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MEMORANDUM

TO: **Bob Pietras, Area Manager, Southwest Supervisory Area**

FROM: **Tom Eckberg, Forest Health Program Manager**

DATE: **12 July 2019**

SUBJECT: **Douglas-fir tussock moth issues at Packer John Forest**

INTRODUCTION

On October 9-11, 2018, I visited Endowment, private and Forest Service lands in the Round Valley, Smiths Ferry and Crouch areas to survey for egg masses and defoliation by Douglas-fir tussock moth (DFTM), and to give an assessment of tree survival after defoliation. This report is available here. The presence of egg masses in fall is a good predictor of defoliation in the coming year. Heavily defoliated trees can be killed outright, but they can leaf out again the year following defoliation. Figure 1 is an example of the level of defoliation observed last October. Defoliation was much more severe than the 2010-2012 outbreak in northern Idaho, probably exacerbated by the dry weather in southern Idaho during 2018 (Appendix 1). Tussock moth has periodic outbreaks in southern Idaho, and the last one in this area concluded in 1993 and defoliated almost 400,000 acres at its peak. That outbreak was centered in the Boise NF to the east of Garden Valley with more defoliation west of Smiths Ferry; there was little direct impact to the Packer John Forest (Figure 2-R). The 2018 outbreak was concentrated in the Smiths Ferry area with approximately 100,000 acres of defoliation, and Packer John was heavily impacted (Figure 2-L).

I was asked by Chris Clark and John Sundberg to make a follow up visit to Packer John on June 25-26, 2019 after bud break. Pictures taken by Chris in early June 2019 indicated that the heavily defoliated grand fir (GF) and Douglas-fir (DF) were not leafing out, and that there would be widespread mortality this year (Figure 1, lower photo). Defoliation over 90% has caused outright mortality in the previous DFTM outbreak in the Boise National Forest and adjacent areas during 1990-1993. Weatherby et. al 1997 found that 88% of DF and 95% of GF that were defoliated more than 89% were dead within five years of the conclusion of the outbreak. They also felt that drought conditions during the outbreak contributed to the mortality. I made observations and took photographs at 32 locations to survey the damage around the perimeters of the two proposed management units, Center Howell (very high levels of defoliation and mortality), and Hidden Scriver (has areas of high mortality, but not as contiguous as Center Howell) (Figure 3). Geoff Klein and Silas Whitley used a UAV to take over 50 aerial photos that give a 360^{O} view of the damage (Figure 4).

PACKER JOHN BACKGROUND

This area is east of Smiths Ferry and northwest of Crouch, and consists of private land, private industrial (DF Development) land, the Packer John State Forest, and US Forest Service lands to the east. Elevations range from 4500 at Smiths Ferry to over 7000 feet on Packer John Mountain. Crouch is approximately 3000 feet on the east side. Ponderosa pine (PP) and DF are at the lower elevations and

GF, Engelmann spruce (ES), lodgepole pine (LPP) and subalpine fir (SAF) are found at higher elevations and moister aspects. I am told that this area has a history of selective logging going back to at least the 1930's. Chronic western spruce budworm (WSBW) outbreaks were common in the past, and continue to the present. Spruce budworm feeds on the same species as DFTM, and has negatively impacted regeneration of DF and GF. Balsam woolly adelgid (BWA) has been causing considerable mortality in the SAF within the last 10 years. Foresters have been addressing the WSBW outbreaks through silviculture by reducing numbers of large diameter hosts (DF, GF and SAF), planting non-preferred hosts, and discouraging multistoried stands. This approach is also effective for mitigating DFTM outbreaks.

DOUGLAS-FIR TUSSOCK MOTH BIOLOGY

The Douglas-fir tussock moth is a native defoliating insect that feeds on DF, true firs, and occasionally ES throughout the West. Eggs overwinter in masses of up to 350 individuals that are laid on host branches by flightless females in late summer. Egg hatch occurs the following late spring or early summer, depending on weather and elevation, and coincides with bud break of the host plant. Emerging larvae are very small and can be blown to other trees (Figure 5). Young larvae (the first two molts) must feed on new growth before feeding on older needles. Larvae go through five or six molts and can defoliate entire trees in one season if populations are large enough. Pupation occurs in the late summer and adults usually emerge in August. This insect is characterized by explosive, often severe, outbreaks that can cause significant host mortality. Outbreaks occur approximately once per decade in Idaho, and the area from Moscow north to Coeur d'Alene has historically experienced serious infestations. While this pest is usually most problematic in northern Idaho, substantial outbreaks have occurred in southern Idaho, especially in the Owyhee Mountains, and in the Boise, Payette and Sawtooth National Forests. The last outbreak occurred in this area from 1991 to 1993 (Figure 2). Outbreaks usually subside through natural means after causing defoliation for 1-3 years (Wickman 1978, Randall 2010). A naturally occurring virus disease specific to this caterpillar is the primary cause of the population crashes (Figure 5-L), along with other natural enemies such as parasites and predators. Due to the large size of the mature caterpillar and rapid population build-up, tree mortality can occur by feeding alone or by bark beetles attacking weakened trees after the outbreak subsides.

GENERAL OBSERVATIONS

The October egg mass survey indicated that there were viable tussock moth populations, though there was evidence of virus and parasitism (Figure 5). Defoliation from 2018 feeding was extensive, with almost complete browning or needle loss on both DF and GF (Figure 1). Even though dormant buds were observed on many trees in 2018, most trees in the heaviest defoliated areas (especially in the Center Howell proposed salvage unit) failed to produce new needles in 2019. Phloem of totally defoliated trees was checked at many sites, and it was still moist. This means that drying and checking of the wood will delayed, which is good news for salvage. It also means that the trees will be suitable for bark beetles through this year, and wood borers for the next several years.

During the last DFTM outbreak in northern Idaho, often dramatic recovery of heavily defoliated trees occurred though some mortality of GF was observed near Plummer. Similar recovery occurred in 2006 during the last DFTM outbreak in southern Idaho (See October 2018 summary). I was expecting better survival of defoliated trees in the Packer John area based on this experience. It was clear from the June 2019 survey points and UAV photographs (Figure 6, drone footage link) that this outbreak was very unlike the last northern or southern Idaho outbreaks. Drought during the 2018 growing season in southern Idaho likely contributed the high levels of mortality (Appendix 1). There was only 0.32" of

precipitation in Garden Valley during the months of June-September 2018. No precipitation fell during July and only 0.1" fell during August, when the majority of defoliation occurs.

JUNE 2019 OBSERVATIONS

CENTER HOWELL PROPOSED SALVAGE UNIT

This area saw the highest levels of defoliation in 2018, and is located on the west side of the ridge, closest to Highway 55 (Figure 7). Aerial imagery obtained by UAV gives the best impression of the extent of the damage. An example of the mortality is shown in Figure 6, but the archived map with each photo point is available here at this link. Douglas-fir, GF and some SAF were heavily defoliated last year and did not refoliate this year. Ponderosa pine, LPP and ES showed very little damage. Spruce is a known, but non-favored host for DFTM. Spruce also tends to occur in cold pockets and draws where lower temperatures slow the onset of budbreak. The first two larval instars must feed on the soft, current year's needles. At all areas that I checked, larval emergence had taken place, but ES buds were just beginning to open. Thus, the spruce may be "missing" the worst of the defoliation due to later phenology.

