STATE & PRIVATE FORESTRY
FOREST HEALTH PROTECTION
SOUTH SIERRA SHARED SERVICE AREA

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To: Kevin B. Elliot, Forest Supervisor, Sequoia National Forest
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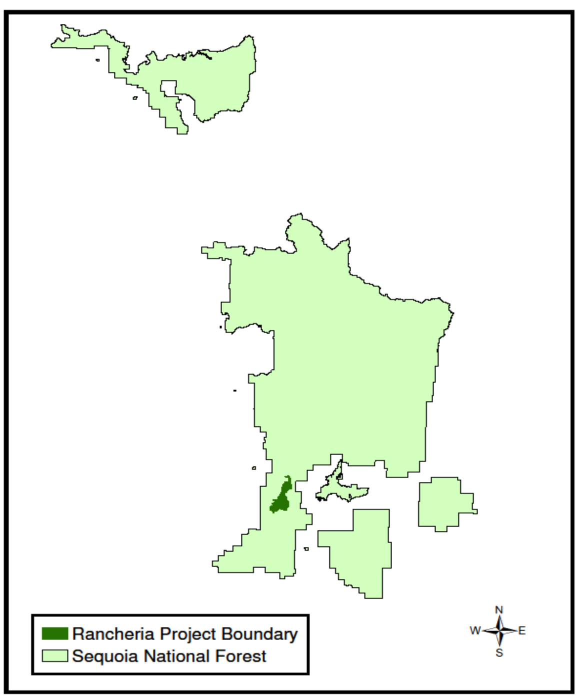
Subject: **Rancheria Forest Health Project**
Kernville Ranger District, Sequoia National Forest

Forest Health Protection, South Sierra Shared Service Area personnel Beverly M. Bulaon and Martin MacKenzie made several visits to Rancheria Project, Sequoia National Forest to assess forest health issues within proposed project boundaries. This report is a summarization of observations, general pest biology, and potential management recommendations regarding forest health.

Introduction

Rancheria Project is located along the ridgeline of Greenhorn Mountains adjacent to Rancheria Road, near the Alta Sierra community. Most of the project lies in Township 26 S, Range 32 E, Sections: 6, 7, 18, 19, 30, 31 and Township 26 S, Range 31 E, Sections: 26, 35, 36. Based on recent Forest Service watershed assessments, the Greenhorn Mountains were evaluated to be a high priority watershed. Main project objectives are to restores the area to healthy, fire-resilient forests and support more naturally functioning ecological processes by reducing stand densities and fuel loads (*Rancheria Scoping Letter*, dated May 9, 2011).



Proposed project areas range in elevation from 7000 to 4500 feet; most of the project is mixed conifer-pine forest type. Annual precipitation ranges from 30 to 40 inches on average; Dunning tree classifications range from 2 to 5 over the project area with a site class rating of 3 being most typical of the project area. Jeffrey pine, white fir, incense cedar, and red fir are the main conifer species of the landscape; with sugar pines and black oaks comprising small percentages. Manzanita, white thorn *Ceanothus*, and deer brush are substantial in gap openings, but taper off quickly when overhead canopy becomes dense. Due to historical logging, fire exclusion, and site conditions, vegetation has shifted to predominantly incense cedar and white fir – especially on milder sites where white fir consist 70% of the composition, over- and understory (see Figure 1).

Figure 1. Sites representative of mixed conifer on Rancheria project. Note dense incense cedar and white fir overstory and regeneration, low pine density.

The Greenhorn Mountains were extensively logged around the mid- 1800s, in connection with development of local mining communities and the city of Bakersfield. Combined with a half century-long federal policy of fire suppression, conditions have transitioned to dense second-growth forest of small to intermediate size trees surrounded by chaparral and plantations. Since that time, large-scale stand-replacing fires have occasionally swept across the western and northern slopes. However, the section of the Greenhorn Mountains from Davis Flat to Shirley Meadows has not burned.

