescribed fire-A fire ignited under known conditions of fuel, weather, and topography to achieve specified objectives (Agee 1993).

Project-an activity which has the potential to cause a physical change in the environment, directly or ultimately, and that is: 1) undertaken by a public agency, or 2) undertaken with public agency support, or 3) requires the applicant to obtain a lease, permit, license, or entitlement from one or more public agencies. This includes Timber Harvesting Plans (CA Forest Practice Rules 2011).

Public fire agency-California Department of Forestry and Fire Protection, United States Forest Service, Bureau of Land Management, and other federal fire protection agencies, counties providing fire protection pursuant to PRC 4129, or city, county, or local fire agencies (CA Forest Practice Rules 2011).

Quality of Water-the level of water quality as specified by the applicable Water Quality Control Plan, including its water quality objectives, policies and prohibitions (CA Forest Practices Rules 2011).

Rate of spread-The rate at which a fire moves across the landscape, usually measured in m/sec (Agee 1993).

Registered Professional Forester-a person who holds a valid license as a professional forester pursuant to Article 3, Chapter 2, Division 1 of the Public Resources Code (CA Forest Practice Rules 2011).

Riparian-the banks and other adjacent terrestrial environs of lakes, watercourses, estuaries, and wet areas, where transported surface and subsurface freshwaters provide soil moisture to support mesic vegetation.

Riparian-Associated Species-those plant, invertebrate, amphibian, reptile, fish or terrestrial wildlife species that require utilization of riparian zones during any life history stage (CA Forest Practice Rules 2011).

Sampling area-the area delineated on a map accompanying a report of stocking showing the area sampled by one of the procedures specified in 14 CRR 1072 (CA Forest Practice Rules 2011).

Sensitive species-those species designated by the Board pursuant to 14 CCR 898.2(d). These species are the Bald eagle, Golden eagle, Great blue heron Great egret, Northern goshawk,

Osprey, Peregrine falcon, California Condor, Great gray owl, Northern spotted owl, and Marbled Murrelet (CA Forest Practice Rules 2011).

Seral-A plant species or community that will be replaced by another plant community if protected from disturbance (Agee 1993).

Sere-The product of succession: a sequence of plant communities that successively occupy and replace one another in a particular environment over time (Agee 1993).

Significant archeological or historical site- a specific location which may contain artifacts, or objects and where evidence clearly demonstrates a high probability that the site meets one or more of the following criteria

- (a) Contains information needed to answer important scientific research questions.
- (b) Has special and particular quality such as the oldest of its type or best available example of its type.
- (c) Is directly associated with a scientifically recognized important prehistoric or historic event or person.
- (d) Involves important research questions that historical research has shown can be answered only with archaeological methods
- (e) Has significant cultural or religious importance to Native Americans as defined in 14 CCR § 895.1 (CA Forest Practice Rules 2011).

Silviculture-is the theory and practice of controlling the establishment, composition and growth of forests (CA Forest Practice Rules 2011).

Skidding (syn. Tractor Yarding)-that system of transporting logs by a self-propelled vehicle, generally by a dragging the logs with a grapple or chokers (CA Forest Practice Rules 2011).

- **Snag**-a standing dead tree or a standing section thereof, regardless of species (CA Forest Practice Rules 2011).

Stand vigor-is a measure of stand health. A measure of good stand vigor is an exhibition of characteristics which include large live crowns or leaf surface area, high needle retention, pointed tops, crown dominance relative to other trees in the same age or size class, and disease-free (CA Forest Practice Rules 2011).

Stream order-a classification method based on the branching pattern of watercourses in a watershed. As watercourses of equal order meet, they combine to form a watercourse of the next higher order. A first order watercourse is defined as the smallest unbranched watercourse in the headwaters of a watershed (usually an ephemeral channel). When two first order watercourses join, they form a third order water course (CA Forest Practice Rules 2011).

Succession-The process of change in plant communities (Agee 1993).