Estimates of defoliation ranged from 25% to near 100%. Of the nine Center Howell sites that I visited, seven had notations of heavy or very heavy defoliation. At some sites there were scattered single or clumps of trees that were not as heavily defoliated, but these trees still have the potential for top-kill (Figure 8). At each site, I looked for evidence of bark beetles (fir engraver and Douglas-fir beetle-DFB), wood borers, and ambrosia beetles. It was too early for fir engraver emergence (and fresh attacks are difficult to find). I did not see any DFB attacks on 6/25, but Chris Clark reported some attacks on windthrow, and one 24", 50% defoliated tree was attacked near site CH1 at the south end of the unit. On June 26, we did find DFB on two of four DF that we checked at Warm Springs Saddle. Attacked trees tended to have very high levels of defoliation. At site CH4, pockets of PP that were not attacked were noted (Figure 9-L). See Appendix 2 for representative photographs of damage from selected points.

It is important to remember that DFTM larvae that find a food supply (those egg masses that were laid on green or partially defoliated trees last year) will continue to feed this year. Larvae emerging from egg masses that were laid on heavily defoliated trees with no green needles this year will starve. I do feel that the combination of virus and natural enemies (such as predators and parasites) will cause the DFTM population to crash this year, but there will be additional defoliation. A limited assessment of the virus levels was conducted by Forest Service personnel in the winter of 2019, and the virus levels were similar to those in the 2010-2012 outbreak in northern Idaho. During the last year of that outbreak, larvae emerged and fed, but by mid-August larvae were very difficult to find, and there was no additional defoliation in 2013.

HIDDEN SCRIVER PROPOSED SALVAGE UNIT

Hidden Scriver is approximately one mile east of the Center Howell units, with the northern part adjacent to the Boise National Forest. This area is characterized by scattered pockets of high mortality with areas of variable defoliation interspersed. Some trees had 25-50% defoliation, and there were some trees that had little visible defoliation. Tussock moth larvae were observed at all sites, so there will be additional defoliation this year. Eighteen points were surveyed on June 25-26 (Figure 9). On June 26,

Chris and I surveyed 10 sites for DFB, and beetles were found at four sites, (sites HS19-HS22). We did not find any fir engraver, but it was still too early. We surveyed one site (HS28) of mostly GF that appeared to be infected with Annosus root disease. An apparent root disease center was observed with heavily defoliated GF with dead trees of different ages, and windthrown trees showing laminated-type decay (Figure 10). Chris has found similar areas while cruising stands on July 2. Annosus is one of the more prevalent root diseases in southern Idaho, and is most damaging on GF in this area. See Appendix 3 for representative photographs of damage from selected points.

Other Forest Health Issues

Western Spruce Budworm

Douglas-fir tussock moth has periodic outbreaks, but western spruce budworm (WSBW) has been causing low-level defoliation and has affected the Packer John forest for decades. Budworm feeds on the same hosts (DF, GF, SAF, and sometimes Engelmann spruce), but it can also mine inside developing cones, which impacts regeneration. The feeding pattern is a little different, with most of the damage concentrated on the new growth. Stands can tolerate long periods of defoliation by WSBW without suffering much mortality. This chronic feeding can weaken trees over time making them more susceptible to bark beetle attack. The management recommendation for WSBW is similar to that for DFTM: Manage for nonhost or less preferred hosts, i.e. Engelmann spruce, pines (lodgepole and ponderosa) or western larch. Western larch is listed as a host for WSBW, and I have heard of and seen some limited mining of terminals. Overall though, larch is not a preferred host. There is an old US Forest Service demonstration site north McCall, on N. Club Hill Blvd that was planted to ponderosa pine and western larch in the mid 1980's. Budworm is widespread in the control plots, but the pines and larch look very good, with limited feeding (Appendix 4). This is a very good demonstration of feeding preference by WSBW.

Balsam Woolly Adelgid

Balsam woolly adelgid (BWA) is an introduced sucking insect that feeds on SAF and GF. It has caused widespread mortality of SAF since its discovery in Idaho in 1983. This insect feeds on grand fir as well, but in northern Idaho, mortality of GF is rare. The grand fir that occur in southern Idaho are hybrids with white fir (*Abies concolor*, Ott et. al 2015), and there have been reports of BWA-caused mortality of GF in southern Idaho (Laura Lowrey, personal communication). During the June ground survey, defoliated understory GF showed evidence of BWA infestation (Appendix 5). Mortality of SAF by BWA is widespread on the Packer John forest, and dead trees were visible during this survey (Figure 7).

Root Disease

In the Hidden Scriver unit, Chris and I observed what appeared to be a root disease center (Figure 10) in an overmature GF stand. While root disease is not as common in southern Idaho, it does occur, and this stand appeared to be Annosus root disease (*Heterobasidion occidentale*). This disease is very common in northern Idaho, and is damaging to Douglas-fir, subalpine fir, and especially grand fir. Pines, and western larch are less affected by Annosus and should be used for reforestation. Engelmann spruce should not be used in areas suspected to have Annosus because it is a host. I recommend that a forest pathologist visit suspected root disease areas to confirm a diagnosis.

Bark Beetles and Wood Boring Insects

Bark beetles are known to attack trees defoliated by DFTM, and DFB was observed attacking DF during the June site visit. Douglas-fir beetle is the most aggressive bark beetle that attacks defoliated DF, and outbreaks have occurred after DFTM outbreaks (Wickman 1978, Weatherby 1997). Since fir engraver overwinters as a larva, adults were not observed in late June, but will be attacking grand fir later this summer. Fir engraver is not as easy to detect as DFB because it retains more frass inside the gallery, but foresters should be looking for entrance holes on defoliated GF during cruising. Ambrosia beetles were observed at one site in the Center Howell unit (site CH4) infesting GF. These small wood boring beetles leave white, flour-like frass around the base of the tree (Appendix 6). While damage is minor and does not usually result in scaling defect, these beetles do introduce fungi and will hasten the drying of the phloem and wood. Large wood boring beetles such as metallic wood borers and longhorn beetles were not observed during the June visit (probably due to the high elevation), but will undoubtedly fly soon. These beetles also attack recently dead trees, and introduce wood stain and decay fungi. There will be attacks on both DF and GF by wood borers, and there is not anything that can be done to prevent it. Wood borers usually mine under the bark before entering the sapwood. Life cycles are one year or more, and scalers tell me that unless the damage is extensive, there is not usually a deduction during scaling. Detection can be made when inspecting trees during cruising because there is often large amounts of frass in the bark crevices, and galleries under the bark, especially later in the summer (Appendix 6)