Project Background

The Rancheria project proposes to design and implement vegetation treatments to restore a healthy, diverse, fire-resilient forest and support more naturally functioning ecological processes by reducing *stand densities* (overcrowding of trees) and *fuel lo*ads (amount of flammable material a fire can feed on). Treatments will range in size (broad to micro-site), and site-specific where multiple treatments maybe required for restoration efforts as stated in GTR-220.

The project will design treatment strategies to protect life, property, wildlife, and habitat from uncharacteristically severe wildfire. Forest Service officials and Fire Safe Council members have both expressed considerable concern that, without treatment and the limited number of burning days per year, the project area possesses all the elements necessary for experiencing a catastrophic wildfire. However, there are alternatives that can assist in restoration efforts.

The Forest Service document completed in March 2011, Region 5 Ecological Restoration Leadership Intent, explains the scope of the issues this project addresses locally:

> "In the 21st century, three major drivers of change define restoration needs on the National Forests of the Pacific Southwest Region: climate change and shifting hydrologic patterns; increasingly dense and unhealthy forests; and rapidly growing human populations. These synergistic sources of change are resulting in increasingly over-allocated and undervalued ecosystem services (especially water); a dramatic increase in disturbance events such as uncharacteristic large-scale wildfires, floods, and insect and disease outbreaks..."

As stated insects and diseases are a major concern as significant change drivers in forests based on future predictions of climate change. While neither eradication nor suppression are usually effective management options, prevention and mitigation of damage caused by native forest pests can be implemented while still meeting overall project goals.

Observations

Aerial detection surveys from 2008 to 2011 (Forest Health Monitoring 2008-2011) show fluctuations of pest associated mortality occurring within Rancheria Project[1] (see Appendix A). After a few years of below-average winter precipitation, summary results show patches of affected acres, primarily white fir mortality associated with fir engraver (*Scolytus ventralis)*. Notable increases of bark beetle mortality associated with pines are also associated with low precipitation years. By 2010 to 2011, pine mortality had subsided but sugar pines of all age classes continue to decline, not seen from aerial surveys but observed on the ground.

Field surveys including a few service visits with district personnel were conducted in 2011 to assess current conditions within proposed areas. Mixed conifer sites with high white fir composition were consistently found with *Heterobasidion occidentale* root disease in old cut stumps. Seedling or understory trees are often overlooked during aerial surveys. Losses averaging <1 tree per acre (mostly fir) either from direct suppression or other factor; many young sugar pines were dead from blister rust girdling along the bole. Overstocking, composition shift, and low diversity within proposed units were good indicators of high susceptibility to pest infestation and proliferation.

In recent years, aerial detection surveys (Forest Health Monitoring 2008, 2009, 2010, and 2011) show large areas within project boundaries of fir engraver-associated mortality (see Appendix A). Dead trees per acre averaged 1 to 6, but affected acreage ranged from 3 up to 100 acres (median 40 acres), highlighting the scattered selection behavior of fir engraver in seeking weakened hosts. Detected acres appear in similar locations, polygons overlapped year to year. Anecdotal evidence of dense fir stands along the western Sierra found much fir-engraver mortality is associated with prior infection by *Heterobasidion.* Ground surveys confirmed within root disease infection centers, recently dead trees were attacked by engraver.

Mountain pine beetle (*Dendroctonus ponderosae, MPB*) kills were associated with sugar pines previously infected to some degree by exotic white pine blister rust (*Cronartium ribicola*). Dead sugar pines greater than 15 inches were often found with galleries of MPB under the bark, while smaller diameters appeared killed directly by blister rust or other factor. Group kills were also found – a pocket of ~15 trees estimated to have died around 2008, some of which were most likely previously infected with blister rust. Mortality may seem like background levels (one tree/year), but in relation to the small percentage of sugar pines in stands, this is significant loss and may preclude maintaining the species. All sizes of sugar pine were slowly declining or dying – either by blister rust or bark beetle; regeneration was sparse.

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[1]Aerial survey on reports trees attacked the previous year that may have begun to turn color. Currently-infested trees are typically not detected.

