FOREST HEALTH PROTECTION
USDA Forest Service
State and Private Forestry

A BIOLOGICAL EVALUATION OF FOREST HEALTH IN BABBIT PEAK AND SKUNK HARBOR PARCELS

THE WASHOE TRIBE OF NEVADA AND CALIFORNIA

By

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Introduction

During the week of September 8th, 2008, Valerie DeBlander, Forest Technician, Forest Health Protection (FHP) – Ogden Field Office (OFO), Jason Neumann, Biological Technician, FHP – OFO, and I met with Jennifer Johnson, Environmental Specialist, Washoe Environmental Protection Department – Washoe Tribe of NV and CA. The purpose of this visit was to conduct field surveys of Babbit Peak and Skunk Harbor Parcels to help identify tree species present, and identify and quantify the presence and absence of insect and disease activity in those trees. The following summarizes our survey methods, data analysis, and subsequent management recommendations.

Skunk Harbor Parcel is located approximately 5 miles north of Glenbrook, NV and encompasses 293 acres of forested land and 300 feet of beach of on Lake Tahoe. Jeffrey pines, *Pinus jeffreyi*, followed by white fir, *Abies concolor*, and incense-cedar, *Libocedrus decurrens* occupy the largest percentage of the forested landscape within the parcel. The total area surveyed encompassed 293 acres. Aerial detection surveys (ADS) conducted from 2007-2009 mapped various insect activity within a five mile radius of the Skunk Harbor Parcel, including mountain pine beetle (MPB), *Dendroctonus ponderosae* (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/58mtnpb.htm), Jeffrey pine beetle (JPB), *Dendroctonus jeffreyi* (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/59jpnebtl.htm), pine engraver beetle, *Ips pini* (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/60-61pigrvrb.htm), and fir engraver beetle (FEB), *Scolytus ventr*alis (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/64frngrvr.htm) (Figure 1, Appendix I).

Babbit Peak Parcel is located approximately 30 miles north of Truckee, CA and encompasses approximately 480 acres of forest and open meadow land. Western white pine, *P. monticola*, followed by California red fir, *A. magnifica*, white fir, quaking aspen, *Populus tremuloides*, Jeffrey pine, western juniper, *Juniperus occidentalis*, lodgepole pine, *Pinus contorta*, and incense-cedar occupy the largest percentage of the forested landscape within the parcel. The total area surveyed encompassed approximately 240 acres. Aerial detection surveys conducted from 2007-2009 mapped various insect activity within a five mile radius of the Babbit Peak Parcel, including MPB, JPB, and FEB (Figure 2, Appendix I).

Survey Methods

Data Collection

A total of 15 and 75 variable-radius plots were distributed at approximately 5 chain (1 chain = 66 feet) intervals along linear transects laid out in cardinal directions of the forested areas of the Skunk Harbor and Babbit Peak Parcels, respectively, to collect stand data. From plot center, a 20 basal area factor angle gauge was used to select sample trees. Mensurational data collected for each tree included species, status (live or dead) and dbh. Only trees > 5 inches diameter at breast height (dbh) were measured.

All tree regeneration less than five inches dbh, and greater than six inches in height was tallied in a 1/300th acre subplot (radius = 6.8’) at plot center of each variable-radius plot.

Data Analysis

The number of JPB and MPB infested trees were summed for each plot. Other notable damaging agents recorded in our survey included FEB, Western dwarf mistletoe (DMT), *Arceuthobium campylopodum* (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/88-92dwmt.htm), and white pine blister rust (WPBR), *Cronartium ribicola* (http://www.fs.fed.us/r1-r4/spf/fhp/field_guide/38-39whtepnbr.htm). Stand survey data were entered into a spreadsheet and analyzed using the **F**orest **In**sect and **Di**sease **T**ally (FINDIT) program (Bentz 2000). The following statistics were calculated for each parcel:

1. Total trees/acre (TPA)
2. Total live and dead basal area (BA ft^2/ac)
3. Quadratic mean diameter (QMD) of live trees (by species) in stand
4. Live stand density index (SDI)
5. Number of dead and live trees
6. Percentage of each tree species in stand
7. Percentage of basal area (BA) comprised of each tree species
8. Percentage of basal area killed by damaging agents in 2008, 2007, and mortality older than 2007
9. Regeneration trees per acre by tree species.