Suppressed-(trees) are those which have their crowns in the lower layers of the canopy. They receive virtually no direct sunlight, and they are generally growing very slowly (CA Forest Practice Rules 2011).

Surface cover-the cover of litter, downed woody material (including slash, living vegetation in contact with the ground, and loose rocks (excluding rock outcrops) that resist erosion by raindrop impact and surface flow (CA Forest Practice Rules 2011).

Surface fire-A fire burning along the surface without significant movement into the understory or overstory, with flame lengths usually below 1 meter (Agee 1993).

Surface fuel-means loose surface litter on the soil surface normally consisting of fallen leaves or needles, twigs, bark, cones and small branches that have not yet decayed enough to lose their (CA Forest Practice Rules 2011).

Tractor operations-any activity which is associate with timber operations and is performed by tractors or skidders (CA Forest Practice Rules 2011).

Tractor roads-constructed trails or established paths used by tractors or other vehicles for skidding logs. Also known as ‘skid trails’ (CA Forest Practice Rules 2011).

Tractor yarding-means that system of skidding (transporting) logs by a self-propelled vehicle, generally by dragging the logs with a grapple or chokers (CA Forest Practice Rules 2011).

Understory-generally, trees and woody species growing under an overstory (CA Forest Practice Rules 2011).

Understory fire-A fire burning in the understory, more intense than a surface fire and with flame lengths of 1-3 meters (Agee 1993).

Unevenaged management-management of a specific forest, with the goal of establishing a well stocked stand of various age classes and permits the periodic harvest of individual or small groups of trees to realize the yield and continually establish a new crop (CA Forest Practice Rules 2011).

Various age classes-a stand with at least three distinct layers of tree crowns (size classes) (CA Forest Practice Rules 2011).

Vegetation protection-the term used when special measures are required to prevent damage to vegetation for the protection of water quality, the beneficial uses of water, and/or other forest resources (CA Forest Practice Rules 2011).

Water quality requirements-a water quality objective (narrative or numeric), prohibition, TMDL implementation plan, policy or other requirement contained in a water quality control plan adopted by the Regional Board and approved by the State Water Board (CA Forest Practice Rules 2011).

Watercourse-any well defined channel with distinguishable bed and bank showing evidence of having contained flowing water indicated by deposit of rock, sand, gravel, or soil, including but not limited to, streams as defined in PRC 4528(f). Watercourse also includes manmade watercourses (CA Forest Practice Rules 2011).

Watercourse and Lake Protection Zone (WLPZ)- a strip of land, along both sides of a watercourse or around the circumference of a lake or spring, where additional practices may be required for protection of the quality and beneficial uses of water, fish and riparian wildlife habitat, or other forest resources for controlling erosion (CA Forest Practice Rules 2011).

Wet meadows and other wet areas-those natural areas except cutover timberland which are moist on the surface throughout most of the year and support aquatic vegetation, grasses and forbs as their principal vegetative cover (CA Forest Practice Rules 2011).

Wildfire-A fire, naturally caused or caused by humans, that is not meeting land management objectives (Agee 1993).

Woody debris-woody material four inches and greater in diameter and no less than two feet long left on the ground as a result of timber operations (CA Forest Practice Rules 2011).

Yarding-the movement of forest products from the point of felling to a landing(CA Forest Practice Rules 2011).

Appendix C-Forest pests and diseases of concern

Forest pests and disease of concern are listed in alphabetical order, below. This is not an exhaustive list of potential diseases in the assessment area, rather it is a list of the most common and tend to do the most damage. These pests and diseases are primarily of concern when they reach levels beyond the natural range. Excessive tree densities are a cause for concern, as reduced individual tree vigor allows many pests and diseases to prosper. Forest pests and diseases are natural regulating agents and become a primary concern when they cause larger affects than are considered acceptable. Large scale die-off or mortality from forest pests or diseases can create fuels conditions that have the potential to create catastrophic wildland fire. Another cause for concern is excessive damage created by forest pests and diseases that reduces their commercial value. The species below are not inclusive of all pests or diseases that might affect the assessment area, but rather the ones listed are those that can have un-desirable effects.