Figure 2. Sugar pines observed in Rancheria project: pine on the far left was killed in 2010 by mountain pine beetle; center pine shows symptoms of prior blister rust infection in the branches.

Jeffrey pine beetle (*Dendroctonus jeffreyi*) infestations were limited to small groups when noted by aerial survey. Large group losses were noted in a plantation in 2009, first infested by pine engravers at the terminals. JPB finished killing trees the following year. Mortality caused by JPB is often a singular large diameter tree, suffering from an initial stress. Outbreaks rarely occur here despite many stands considered at high risk.

Within the project area, white fir was consistently observed with varying degrees of dwarf mistletoe (*Arceuthobium concolor*), *Cytospora* canker, or an unknown deformation on the bole. Dwarf mistletoe was ubiquitous in stands where white fir composed >50% species composition. Mistletoe ratings[2] per trees ranged from 1 to 6; however, higher infection rates in the upper and mid-crowns of mature trees are likely based on the abundance of visible lower branches with numerous infections. Large unknown swellings along the bole were possibly old dwarf mistletoe infection sites, but more investigation is still needed.

Discussion

Where naturally ignited wildfire was historically frequent at low to mid-elevations, general management strategies often select against fire-intolerant species such as fir. Current management of Sierra Nevada mixed-conifer forests focus on reduction of fir and incense cedar, retaining pine and oak whenever possible (North et al 2009). When drought events occur in California, firs are the first to decline from native pests and physiological stress. Historical records examined by North et al (2009) found that Sierra forests had higher percentages of pine, more open canopies, and higher percentages of fire-tolerant species in larger diameter classes. Inference would then suggest that shifts in species composition and structure are also contributing to the high levels of mortality detected during low-water years. In addition, increased drought episodes due to predicted warming climates would then render high-density forests more vulnerable to native pests (Smith et al. 2005, Fettig et al. 2007).

White fir mortality is consistently correlated with drought events in California; water stress is the most important predisposing factor to pest susceptibility (Ferrell 1974, Ferrell and Hall 1975, Ferrell 1996). Mortality is often caused by a complex of bark beetles, root disease, dwarf mistletoe, and other pathogens that respond quickly to tightening

[2]Hawkworths Dwarf Mistletoe Rating 1977. A six-class dwarf mistletoe rating system.

physiological stress of the host. Bark beetles, particularly fir engraver, will attack in various locations where trees may be vulnerable, primarily the main terminal or at branch points along the bole where mechanical damage has occurred. Unsuccessful attacks may still disrupt water and nutrient conduction causing additional stress to hosts, as well as still inviting symbiotic fungi.

White fir mortality is often very hard to predict, but areas with prior infection of root disease, harsh site conditions, or with annual precipitation less than 20 inches per year (Schultz 1994) would be at high risk for loss. Mortality patterns are often scattered and not distributed evenly among forest types or age classes when widespread die-offs do occur. Densely stocked stands, regardless of component distribution, are susceptible to bark beetle attack due to inter-tree competition for limited resources, space, and water. Prolonged drought periods exacerbate the struggle, inciting stress in pines, oaks, and other species as well. Firs with prior injury or on exposed sites are often the first to fade when annual precipitation is low or insect outbreaks are building up. Douglas fir Tussock Moth favors white firs along ridgetops, boulder fields, or south-facing slopes where harsh site conditions contribute to tree stress (Wickman et al. 1981).

Desired conditions for white fir would be that stand density, age distribution, and structural heterogeneity are such that mortality would not contribute to substantial deviations from historical vegetation patterns. Fires occurring in westside forests in the Sierra Nevada were historically variable, but not often of high severity and intensity that have been consistently occurring within the past two decades (Fites-Kaufman and van Wagtendonk 2006). Infection levels by pathogens or damage by insects should not be so debilitating that forest health is stagnating or deteriorating, rather than sustained. However, dead and declining trees are also a necessary part of this landscape becoming snags or coarse woody debris for habitat variability.