Insect and Disease Hazard Ratings

Hazard rating systems are often used by forest health specialists to evaluate stand conditions conducive to the growth and spread of damaging agents. "Hazard" or "susceptibility" is the inherent characteristics or qualities of a stand of trees that affect its likelihood of attack and damage by an insect or disease agent. "Risk" is defined as the short-term expectancy of tree mortality in a stand as a result of a damaging agent. Risk is a function of tree/stand susceptibility and 'pressure' imposed by the damaging agent. Pressure is the magnitude of the damaging agent population affecting a stand as determined by the number of currently infested/infected trees and their proximity to the stand being assessed. Pressure relates to the likelihood of damaging agents entering a given stand. A "high-hazard" stand can exist with little risk when populations of damaging agents remain low. Conversely, a "low-hazard" stand can have moderate risk when populations of damaging agents are high (Shore et al. 2000, Edmonds et al. 2000).

Numerous insects and diseases damage trees in western forests. Hazard rating systems do not exist for most of these agents because they cause only minor damage or the factors contributing to stand susceptibility are not well understood. Consequently, stand susceptibility was only determined for those bark beetle species for which reliable systems have been developed.

There has been little research conducted in western forests to determine stand susceptibility of Jeffrey or Western white pine stands to bark beetle infestation. However, research conducted in western states shows that trees in overstocked stands are more susceptible to bark beetle attack (Fettig et al. 2007). In general, stands considered most susceptible to MPB attack include those with LPP located below 9500 ft, > 80 yrs of age, and average diameter at breast height (DBH) > 8 inches (Amman et al. 1977); stands contain a high percentage of pine with diameters > 6 inches DBH, average age of dominant trees > 80 years, and the number of trees per acre are

between 304 and 405 (Shore and Safranyik 1992); and stands with densities of 20% to 35% of the maximum stand density index (SDI) and a quadratic mean diameter (QMD) > 8 inches (Anhold et al. 1996). Lodgepole pine susceptibility to MPB was assessed for the Babbit Peak Parcel using, in part, these susceptibility criteria, as well as a MPB loss model developed by Cole and McGregor (1983). This model estimates trees per acre of LPP infested and killed by MPB over a 10 year period based on current population levels in the parcel. It is based on the number of green trees (≥ 5.0 inches dbh) available for infestation, and the number of trees infested the previous year in each diameter class.

With the detection of DMT, the Hawksworth's 6-class dwarf mistletoe rating system (DMR) (Hawksworth 1977) was used to rate individual Jeffrey pines and derive levels of DMT infection. In this system, the live tree crown is visually divided into thirds (top, middle, and bottom). Each third is rated according to the proportion of crown infected (0 = no infection; 1 = ½ of branches in third infected; 2 = greater than ½ of branches in third infected). The ratings of each third are summed to give a total tree DMR from 0 to 6. A tree with a DMR of three is considered moderately infected. Because the distribution of DMT is patchy, a stand with an average DMR of three is considered heavily infected.

Host composition and stand structure is considered most important for the incidence and spread of DMT (Hawksworth and Wiens 1996). Multi-storied stands provide the greatest opportunity for DMT spread as dispersing seeds can infect various size classes (Hawksworth and Wiens 1996). Most growth loss occurs in stands older than 60 years as trees begin to experience age-induced stress (Parmeter 1978). Host tree resistance, ecological, and climatic factors may also limit DMT spread (Conklin 2000).

Results

The following section summarizes the survey results and hazard ratings for the two parcels.