This section details tree species affected that are present in the assessment area (the pests may affect species other than those listed, however only those tree species in the assessment area are listed). The management options are addressed and come directly from *Pests of the Native California Conifers* (Wood et al, 2003). Other information regarding these pests and diseases is available in that publication, as well as numerous others. This report is intended to address management options as this information will assist the Deciding Official and managers. In most cases, wording is directly from the above mentioned publication, with minor changes. The tense for this section is inconsistent with the rest of the document, and is in present tense. This is to maintain consistency with the publication from which the management options were taken, and to avoid confusion in reading.

Identification of the forest pests and disease in this section requires some training, and so field personnel implementing prescriptive management recommendations should be trained to identify specific diseases so management recommendations can be implemented.

Annosum root disease (*Heterobasidion annosum*)

Species affected: Jeffery pine, ponderosa pine, sugar pine, white fir

Significance: In California, this disease is widespread and damaging to nearly all native conifer species. Because the fungus is known to invade freshly cut stumps, spread and intensification of the disease have increased with timber harvesting and intensive forest management. Once infected, the fungus persists in the roots and the soil for many years. Pines suffer the greatest impact as enlarging centers of infection progressively kill trees or render them susceptible to insect attack, especially bark beetles. Moisture stress, insects, and, in some cases, air pollution contribute to the severity of damage caused by *H. annosum*. Firs and other species are not often killed but are weakened, decayed, and made susceptible to uprooting and attack by insects, especially bark beetles. Infected trees in high-use areas pose a hazard to life and property.

Management options: Prevention of infection and spread is the best way to manage annosum root disease of conifers, especially pines. Cut stumps would be treated with borax-based registered chemicals. Thinning of eastside pines during warm, dry periods in summer inhibits fungal growth, and consequently, tree infection. With conifer species other than pines, prevention of wounds, especially in the lower trunk, is the best way to avoid infection.

Armillaria root disease (*Armillaria mellea*)

Species affected: Jeffery pine, ponderosa pine, sugar pine, white fir, black oak

Significance: *Armillaria* root disease is an important disease of conifers in plantations. It is most often associated with sites that have been converted from hardwoods, particularly oaks. Mortality is primarily centered near infected stumps. In native stands, *Armillaria* root disease in conifers is often found near hardwoods that have died from suppression or other causes, allowing *A. mellea* to increase inoculum on the dying root systems. The fungus then spreads to infect adjacent conifers. Bark beetles may kill infected pines and firs.

Management options: Recognition of *Armillaria* in a forest is the first step to management. Practices that enhance tree vigor and reduce stress are recommended. Avoid planting on sites with extensive disease in stumps and residual trees, and plant less susceptible species such as ponderosa pine. The most susceptible species in the assessment area is white fir.

California Five-spined Ips (*Ips paraconfusus*)

Species affected: Jeffery pine, ponderosa pine, sugar pine

Significance: Multiple generations per year allow opportunity for outbreaks. At the outbreak level, this species can cause considerable tree mortality and, thus, it is an important pest in timber-producing regions. Outbreaks are usually short-lived, not lasting more than one year, although outbreaks have been known to last two to three years during periods of extreme drought. Beetle densities can increase in logging debris, leading to the infestation of nearby living trees. Trees with tops killed by *I. paraconfusus* are often subsequently killed by Western Pine Beetle, *D. brevicornis*, Mountain Pine Beetle, *D. ponderosae*, or both. The California Five-spined Ips can kill ornamental pines of very high aesthetic value, especially ponderosa pines in native stands.

Management options: Cut, lop and scatter branches from tree-tops remaining after logging. Exposure to the sun will kill broods beneath the bark. Chip or burn logging debris, or pile it beneath clear plastic exposed to the sun. Elevated temperatures will kill broods beneath the bark. Insecticides can be applied to the bark of highly valued trees to prevent infection.