Management Options

- *No action.* Tree mortality caused by insects, pathogens, or other disturbances are natural complex events in the Sierra Nevada (Ferrell 1996). Background levels of mortality are often by bark beetles removing weakened, stressed individuals creating openings for new seedlings to release; root diseases in white fir are common predisposing factors that incite beetle attack eventually culminating to tree mortality. Standing or prostrate dead trees provide needed habitat, forage, and nesting sites for various wildlife species, or even substrates for other beneficial pathogens or insects that contribute to nutrient cycling.

  Under No Action alternative, low levels of white pine blister rust-mediated mortality of small diameter (< 9 inches) sugar pine will continue. While this mortality rate will be below 1 tree per acre per year, it predicts the future trend taking place within Rancheria project. If mature sugar pines are dying due to compounding mortality agents and stand conditions, their sparse regeneration are dying as well. Before the end of the current century, most of today's legacy sugar pines will most likely die from combined effects of old age, climate change, and biotic agents – native and exotic – leaving no natural seed sources or cohort replacement.

  Past management practices and other global changes have significantly altered forest stand and structure, leading to current conditions that are highly susceptible to pest incidence and associated mortality (Fettig et al. 2007). Current conditions within the Rancheria project, particularly within fir-dominated stands were found with high incidences of root disease, dwarf mistletoe, and *Cytospora* canker as mentioned previously. Root connections and grafts with other infected hosts are increased when more hosts are available on site; increasing species diversity breaks host root links reducing underground spread. Most often, overstocked or stands with high basal areas of white fir were found to have higher levels of mortality. Mortality can also be higher of large diameter (>40 inches) trees in dense stands (Smith et al. 2005). Prevention measures against further new infections of *Heterobasidion occidentale* will mitigate losses and improve vigor of residual trees especially during times of drought.

- *Thinning.* Thinning is one of the best preventive measures against bark beetles (Fettig et al. 2007). Low density stands have overall low resource competition which improves tree resistance (Fettig and McKelvey 2010). With white fir forests, host abundance is directly correlated with potential levels of mortality particularly during drought years (Egan et al. 2010). According to Oliver and Uzoh (1997), imminent mortality in ponderosa pines begins at stand density indexes of 230, maximum of 365 when losses exceed growth. Hayes et al (2009) confirmed that stand density (as basal area or stand density index measurements) is still the best predictor of risk for western pine beetles. As for true fir, dense stands experience higher mortality due to intensifying inter-tree opposition (Zhang et al. 2007). Studies have shown that thinning from below and leaving 55-70% of the *original* basal area should maximize tree growth (Zhang et al. 2007) and reducing the proportion of white fir in the stand can mitigate losses during periods of low water yield. Care should be taken to prevent injury on residual trees. Open wounds can become entry points for pathogens and insects, indirectly increasing pest incidence.

Thinning treatments in pine or fir plantations help release developing trees from brush and natural regeneration competition. Creating wide spacing between trees whether by mastication, hand-thinning, or prescribed fire should improve tree vigor, thus reducing beetle attraction. For pines, piling of slash or logs at tree bases should be avoided. Pine engravers (*Ips* species) will typically not attack material with bark thickness greater than 1 inch; however prudent treatments should focus on proper timing and implementation. Relocating slash away from residual stands, accelerating wood drying, or promptly treating slash will prevent beetle movement into green trees (DeGomez et al. 2008).

- *Prescribed Burn.* Fire is a useful tool that can achieve additional objectives in addition to beetle protection. However, proper timing and extreme care is recommended to avoid further injuring trees rendering them susceptible to subsequent insect attack. Slash piling to burn should also be properly timed and located as to avoid inviting beetles that can move from downed wood to standing green trees. Forest Health Protection can provide specific guidelines on proper techniques.