Skunk Harbor Parcel: Jeffrey pine was the dominant tree species in this parcel, comprising 56% of the total trees per acre and 71% of the total mean basal area (Table 1). Species and diameter class distributions in this parcel indicated that stands possessed compositional and structural diversity. The stand density for this parcel was approximately 115ft^2/acre (Table 1). The QMD of all tree species in this parcel was approximately 18 inches (Table 1).

JPB – Endemic JPB activity was noted in this site with only one 16.5 inch JPB strip-attacked tree. The 2008 ADS data mapped one pocket (pocket refers to tree mortality) of 5-14 Jeffrey pine within a mile to the north of this parcel. In addition, there were eight small pockets (1-4 trees) and six larger pockets (5-14 trees) within 4 miles of this parcel. The more recent 2009 ADS data revealed continuing JPB activity with 8 pockets of 1-4 trees mapped within a few miles of this parcel (Figure 1, Appendix I).

MPB – There was no MPB activity detected in our survey. However, the 2008 ADS data mapped one pocket of 5-14 LPP trees and three pockets of 1-4 Western white pine trees within 4 miles to the east and northeast of this parcel (Figure 1, Appendix I).

FEB - Endemic FEB activity was noted in three of the 15 plots. In 2008, a 20-tree polygon was mapped within 2 miles southeast of Skunk Harbor Parcel. Additional pockets of 5-14 trees were mapped within 5 miles to the east of this parcel. In 2009 a small pocket of 1-4 trees and two pockets of 5-14 trees were mapped two miles to the north and two miles to the south east, respectively (Figure 1, Appendix I).

DMT – There were moderate levels of DMT in the Jeffrey pines in this parcel, with 18 TPA, approximately 48%, of the Jeffrey pines in our survey having some level of DMT. The mean dwarf mistletoe index of the plots containing Jeffrey pines is 3.3.

Regeneration - There was only one white fir seedling tallied in one of the plots in this parcel, which was not enough analyzed by the FINDIT program to extrapolate to stand level regeneration estimates.

Babbit Peak Parcel: Western white pine was the dominant tree species in this parcel, comprising 33% of the total trees per acre and 40% of the total mean basal area, respectively (Table 1). Species and diameter class distributions in this parcel indicated that stands possessed compositional and structural diversity. The stand density for this parcel was approximately 130ft^2/acre (Table 1). The QMD of all tree species in this parcel was approximately 17 inches (Table 1).

MPB – Endemic MPB activity was detected in this parcel. The FINDIT model predicted the loss of LPP due to MPB after a 10-year period would decrease from 2.79 TPA to 1.95 TPA. In general, this coincides with low stand susceptibility (Shore and Safranyik 1992). The 2007 ADS data mapped two pockets of 1-14 LPP trees near the northern border of this parcel. In 2008, one pocket of 5-14 Western white pine trees were mapped 3 miles to the northwest of this parcel. The 2009 data mapped a closer pocket of 1-4 Western white pine trees one mile to the north of this parcel. Additionally, two pockets of 1-4 LPP trees were mapped within 5 miles southeast of this parcel (Figure 2, Appendix I).

JPB - There were no signs of JPB activity within our survey plots. However, 2008 ADS data mapped several pockets ranging from 1-20 trees within 5 miles around this parcel. The 2009 ADS data mapped one pocket of 1-4 trees within 3 miles northeast of this parcel. (Figure 2, Appendix I).

FEB - There were endemic levels of FE activity detected in three of the 75 plots. In 2008, a 50-tree polygon was mapped two miles to the northeast of this parcel. In 2009, there were 5-14 additional trees mapped in the same area as 2008. (Figure 1, Appendix I).

WPBR – This exotic pathogen is another damaging agent that has increasingly been detected on white pines in California (Gibson *et al* 2008). The presence of WPBR in this area around Babbit Peak is a relatively new introduction from the late 1990s (J. Guyon, personal communication, February, 2010). From our survey in this parcel, there were 6.84 western white pine trees per acre with WPBR. This equates to approximately a 21% infection rate of the residual (live) Western white pines surveyed. E. Robbins, personal communication, January 4, 2001

Regeneration - There was better regeneration in surveyed area of this parcel versus Skunk Harbor Parcel, in particular, for Western white pine at 700 TPA (Table 2). However, the TPA of the aspen and firs may, depending on management objectives, be inadequate to sustain themselves within mixed stands (Table 2; J. Guyon, personal communication, February, 2010).