Dwarf mistletoes (*Arceuthobium* spp.)

Species affected: Jeffery pine, ponderosa pine, sugar pine, white fir

Significance: In California and throughout much of the West, dwarf mistletoes are considered among the most damaging forest disease agents. Mortality, growth reduction, poor wood quality, reduced seed production and hazardous trees are the consequences of infected forest stands. Infected trees and stands are also predisposed to insect infestation, especially bark beetles and other diseases, particularly during periods of drought or other tree stress.

Management options: Dwarf mistletoes are obligate parasites. Therefore, the mistletoe dies when the infected part of the host dies or is removed. In the forest various combinations of harvesting of infected trees, thinning, favoring non-susceptible hosts, and pruning have been used to reduce losses from dwarf mistletoes. Eradication of the pest is not necessary. Keeping the disease at low to moderate levels in the forest is usually enough to prevent unacceptable damage. Highly valued trees, or trees in high use areas, will require greater levels of management to reduce loss or to minimize hazards

Fir Engraver (*Scolytus ventralis*)

Species affected: white fir

Significance: Trees weakened by root disease, especially annosus root disease, dwarf mistletoe, high stand density and drought are infested by the Fir Engraver. Extensive mortality in northern California was related to the extreme drought of 1987-1992. Trees killed during this drought are especially notable in the Lake Tahoe Basin.

Management options: Lower stand density will promote rapid growth of the residual stand. In root-diseased areas, stands can be converted to species not susceptible to annosum root disease. In urban areas, infested trees should be felled and broods killed by removing and destroying the bark. High-risk trees can be removed by infestation by this destructive bark beetle.

Jeffery Pine Beetle (*Dendroctonus jefferyi*)

Species affected: Jeffery pine

Significance: This bark beetle is the principle insect pest of overmature and mature Jeffrey pine. Young trees over 12 inches in diameter are also frequently killed. Like Mountain Pine Beetle, Jeffrey Pine Beetle prefers to colonize trees weakened by lightning, disease, fire, wind or drought.

Management options: As with other species of bark beetles, removal of weakened trees before infestation by this species will lower the risk of high-level tree mortality. Removing infested trees before emergence of Jeffery pine beetle in June may lower the risk of future infestations. Insecticides can be applied to the bark of highly valued trees to prevent infestation.

Mountain Pine Beetle (*Dendroctonus ponderosae*)

Species affected: ponderosa pine, sugar pine

Significance: Mountain Pine Beetle is the principal insect pest of mature and overmature ponderosa pine and sugar pine, although younger trees, from 4 to 5 inches in diameter can be killed. Mountain Pine Beetle typically colonizes trees weakened by lightning, fire, wind and drought. Outbreaks of this bark beetle can kill millions of trees covering many hectares.

Management options: As with other species of bark beetles, removal of trees weakened by drought, competition, dwarf mistletoe, root disease, fire and wind before infestation by Mountain Pine Beetle will lower the risk of high-level tree mortality. Removing infested trees before emergence of this bark beetle in June may lower the risk of future infestations. Insecticides can be applied to the bark of highly valued trees to prevent infestation.

Pine Engraver (*Ips pini*)

Species affected: Jeffery pine, ponderosa pine

Significance: At outbreak levels, the Pine Engraver can cause considerable tree mortality and, thus, it is an important pest in timber-producing regions. Outbreaks are usually short-lived, not lasting more than one year, although outbreaks have been known to last two to three years during periods of extreme drought.

Population densities of this engraver beetle can increase in logging debris, leading to the infestation of nearby living trees. Trees with tops killed by Pine Engraver are often subsequently

killed by Western Pine Beetle, *D. brevicomis*, Mountain Pine Beetle, *D. ponderosae* or Jeffery Pine Beetle, *D. jefferyi*.