- *Root disease Prevention*. It is strongly encouraged to utilize a preventative application of a registered borate fungicide (e.g: Sporax®) to ***all*** freshly cut conifer stumps greater than 14 inches in diameter. For best results, preventative root disease treatments should be applied within the first four hours of tree falling. Treatments such as this can reduce the establishment of *Heterobasidion occidentale* (S type) and *Heterobasidion irregular* (P type) onto exposed fresh stumps thus reducing the potential for tree decline or mortality. Treatments do need to be conducted wherever root disease is suspected, or if stand has the potential for infection (e.g.: high white fir composition). Treatments are proven effective prevention measures; even if disease signs or symptoms (P or S type) may not have been observed, prudently treating all sites should prevent subsequent disease establishment.

Combinations of various options can be utilized to meet project objectives. If prescribed fire is used in combination with mechanical treatments, wait at least one year between treatments to allow forests to recover from initial disturbance. Chemical prevention or suppression treatments (direct controls) are not recommended here and usually reserved for high value trees or sites (e.g.: campgrounds) rather than general forest settings. If specific trees or areas are considered for full protection, further discussion with FHP is recommended.

Management Options

Changes are happening on a global scale affecting all the world's forests, managed or not. PRISM data compiled by Meyer and Safford (2010) show that temperatures are increasing by at least 1 degree over most of Sequoia National Forest. Large scale bark beetle epidemics are occurring at unprecedented scales never recorded before in North America. Predicted warming temperatures and varying precipitation patterns will have significant effects on native insects and diseases (Bentz et al. 2010). Consequently, decreased fire frequencies in westside forests have elevated native insects and diseases as the primary drivers of forest disturbance and change (Smith et al. 2005). Promotion of ecological restoration treatments should improve the sustainability and retention of forest resources in the face of climate change or other disturbance in the future. Proactive treatments are more effective, less costly, and provide benefits in the interim compared to suppression or rehabilitation that may take years to recover. Wildfires and bark beetle epidemics will occur, but mitigation and prevention efforts in forests now can significantly reduce damaging effects and losses.

Forest Health Protection supports proposed treatments that improve forest conditions at stand and landscape levels. Use of root disease prevention treatments will significantly reduce the incidence of new infection centers from establishing. Treatments that alter dense or overstocked conditions should decrease bark beetle attraction while improving overall tree vigor against other disturbance or damage agents.

If the district requires more information or has any questions regarding this report, please do not hesitate to contact us.

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References

Bentz, B., J. Regniere, C.J. Fettig, M. Hansen, J.L. Hayes, J.Hicke, R.G. Kelsey, J.F. Negron, and S.J. Seybold 2010. Climate Change and Bark Beetles of the Western United States and Canada: Direct and Indirect Effects. Bioscience 60(8): 602-613.

DeGomez, T., C. Fettig, J.D. McMillan, J.A. Anhold, and C. Hayes 2008. Managing Slash to minimize colonization of residual trees by Ips and other bark beetle species following thinning in southwestern Ponderosa pine. University of Arizona, Cooperative Extension, Publication AZ1448.

Egan, J., W.R. Jacobi, J.F. Negron, S.L. Smith, and D.R. Cluck 2010. Forest Thinning and subsequent bark beetle-caused mortality in Northeastern California. Forest Ecology and Management 260 (10): 1832-1842.

Ferrell, G.T. 1974. Moisture Stress and Fir Engraver (Coleoptera: Scolytidae) attack in white fir infected by true mistletoe. Canadian Entomologist 106: 315-318.

Ferrell, G.T. and R.C. Hall 1975. Weather and tree growth associated with white fir mortality caused by fir engraver and roundheaded fir borer. USDA Forest Service, Pacific Southwest Forest and Ranger Experiment Station, Research Paper PSW-109.

Fettig, C.J., and S.R. McKelvey 2010. Bark beetle responses to stand structure and prescribed fire at Blacks Mountain Experimental Forest, California, USA: 5-year data. Fire Ecology 6(2): 26-42.

Fettig, C., K. Klepzig, R.F. Billings, A.S. Munson, T.E. Nebeker, J.F. Negron, and J. T. Nowak 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forest of the western and southern United States, Forest Ecology and Management, 238: 24-53.