CONCLUSIONS AND RECOMMENDATIONS

The 2018 defoliation and subsequent lack of refoliation observed on the Packer John forest was very unlike the 2010-2012 outbreak in northern Idaho. Heavily defoliated trees observed in October still retained a large number of red needles. There was partial feeding on the needles, which dried out during the dry summer and fell off during the winter snows. These defoliated trees formed dormant buds in the summer of 2018, which led me to believe that they would refoliate in 2019. This was not the case in many areas, especially in the Center Howell proposed salvage area, and there is widespread mortality. During the June 2019 survey, most of the defoliated trees still had moist phloem, which is good news. Moist phloem retains moisture and will slow the drying and checking of wood for the proposed salvage operations. The moist phloem is also suitable habitat for bark beetles. The high elevation (5000 feet and higher) slowed the development of bark beetles that overwinter as larvae (fir engraver). Fir engraver had not started to fly when I visited the site on June 25 and 26, but Douglas-fir beetle, which overwinters as an adult, had flown and was found at four sites. Trees that were attacked by DFB tended to have high levels of defoliation. Douglas-fir beetle has one generation per year, and the trees attacked in 2019 will be a source of beetles next year. I expect an increase in DFB and fir engraver activity over the next several years due to the large number of stressed trees.

The Center Howell unit has extensive mortality akin to what would be seen after a fire. The prognosis for many of these stands is poor and prompt salvage will capture value that might be lost to wood borers and decay. Some ground sample sites had areas of lesser defoliation, but even trees that are defoliated 25% or more are likely to lose their tops due to top-kill, Weatherby et. al 1997, Wickman 1978). The defoliation pattern in the Hidden Scriver unit is more variable, with a mosaic of heavy defoliation and mortality interspersed with stands with variable damage.

Engelmann spruce experienced light defoliation so far in this outbreak, even though it is a suitable host for DFTM, it is not a preferred host (Wickman et. al 1981). Ponderosa and lodgepole pines also showed very little damage. These nonhost or less favored hosts should be used for reforestation. Tussock moth will continue to feed this year, though this should be the last year of the outbreak. Initial assessments of whether individual trees or stands may survive the outbreak should be made after feeding concludes

in late summer and buds have formed for the year. Heavily defoliated trees that had dormant buds in the fall of 2018 did not survive by the following June, so any final assessments should be made in spring 2020.

The best long-term management approach is to reduce the amount of susceptible host type (GF/DF) in the affected stands. Pines and western larch are poor hosts for DFTM. Even Engelmann spruce, while a suitable host, is not preferred (Wickman et. al 1981), and would be a better candidate for reforestation than Douglas-fir. Since DFTM females do not fly, infested stands have always had populations, or first instar larvae blew in from nearby. Tussock moth larvae will drop from an infested overstory onto smaller trees in the understory, so avoiding two storied stands is important (Brookes et. al 1978).

Remember that DFTM is cyclical, and may return in another 10 years (though the last outbreak in the early 1990's largely missed Packer John). Western spruce budworm is a perennial issue and feeds on the same hosts. Therefore any treatments done during this salvage for DFTM will also work for WSBW. Other forest health issues such as root disease, Douglas-fir beetle, fir engraver and even balsam woolly adelgid will respond favorably to stand conversion to pines, larch and where appropriate, spruce.

Please contact me if you or your staff have any questions or concerns. I am always available to make site visits if further assistance is needed.

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Figure 1. Extensive needle browning and defoliation on October 11, 2018 (top photo). This photograph was taken in the southern part of the Hidden Scriver propsed salvage unit near point HS19 on the Figure 7 map. Defoliation and mortality in the Center Howell proposed salvage unit on June 8, 2019 (Lower photo by Chris Clark)

Figure 2. Douglas-fir tussock moth-caused defoliation in the Round Valley and Packer John areas in 2018 (L) and 1991-1993 (R). The 2018 defoliation totaled approximately 100,000 acres. At its peak, the 1990's outbreak was over 400,000 acres, but most defoliation was to the east, on the Boise and Sawtooth NF's. Packer John was minimally impacted in the earlier outbreak.

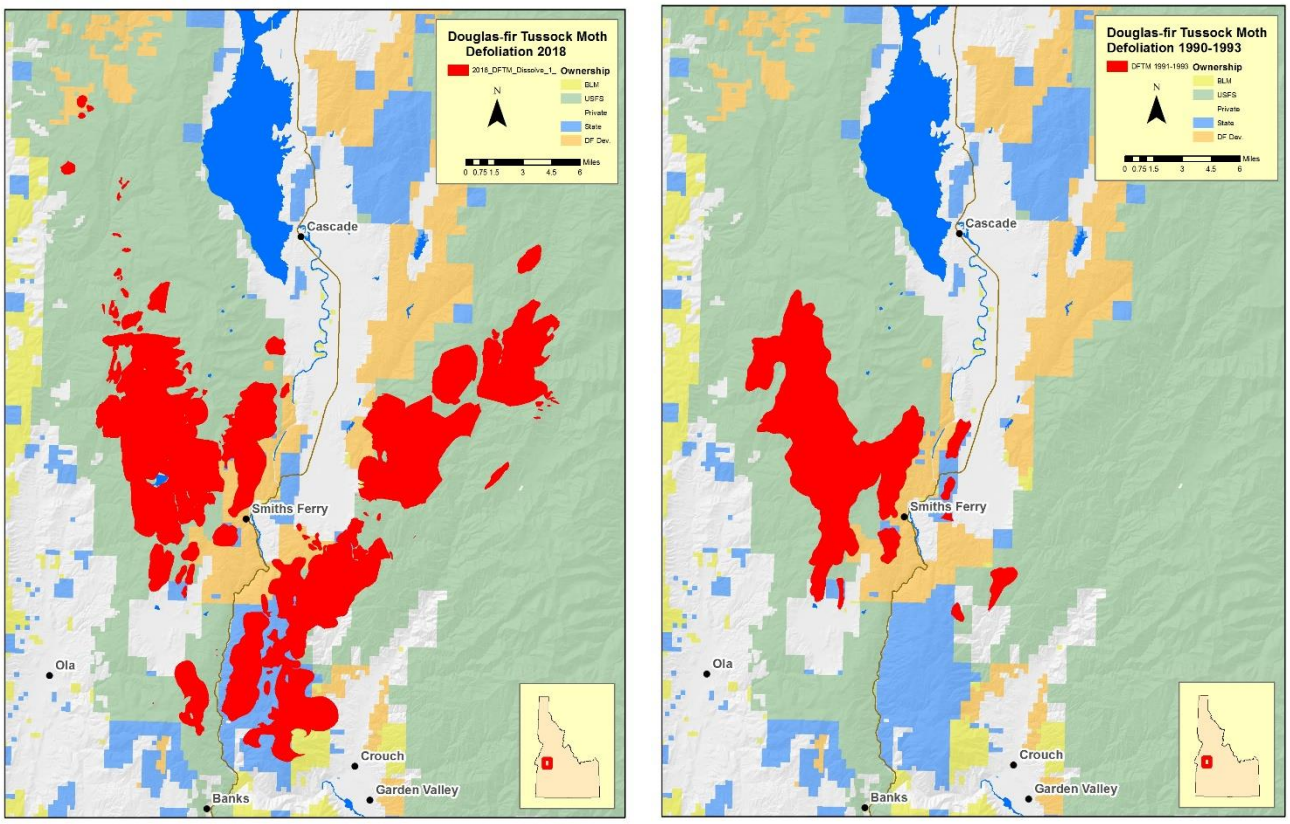


Figure 3. Variable mortality and defoliation typical in the Hidden Scriver proposed salvage area. This is the view looking north at point 'OO' in the Figure 4-Right map (upper photo). Balsam woolly adelgid mortality of subalpine fir is visible in the lower left. The lower photo is the view looking northeast at point 'RR'.