Management options: Cut and scatter branches from treetops remaining after logging. Exposure to the sun will kill broods beneath the bark. Insecticides can be applied to the bark of highly valued trees to prevent infestation

Red Turpentine Beetle (*Dendroctonus valens*)

Species affected: Jeffery pine, ponderosa pine, sugar pine

Significance: Red Turpentine Beetle is attracted to wounded trees and freshly cut stumps, which release certain terpene hydrocarbons attractive to this insect. Trees attacked over the course of several years are weakened but rarely killed by Red Turpentine Beetle. Rather, attacked trees are more frequently killed by Western Pine Beetle, *D. brevicomis* (ponderosa pine) and Mountain Pine Beetle *D. ponderosae* (sugar pine and ponderosa pine). Stumps are readily infested and may produce populations that attack nearby living trees. Red Turpentine Beetle attacks are often associated with pines infected with black stain root disease.

Management options: Avoid wounding trees. A pesticide may be applied to the bark on the lower trunk of highly values trees to prevent further attacks by Red Turpentine Beetle and lower the risk of tree mortality caused by *Dendroctonus* spp. and *Ips* species. Cover the lower trunk with window screen is often an effective alternative to pesticides.

Western Pine Beetle (*Dendroctonus brevicomis*)

Species affected: ponderosa pine, sugar pine

Significance: The Western Pine Beetle is the most destructive insect pest of ponderosa pine in California, infesting trees weakened by smog, annosum root disease, fire, drought and lightning. Dead trees may appear singly or in small groups when Western Pine Beetle attacks at low population levels. At high population levels, groups of 10-20 trees are killed.

Management options: Stand management practices such as thinning and maintaining a mixture of species help mitigate against the high-level tree mortality associated with large areas of dense, mature pines. Insecticides can be applied to the bark of highly valued trees to prevent infestation.

White fir mistletoe (*Phoradendron pauciflorum*)

Species affected: white fir

Significance: In general, white fir mistletoe is a problem only in the larger, older firs in a stand. Young or small trees are seldom infected. Growth reduction resulting from intensive infection and, eventually top dieback are the greatest impacts of this mistletoe. Often insects are responsible for death of the badly weakened tops. Reduction of cone crops and decay entering the trunk from dead tops are also significant losses attributable to white fir mistletoe. Some trees die as a result of extensive mistletoe infection and insect attack, particularly during years of drought.

Management options: Because white fir mistletoe is spread by birds, prevention of the disease in native stands is not practical. Young trees are seldom seriously affected by this mistletoe. Older, heavily infected firs should be harvested before they are killed by insects, drought, or a combination of both. Trees with dead and dying tops will in time undergo extensive trunk decay

unless they are harvested. No chemical control is available, and pruning infected branches is not practical.

White Pine Blister Rust (Cronartium ribicola)

Species affected: sugar pine

Significance: White pine blister rust is the most damaging disease of pines and has cost more to control than any other forest disease in North America. In California alone, millions of trees are damaged or killed each year, and millions of dollars have been spend, probably fruitlessly, on control through eradication of *Ribes* spp. Small trees are particularly vulnerable: only a few branch infections or a single trunk infection can result in tree death. Larger infected trees can also be severely weakened and eventually die or are killed by bark beetles.

Management options: *Ribes* spp. Eradication has been discontinued as an effective method of controlling blister rust. Growth of nonhost species on high rust hazard sites is encouraged. Current research and development of rust-resistant pines may lead to a valuable management option in the near future

Appendix D-Metrics for Density Measurement of Tree Vegetation

Tree density measures allow for an approximation of growing space allocation. Site resources in dry summer months become exceedingly scarce, particularly water. Density should be appropriately managed to allow for the vegetation to remain viable in dry summer months. Some useful metrics to evaluate a management zone are detailed below.