Fites-Kaufman and van Wagtendonk 2006. Sierra Nevada Bioregion. *In*: Fire in California's Ecosystems, edited by N. Sugihara, J. van Wagtendonk, K. Shaffer, J. Fites-Kaufman, and A. Thode. University of California Press, pgs: 264-294.

Forest Health Monitoring 2008, 2009, 2010, 2011. Aerial Survey Results: California. USDA Forest Service, Forest Health Monitoring, Davis, CA.

Hayes, C., C.J. Fettig, and L. Merrill 2009. Evaluation of Multiple Funnel Traps and Stand Characteristics for Estimating Western Pine Beetle-Caused Tree Mortality. Journal of Economic Entomology 102(6):2170-2182.

Hawkworths Dwarf Mistletoe Rating 1977. A six-class dwarf mistletoe rating system. USDA Forest Service, General Technical Report RM-48.

Maloney, P. and D. Rizzo 2002. Dwarf Mistletoe-Host Interactions in Mixed-Conifer Forests in the Sierra Nevada. Phytopathology, Vol. 92, No. 6.

Meyer, M. and H. Safford 2010. A summary of current trends and probably future trends in climate and climate-driven processes in the Sequoia National Forest and neighboring Sierra Nevada. Released Dec 15, 2010. USDA Forest Service, Pacific Southwest Region.

North, M., P. Stine, K. O'Hara, W. Zielinskiand, S. Stephens 2009. An ecosystem management strategy for Sierran Mixed Conifer Forests. USDA Forest Service, Pacific Southwest Research Station, General Technical Report, PSW-GTR-220.

Oliver, W.W. and Uzoh, F.C.C., 1997. Maximum stand densities for ponderosa pine andred and white fir in Northern California. In: Forest Vegetation Management Conference. Proceedings of the Annual Forest Vegetation Management Conference Symposium Proceedings, pp. 57–65.

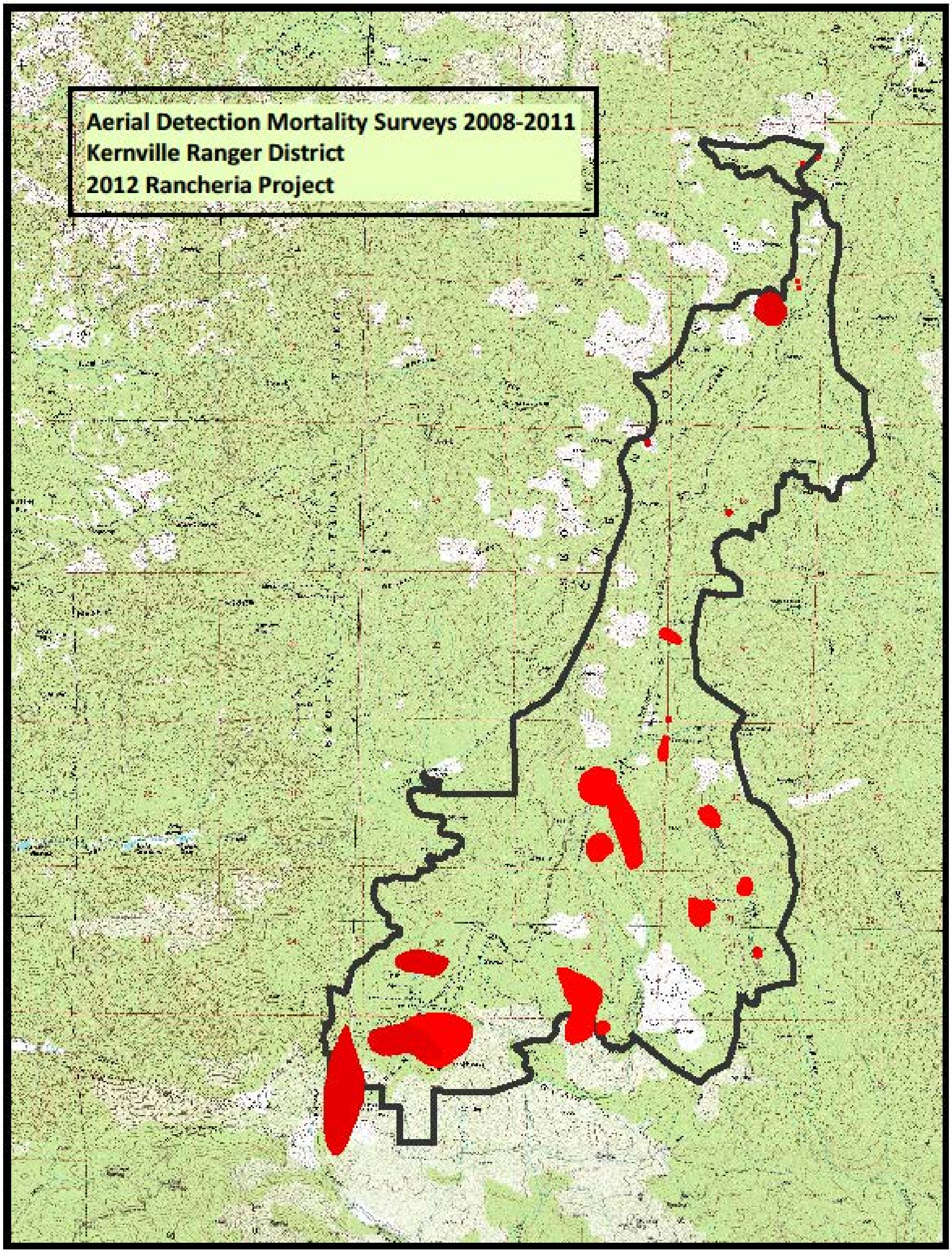
Schultz, D. 1994. Evaluation of White fir Mortality on Big Valley Ranger District. USDA Forest Service, Forest Pest Management, FPM Report NE94-2.