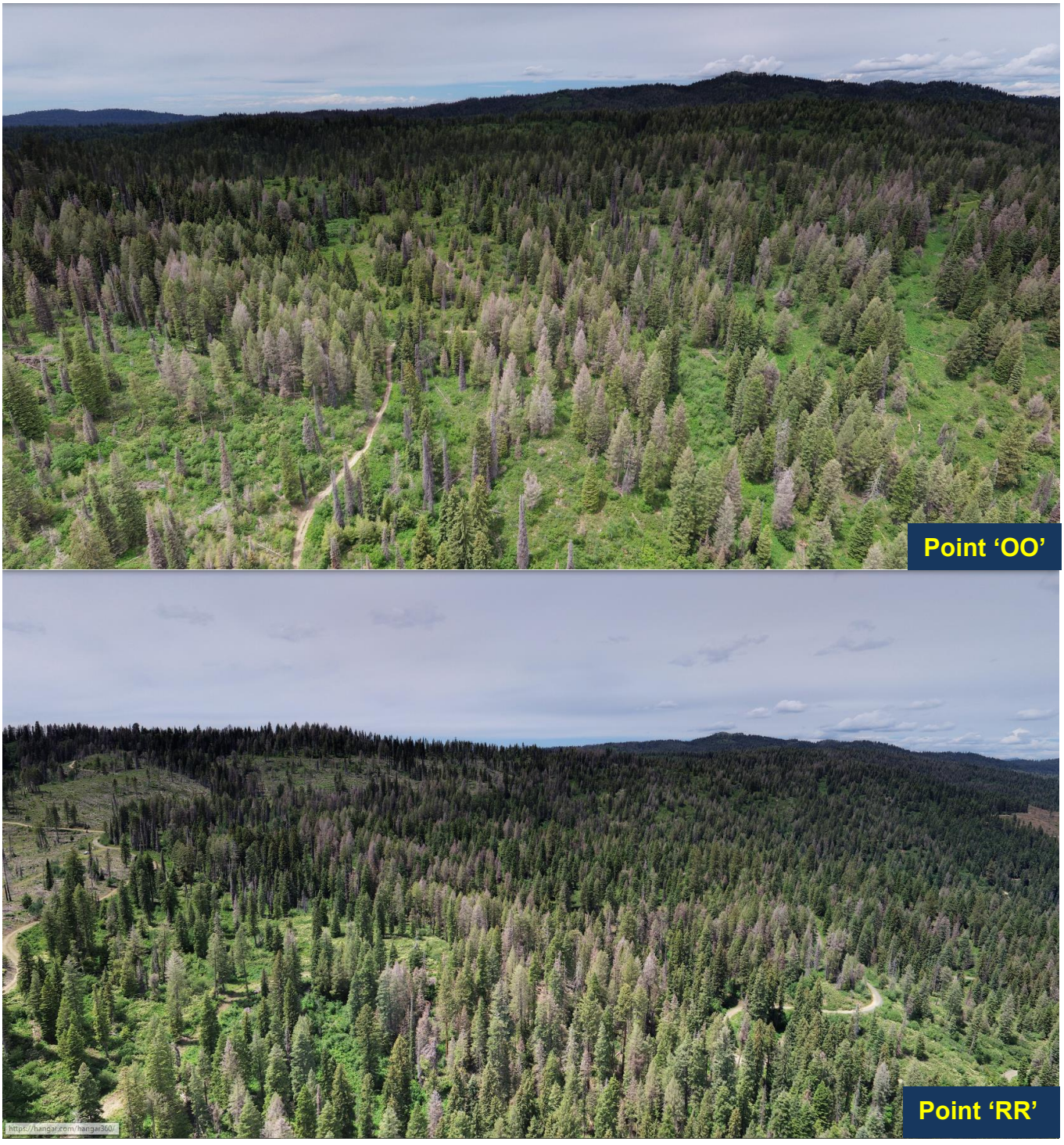


Figure 4. Location of UAV 360^{O} photographs taken by Geoff Klein and Silas Whitley.