Table 1. Summary of variable plot data and MPB hazard rating for both parcels.

Parcel	Species	TPA (%)	MBA (%)	QMD (in)	SDI	Rating
Skunk Harbor	WF	23 (27)	21 (16)	16.2	25	N/A
	JP	46 (56)	71 (68)	20.1	96	N/A
	IC	13 (17)	21 (16)	25.1	22	N/A
Subtotal		**82**	**116**	**18.3**	**143**	N/A
Babbit Peak	WJ	4(4)	3 (3)	16.3	5	N/A
	LPP	3 (3)	5(4)	16.9	7	L
	WWP	36 (33)	53 (40)	18.9	66	L
	ASP	8 (7)	2 (2)	6.7	4	N/A
	WF	19 (18)	19 (14)	15.8	26	N/A
	RF	31 (30)	41 (33)	21.0	55	N/A
	JP	5 (5)	6 (5)	19.6	9	N/A
	IC	0.4 (0.4)	0.3 (0.2)	11.0	1	N/A
Subtotal		**106**	**129**	**16.7**	**171**	

WF = white fir; JP = Jeffrey pine; IC = incense cedar; WJ = Western juniper; LPP = lodgepole pine, WWP = Western white pine; ASP = aspen; RF = red fir; TPA = trees per acre; MBA = mean basal area (ft^2) per acre; QMD = mean quadratic diameter; SDI = stand density index; N/A = not measured; Susceptibility rating (Cole and McGregor (1983)) used: L = low hazard; M = moderate hazard; H = high hazard

Table 2. Summary of regeneration data collected in Babbit Peak Parcel.

Regeneration (TPA)					
DBH Class	**WWP**	**ASP**	**WF**	**RF**	**Total**
0.0-2.9	700	132	24	20	876
3.0-4.9	0.0	0.0	0.0	0.0	0.0
Total	700	132	24	20	876

Discussion and Recommendations for Management

Native insects and diseases naturally occur throughout Western woodland and forest cover types. The level of insect and disease activity fluctuates with the availability of host material, stand conditions, environmental factors, and the abundance of parasites and predators. These agents typically occur at endemic levels within forest ecosystems affecting overmature and weakened

trees (Edmonds et al. 2000, Samman and Logan 2000, Goyer et al. 1998). Periodically, populations of insects and diseases reach outbreak levels and impact healthy trees. Past management practices including fire exclusion, livestock grazing, and timber harvesting have altered some forest types throughout the West. As a result, many stands have become overmature, less diverse, and more susceptible to insects and diseases (O'Brien and Pope 1997). With their potential to cause extensive tree mortality, bark beetles pose the greatest threat to important resource values.

Bark Beetle Management Strategies

We did not detect active populations of bark beetles in the stands surveyed in these two parcels, suggesting that the risk of bark beetle outbreaks is presently low. The susceptibility of stands to bark beetle outbreak is also low in both parcels due to the low density of host type. There are however, active bark beetle population pockets in neighboring landscapes as indicated by the ADS data (Figures 1 & 2, Appendix I).

Bark Beetle Prevention Strategies

Vegetation management plans associated with resource objectives should be developed for both parcels that incorporate species mix and age class strategies to minimize adverse impacts associated with insects and diseases. A single treatment strategy generally does not address all resource values within a susceptible and/or infested landscape. Therefore, the selection of ecologically appropriate and economically feasible treatments should consider resource management priorities.

Further loss of trees due to bark beetles may conflict with critical resource values in the two parcels such as timber, recreation, and providing ecological diversity. While bark beetle risk remains low, I recommend developing and implementing treatments to minimize the potential for outbreaks. Prevention strategies offer the greatest likelihood of reducing the long-term susceptibility of stands to bark beetle infestation by creating a mosaic of structures, age classes, and species mixtures.