Smith, T.F., D.M. Rizzo, and M. North 2005. Patterns of mortality in an Old-growth mixed conifer forest of the southern Sierra Nevada, California.   Forest Science 51(3): 266-275.

Wickman, B., R.R. Mason, and G.C.Trostle 1981. Douglas-Fir Tussock Moth. USDA Forest Service, Insect and Disease Leaflet 86. 11pgs.

Zhang, J., W. W. Oliver, and M. W. Ritchie 2007. Effect of stand densities on stand dynamics in white fir forests in northeast California, USA. Forest Ecology and Management, 244: 50-59.

Appendix A. Forest Health Monitoring Aerial Detection Surveys 2008-2011, summary of detected mortality.



Appendix B. *Heterobasidion* Information

The web sites listed below provide links to the most important literature on this disease and optimal protective measures.

Heterobasidion Information http://www.fs.fed.us/r5/spf/fhp/heterobasidion.shtml

- R5 Insect & Disease Manual: *Heterobasidion* (pdf 1.9 MB)
- R5 *Heterobasidion* Handbook (pdf 98 KB)
- Cellu-Treat Information, Product Label, and Material Safety Data Sheets (pdf 356 KB)
- Otrosina Heterobasidion taxonomy paper (pdf 1.5 MB)
- CA Forest Pest Conditions 2009: *Heterobasidion* (pdf 2.4 MB)

There is a white paper that should be considered prior to beginning a project-NEPA document. This white paper can be found at: http://www.fs.fed.us/r5/spf/fhp/pesticide/index.shtml. It is referred to as the pesticide use advisory memorandum 06-01 (two documents on the web page: cover letter and CATS attachment ("white paper"). There is also a national risk assessment for "Borax" fungicides that discusses human as well as ecological health risks, located on-line at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Forest Service regional policy on Sporax® is currently being updated. Revisions are still ongoing and a draft can be provided if requested (contact Dave Bakke, Regional Pesticide Specialist). As soon as the update comes back from review, it will be listed on the first web site.