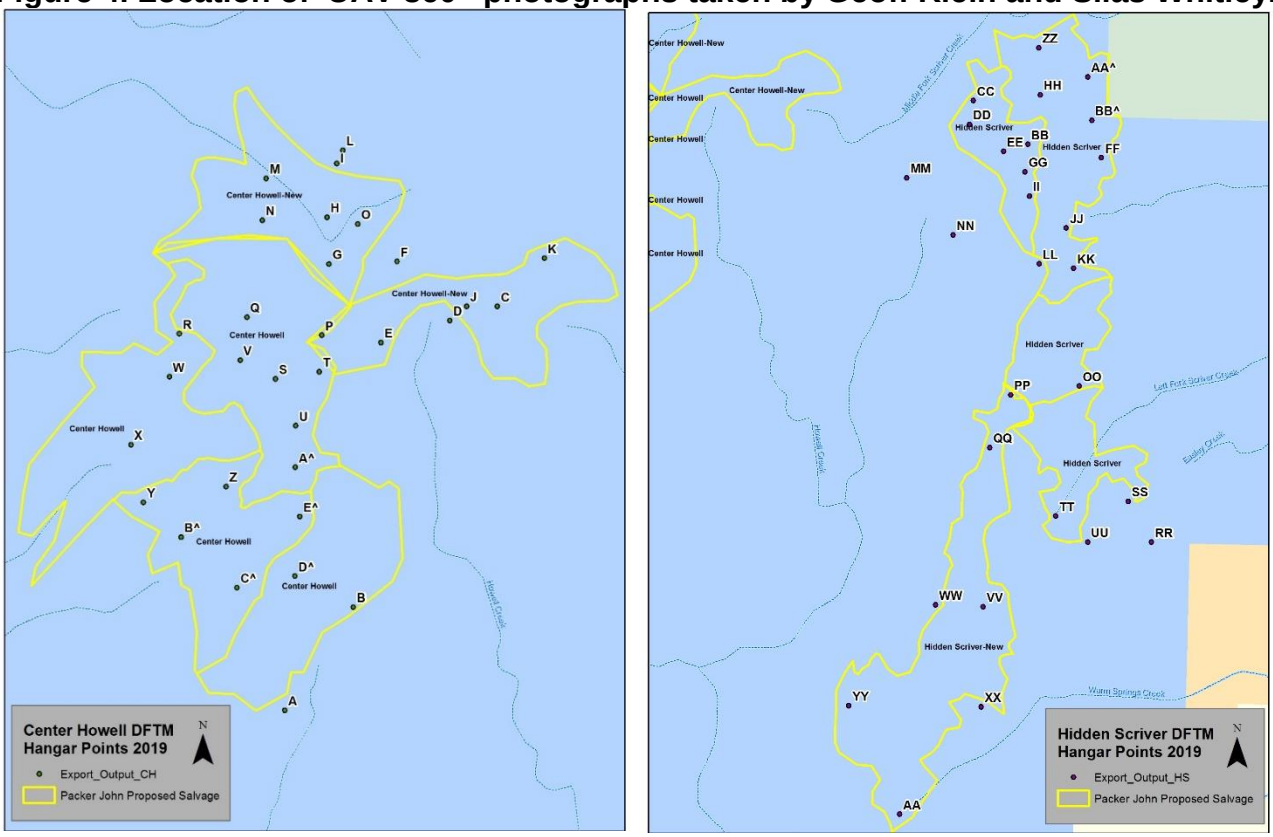


Figure 5. (L) Egg mass from October 2018 survey, with larva killed by virus. (R) First instar larvae resting on egg mass after emergence on June 25, 2019.

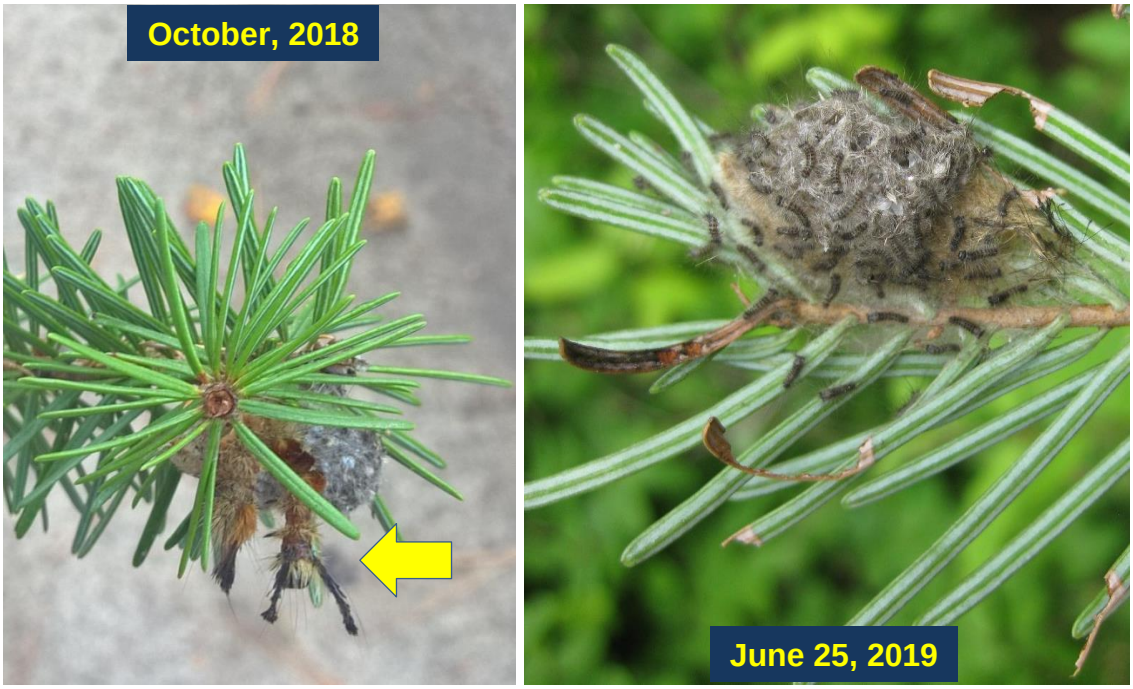


Figure 6. Upper photo- Heavy mortality in the Center Howell proposed salvage area on June 25. This is the view looking northeast at point 'Z' in the Figure 4-(Left) map. Lower photo- Heavy mortality at Center Howell Point 'I', but also showing Engelmann spruce in draw with minimal feeding. Spruce should be reserved as a seed source because they are non-favored hosts for DFTM and WSBW.

Figure 7. Location of proposed salvage units within the Packer John State Forest

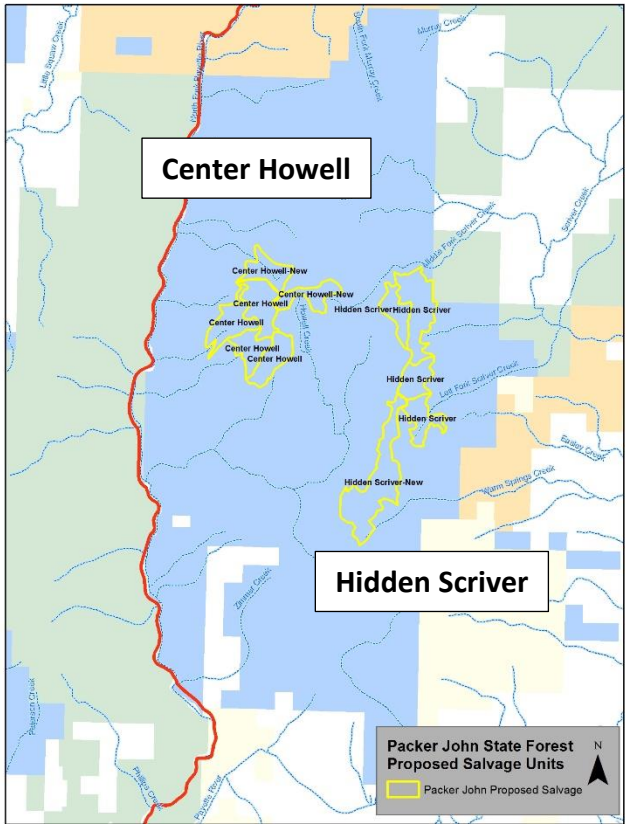


Figure 8. Partially defoliated Douglas-fir (L) and grand fir (R), observed at Center Howell site CH9. These trees were not killed by defoliation, but are likely to experience some top-kill in 2019. It appears that the two trees on the right already have spike tops. It is important to remember that additional feeding will take place in 2019. Final assessment of damage should be made in spring 2020.