Traditionally, thinning (density management) has been the preferred strategy for bark beetle management in western forests (Goyer et al. 1998). Thinning effectively reduces a particular host resource base that supports bark beetle populations, reduces competition for water and nutrients, and disrupts the effectiveness of pheromone communication. The higher temperatures in thinned stands also reduce beetle survival and alter attack behavior of the insect (Schowalter et al. 1992, Amman et al. 1988, Schmid and Frye 1977, Sartwell and Stevens 1975).

In general, thinning treatments should reduce stand densities to less than 80ft^2/acre while maintaining inner-tree spacing and reducing average stand diameters to eight inches dbh. As density increases above 100ft^2/acre, bark beetle susceptibility generally increases.

In uneven-aged stands, susceptibility also will increase as Western white pine or Jeffrey pine dbh reaches eight inches or larger. Smaller diameter trees will be attacked when mixed with larger trees. Inter-tree spacing guidelines should be employed to reduce

susceptibility. In sites where resource objectives rely on the clumpiness of Western white pine or Jeffrey pine, inter-tree spacing guidelines should be implemented between clumps with age-class diversity emphasized within clumps to reduce losses if an outbreak does occur.

Bark Beetle Suppression Strategies

In addition to developing prevention strategies, I recommend monitoring Western white pine and Jeffrey pine stands annually for the early detection of building bark beetle populations. In the event of building populations, suppression strategies are usually implemented to reduce bark beetle population levels and rates of spread. Treatment alternatives associated with suppression, however, are usually limited often occurring at small scales. Because treatments may not sufficiently modify stand conditions, the benefits are often short term.

> SANITATION. Sanitation treatments may reduce local bark beetle levels in stands with low, but building populations and decrease stand susceptibility. Sanitation treatments involve the removal of infested and susceptible host trees. The removal of some of the larger diameter trees reduces stand densities and alters residual stand structure. To minimize the probability of re-infestation, particularly where risk remains high, sanitation treatments would need to address the entire susceptible host component. Created openings may promote some age class diversity in treated sites. Stands to consider for sanitation treatment would include infested stands with a susceptible host component that remains at risk to bark beetle attacks.
>
> Benefits of this treatment could include deriving some commercial value from harvested timber and creating greater species and structural diversity while treating fewer acres. By reducing local susceptibility, this treatment would also offer long-term management for bark beetles and provide the greatest opportunity for maintaining mature trees on the landscape. This treatment would require access to susceptible and infested trees increasing short-term site impacts. Other undesirable consequences of this treatment would include loss of large diameter trees, probable damage to residual trees and increased potential for windthrow.
>
> Treatment success decreases with rapidly expanding bark beetle populations. Openings created in stands could predispose trees to blowdown. This treatment would not reduce the overall susceptibility of stands to subsequent bark beetle attacks and may require additional entries to treat or remove downed host material, or newly infested standing trees.

Bark Beetle Restoration Strategies

The majority of the stands we surveyed in these two parcels lacked sufficient regeneration and younger age classes of trees for maintaining desirable stocking levels and a mature tree component over the long-term. A comprehensive vegetation management plan should include guidelines for enhancing desirable tree species age-class

and structural diversity. Consider planting a mixture of tree species to create an environment that supports diversity and reduces long-term insect and disease impacts.

Vegetation Management Plan: Developing vegetation management plans incorporating both long and short-term insect and disease treatment strategies for these two parcels will provide direction for minimizing adverse impacts caused by disturbance agents. The vegetation management plan should include short term suppression measures. A single treatment strategy to suppress a developing insect population or a particular disease agent may not be an effective treatment that meets most of the resource values within a susceptible stand and/or landscape. Therefore, when selecting a suppression treatment or treatments, the resource specialist must consider resource management objectives and priorities to implement an effective suppression strategy.