D.1-Stand Density Index

Stand Density Index (SDI) is a measure of relative density developed by Reineke in 1933 and is based on the ‘-3/2 Law’, or ‘Law of Self-Thinning’, where a stand begins to self-thin and competition induced mortality starts to occur. This ‘Law’ is based on empirical evidence that there are biological limits to any given system in nature (Yoda et al. 1963). For forests this limit is the point when the site is fully occupied (all resources are being utilized and one or more resource(s) is limiting growth, appropriately named ‘maximum SDI.’ SDI is a measure of residual density in a stand.

SDI is based on the relationship between tree size and number, and the changes in both as a stand develops and self-thins as it matures. SDI the basis for most density management diagrams and is a useful metric to define management zones (Shaw and Long 2009, Long 1995). Stands can reach a ‘limiting SDI’ (SDInormal) *before* maximum SDI (SDImaximum) is reached. Limiting SDI’s are based on an environmental factor which limits the tree species before a biological maximum, or site resource is scarce. A limiting SDI for ponderosa pine is various species of *Dendroctonus* bark beetle. Limiting SDI’s are likely considered when selecting a management zone (Oliver 1995).

The following is taken directly from personal correspondence with Dr. James Long regarding an appropriate SDI maximum for the Breckenridge project.

“SDI maximum is an approximation of the maximum size-density relation – the theoretical boundary for combinations of mean diameter and density. It is important to be clear concerning the SDI maximum construct. SDI maximum represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type. In a large sample of stands, the vast majority will have combinations of mean size and density below the estimated maximum. In such a large sample, only a few stands will have SDI values close to the putative SDI maximum. And stands with SDIs greater than SDI maximum will be vanishingly rare. Confusion can arise when alternative characterizations of ‘maximum SDI’ are used without explicit explanation. ‘Average maximum density’ (AMD) is, for example, an alternative characterization corresponding to the average SDI of self-thinning stands; AMD is assumed to be about 80% of SDI maximum.(Long and Shaw 2005).

Long and Shaw (2005) suggest for even-aged stands of ponderosa pine an SDI maximum equal to 450. DeMars and Barrett (1987) and Cochran et al. (1994) suggest, in general, that the SDI of “normal” or “fully stocked”(SDI normal) ponderosa pine in northeast Oregon and southeast Washington is 365. SDI normal does not correspond to SDI maximum but rather to the average SDI of self-thinning populations, i.e., AMD.. In general, SDI normal is thought to be about 80%

of SDI maximum and, therefore, the 365 estimate of SDI normal corresponds to an SDI maximum of 456, i.e., essentially 450.” Choice of SDI provides a metric for which to apply critical SDI zones, as described in table 1-4. (Personal Correspondence, Jim Long 7 March 2011).

Table 1-4: Critical SDI zones are shown in the following table:

| SDI percentage of maximum | Definition | Biological Implication |
|----------------------------------|---|--|
| 25% | Onset of competition | Site resources become scarce |
| 35% | Lower limit of full site occupancy | Site is at capacity, one or more resource becomes limiting |
| 55% | Upper limit of full site occupancy | Regeneration limited |
| 60% | Lower limit limit of self thinning begins | Mortality begins to occur |

For a given vegetative type, the appropriate SDI is applied and then a management zone is selected based upon management objectives.

D.2-Basal Area

Basal area is a measure of the cross-sectional area of a tree at breast height (Avery and Burkhart 2002). Normal basal area stocking is considered as the basal area per acre level where mortality begins as additional growth takes place. Normal basal area is effectively the lower limit of self thinning, or 60% of maximum SDI (Oliver and Larson 1996, Reineke 1933). Normal basal area measures are generally researched for even-aged stands (Meyer 1938; Dunning and Reineke 1933; Oliver and Powers 1978). Basal area per acre is the amount of biomass that is growing on an acre.

Basal area is a useful measure which allows field implementation of complex metrics, such as SDI. Maximum SDI multiplied by the desired SDI percentage of maximum (described in Table 1-4) equates to desired basal area. Desired basal area provides a prescriptive metric to implement residual density treatments to forest stands.