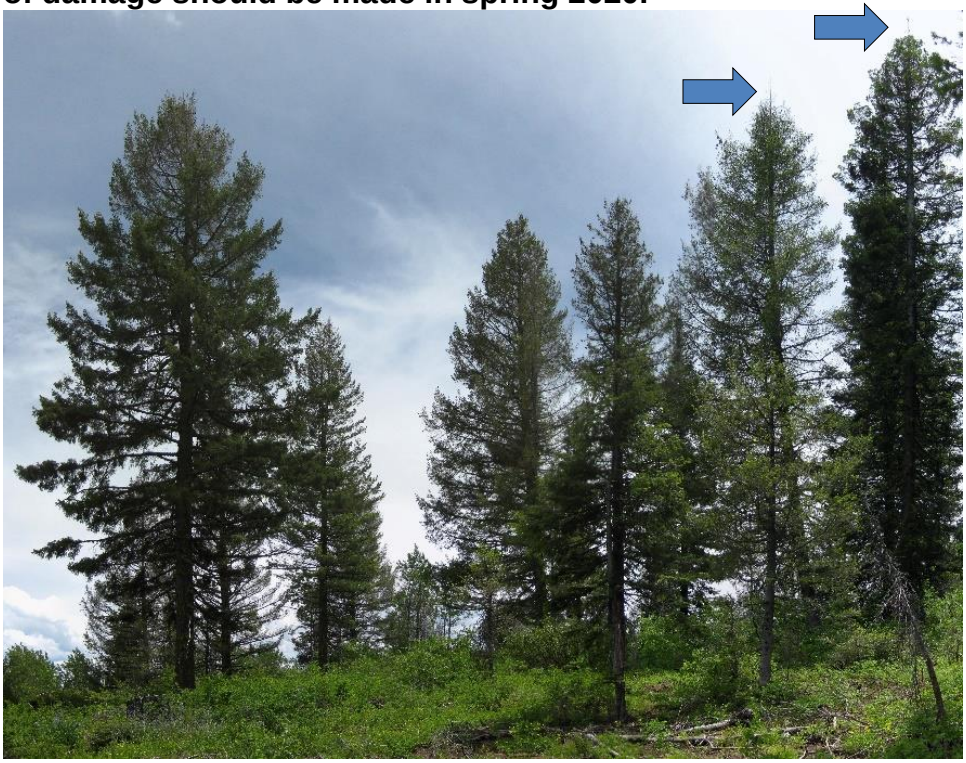


Figure 9. Location of June 2019 ground survey points.

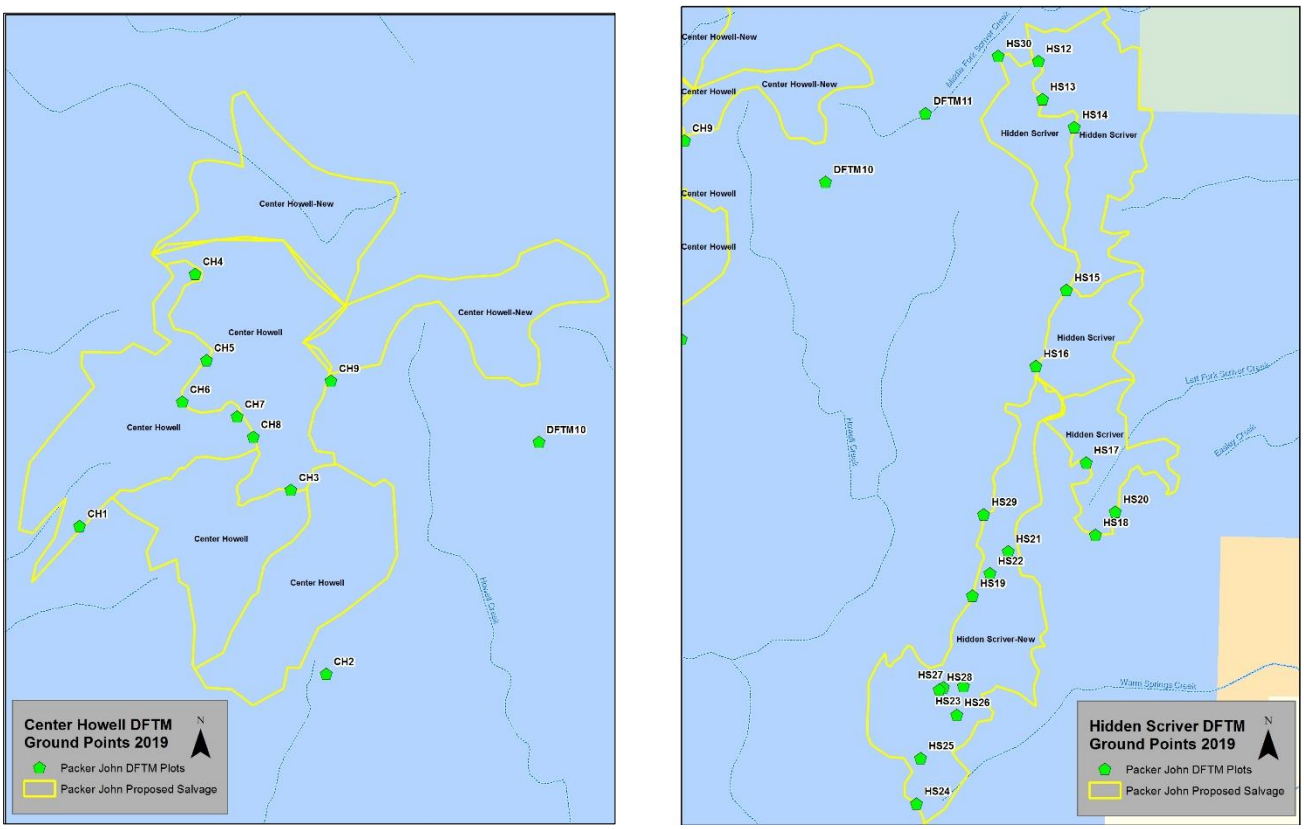
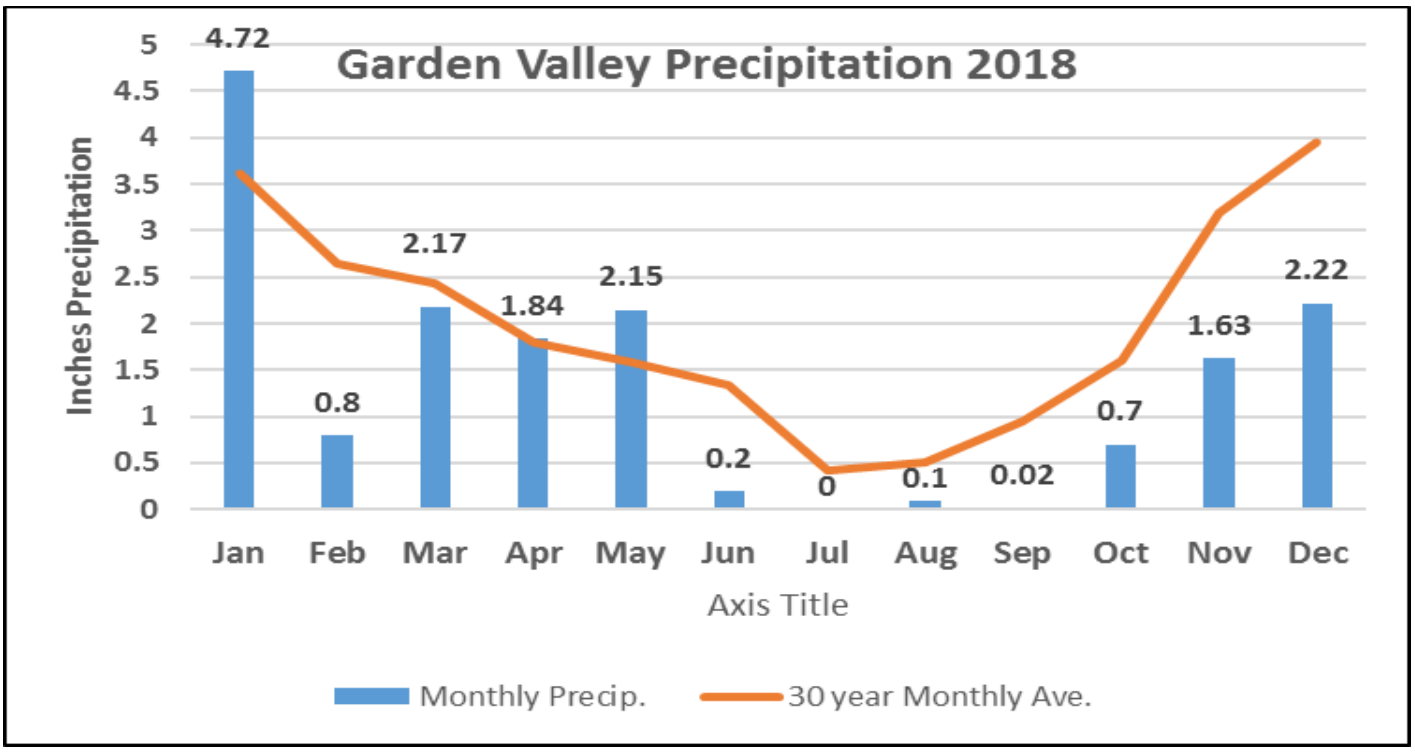
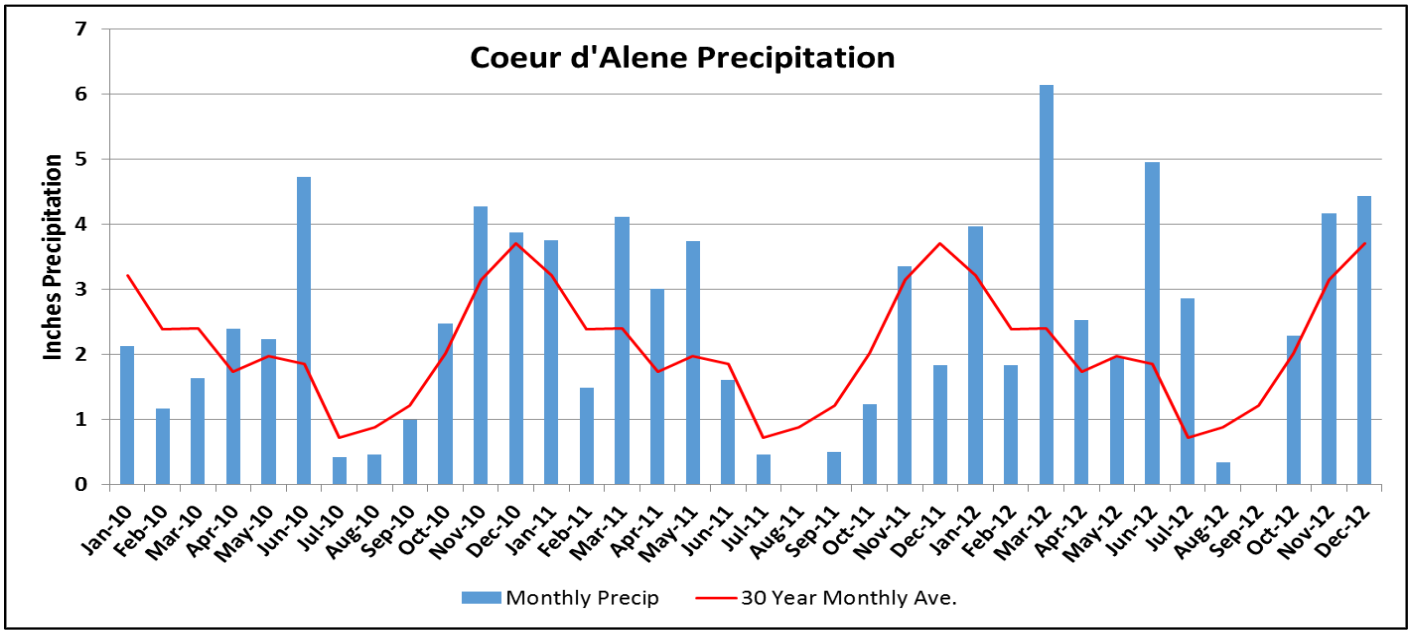