Insuring tree health is best accomplished by maintaining vigor and diversity within the landscape. Cultural practices that include removing infested, dead or severely damaged portions of trees will reduce insect populations, disease incidence and potential hazards. Planting a mixture of tree species will create a landscape that mitigates insect and disease impacts.

Dwarf Mistletoe Management Strategies

Many Jeffrey pine trees throughout the Skunk Harbor Parcel have greater than 48% of trees infected by DMT. Although DMT is widespread, only those stands with important timber and wildlife values would require treatment in the near future.

Several features of dwarf mistletoes allow for effective treatment of stands using cultural methods. Dwarf mistletoes require a living host to survive and are host specific. Spread rates of the disease are relatively slow. The visibility of signs and symptoms (i.e. plants, branch swellings, brooms) make infected trees easy to detect. In portions of the Skunk Harbor Parcel managed for timber and wildlife, silvicultural methods including clearcutting, seed tree cuts, shelterwood cuts, and sanitation thinning are recommended for dwarf mistletoe management. Clearcutting would involve removing infested Jeffrey pine stands and replacing them with mistletoe-free regeneration.

Optimal clearcuts for dwarf mistletoe would have as large of an area/perimeter ratio as possible to minimize edge effects and prevent re-infection from neighboring stands. In seed tree and shelterwood cuts, desirable leave trees would include those that are mistletoe-free. If necessary, leaving lightly infected trees (DMR's ≤ 3) would be admissible if overstory removal occurred before the regeneration was taller than 3', or older than 10 years. Favoring non-host species during these treatments helps reduce long-term DMT damage. Without treatment, the level of DMT infections will increase over time and result in continued loss of tree growth and vigor, and eventually tree mortality. Regeneration would also have a greater likelihood of becoming infected if infected overstory remains on site.

Pruning mistletoe-infected branches provides another option for management. Because cost and labor usually prohibit this treatment, pruning is only done to improve the vigor of high value

trees, remove dangerous brooms, and reduce hazardous fuels. Criteria for selecting trees as candidates for pruning include those having DMR ratings < 3 with infections limited to the lower crown half (Hawksworth and Johnson 1989).

White Pine Blister Rust Management Strategies

From our survey in the Babbit Peak Parcel, there were 6.84 western white pine trees per acre with WPBR. This equates to approximately 21% of the residual (live) Western white pines surveyed. The most important ecosystem affect of MPB and blister rust damage is the decreased seed availability for species proliferation and forest recovery (Schoettle and Sneizko 2007). A strategy for local, short-term management of WPBR to high-value trees is to prune infected branches to prevent it from spreading into the trunk, where it will girdle and kill the tree. This approach can be used to keep individual trees alive; however, it does not make them or other trees on the landscape any more resistant to future WPBR infection. The long term sustainability of high elevation ecosystems in the presence of WPBR will depend on the level of genetic resistance in the populations and the ability of trees to sustain themselves after disturbance. Current management strategies to mitigate the development of impacts caused by WPBR include reducing pest populations, managing forest composition, improving host vigor, introducing resistant stock with artificial regeneration, and diversifying age class structure to affect the natural selection process for resistance (Schoettle and Sneizko 2007).

It was a pleasure working with Jennifer Johnson and her crew. I appreciate her interest in forest health and her perspective on maintaining the vegetative integrity of Babbit Peak and Skunk Harbor Parcels. Forest Health Protection can provide funding for suppression treatments and technical assistance to develop vegetation management plan for these parcel areas. If you have further questions regarding this functional assistance report, please contact me by phone at 801-476-9720 ext. 214, or by email at dblackford@fs.fed.us.