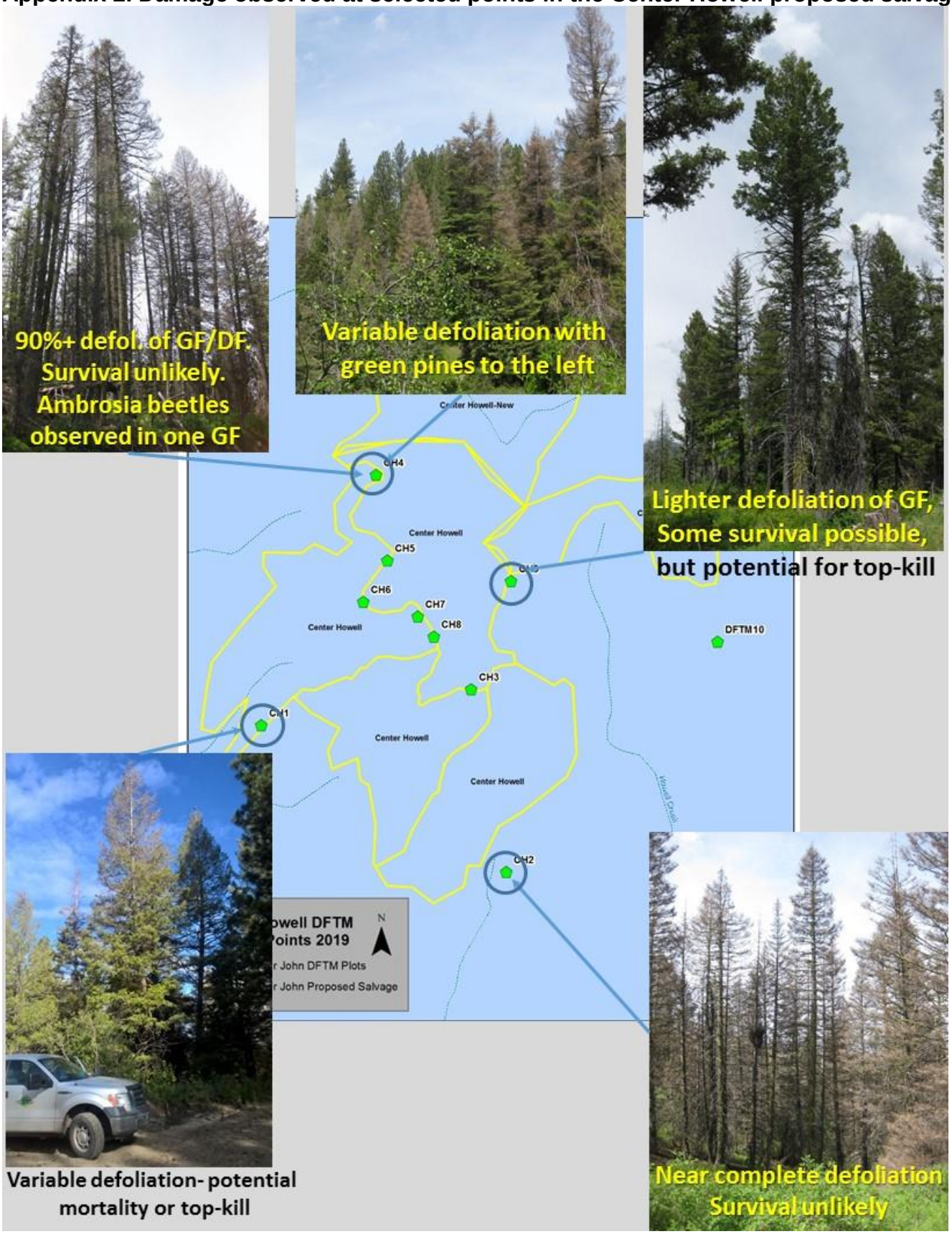
Figure 10. Left photo- Suspected Annosus root disease center at site HS28 in the Hidden Scriver proposed salvage unit. This stand is mostly heavily defoliated grand fir, with scattered Douglas-fir. Dying trees of all ages in an opening with suspicious decay in the roots. Right photo- Laminated-type decay from a similar site at Center Howell (Chris Clark photo).

Appendix 1. Comparison of monthly precipitation at Garden Valley during the 2018 outbreak, versus the Coeur d'Alene area during the 2010-2012 outbreak. Precipitation during June was much more abundant in the north, which may explain the lower levels of mortality during that outbreak.

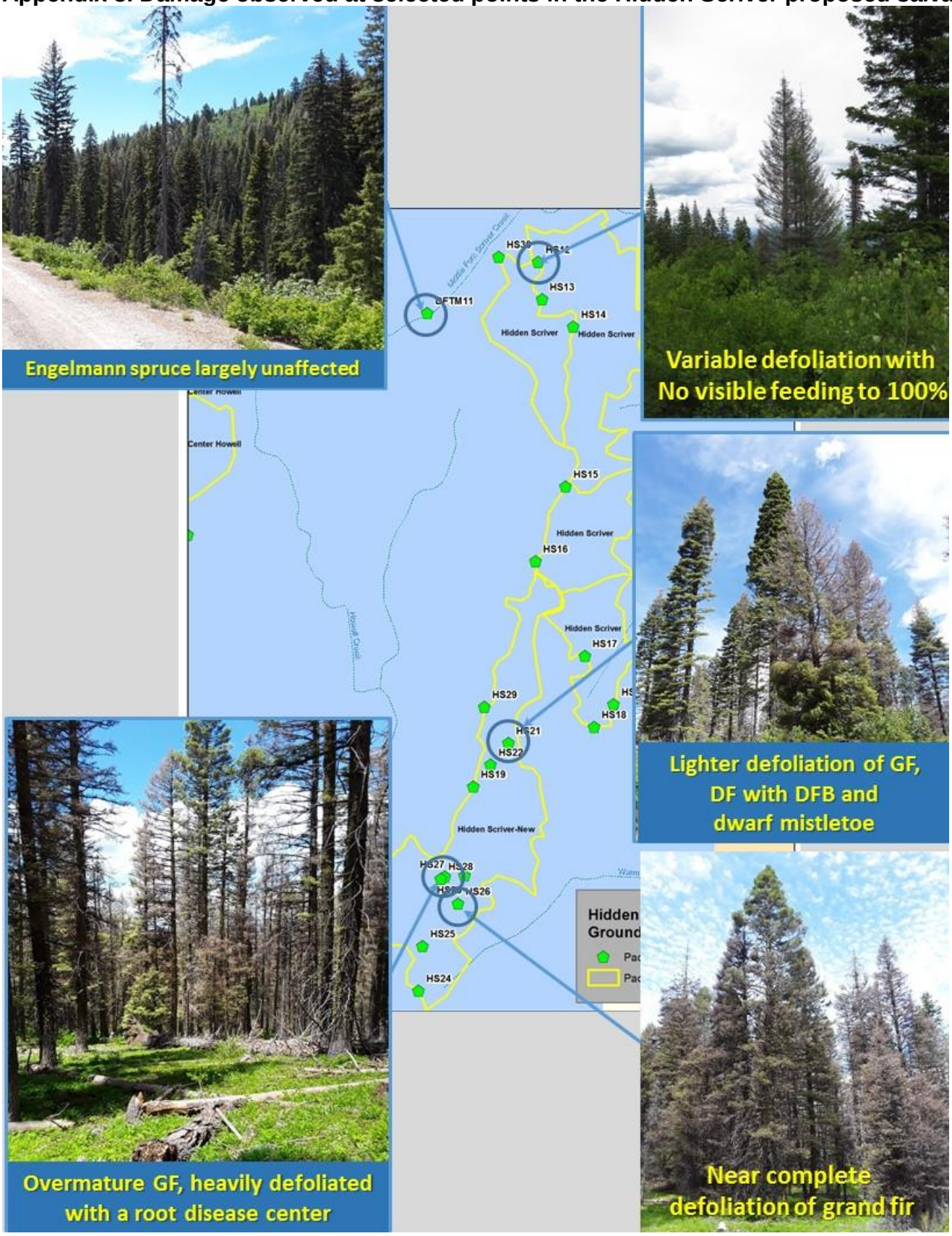




Appendix 2. Damage observed at selected points in the Center Howell proposed salvage area.



Appendix 3. Damage observed at selected points in the Hidden Scriver proposed salvage area.



Appendix 4. Top photo: Ponderosa pine and western larch planted in mid-1980's after a clearcut on Club Hill Blvd north of McCall in a USFS trial assessing different WSBW treatments. Lower photo: Control plot of Douglas-fir and grand fir defoliated by WSBW. These trees are across the parking lot from the above photograph. Photographs taken July 2016.

Appendix 5. Defoliated grand fir with gouting injury due to balsam woolly adelgid feeding.

Appendix 6. Evidence of bark beetle and wood borer attack on dead or weakened trees.

Bark Beetle Frass and Galleries

Douglas-fir Beetle Frass

Fir Engraver Gallery
(Frass outside bark is rare)

Wood Borer Frass and Galleries