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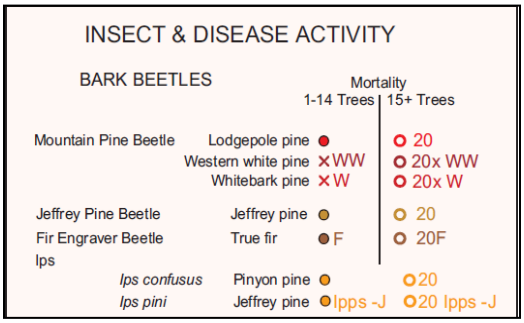
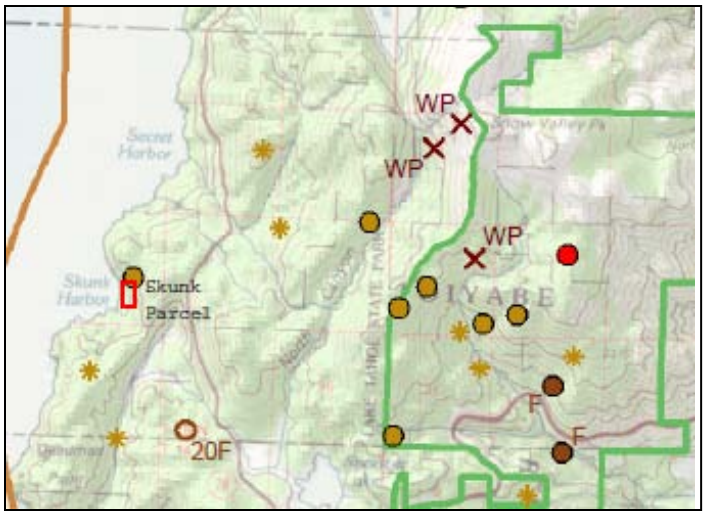
Appendix I

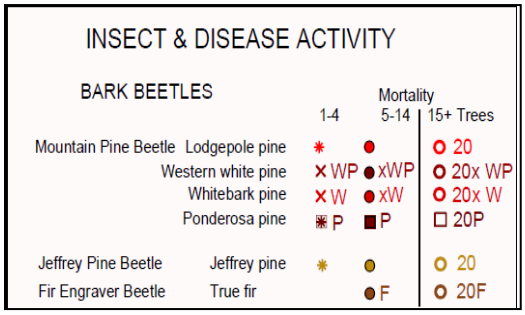
Figure 1. 2007-2009 Aerial Detection Data near Skunk Harbor Parcel.

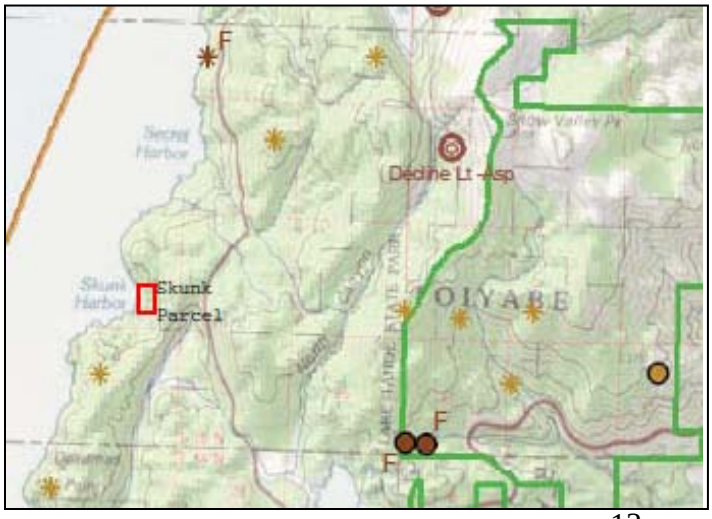
2007





2008





2009

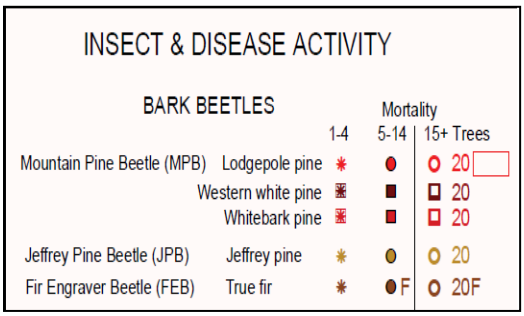
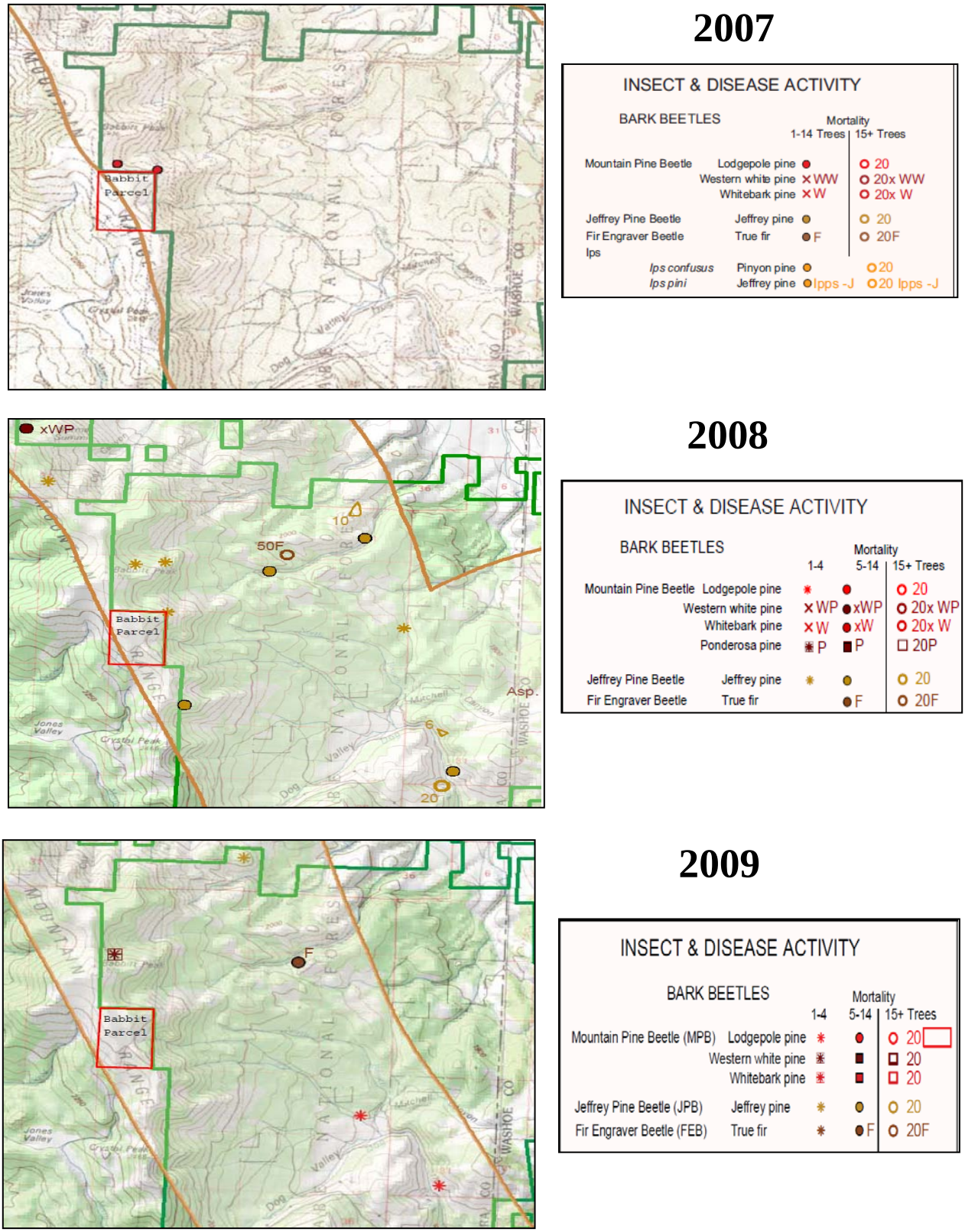



Figure 2. 2007-2009 Aerial Detection Data near Babbit Peak Parcel.