2021 Idaho Douglas-fir Tussock Moth Monitoring Report

Moon Pass, Idaho. Top: Douglas-fir tussock moth-caused defoliation in 2020; Bottom: Recovery in 2021

Table of Contents

Report No. IDL 21-2

December 2021

2021 IDAHO DOUGLAS-FIR TUSSOCK MOTH MONITORING REPORT

Erika Eidson, Forest Health Specialist
Tom Eckberg, Forest Health Program Manager
Idaho Department of Lands

Gina Davis, Group Leader/Entomologist
Danielle Malesky, Entomologist
Jacob Betzen, Biological Science Technician
USDA Forest Service, Northern Region, Coeur d'Alene

Carl Jorgenson, Group Leader/Entomologist
Nicole Green, Entomologist
Jason Neumann, Biological Science Technician
USDA Forest Service, Intermountain Region, Boise

Report No. IDL 21-2
December 2021

Executive Summary

Northern Idaho

In northern Idaho, Douglas-fir tussock moth (DFTM) activity in the Silver Valley crashed, and most trees that were defoliated there in 2020 are recovering. There was a second year of defoliation in the Floodwood area (over 9,500 acres recorded via aerial survey), although it was centered a bit further north. Light defoliation was also noted in ground surveys in the Sheep Mountain Range on the Clearwater National Forest, and forest health staff received reports of moderate to heavy defoliation and topkill that may be attributed to DFTM from private landowners in the Twin Lakes area. There was no evidence of defoliation in the typical outbreak areas in Latah and Benewah counties in 2021.

Monitoring efforts were hindered by multiple wildfire closures and staffing shortages in 2021. Larval sampling was conducted at 63 sites. Most sites had no or low populations of larvae. The highest larval populations were found (1) south of Avery, (2) east of Clarkia on the northern part of the Floodwood State Forest, and (3) northwest of Elk City. A total of 169 adult trap sites were monitored (132 by IDL and 37 by USFS-R1) in 2021. The overall mean trap capture was 7.68 moths per trap for IDL traps and 12.38 moths per trap for USFS R1 traps. Egg mass sampling was conducted at 69 sites (14 sites by IDL and 30 sites by a contractor on private industry ground east of Clarkia). Only one egg mass was found at McCroskey State Park, although many old egg masses were observed east of Clarkia.

Defoliation predictions for 2022 are uncertain due to a lack of observed egg masses and monitoring limitations in 2021. Areas to watch for 2022 defoliation include the Floodwood area, Elk Summit, the Sheep Mountain Range on the Clearwater National Forest, the Twin Lakes area, and typical outbreak areas in Latah and Benewah Counties.

Southern Idaho

In southern Idaho, over 3,300 total acres of defoliation were recorded in aerial surveys in 2021. There continued to be small areas of defoliation near the Oregon border in the Cuddy and Hitt mountain ranges, similar to the defoliation pattern in 2020. A majority of the defoliation, approximately 3,000 acres, was recorded in the Owyhee mountains in the drainages surrounding Silver City on mostly Bureau of Land Management and private lands. The defoliation recorded in the Owyhee mountains was severe. There were credible ground reports of DFTM-caused defoliation occurring in the southeastern corner of the state, but due to the timing of the report they were not able to be confirmed by forest health staff.

USFS Region 4 staff conducted larval sampling west of Driggs, where DFTM-caused defoliation had occurred in 2020, and did not find any DFTM larvae. A total of 30 adult trap sites were monitored during 2021, and the average number of captured males was 14.04 moths per trap.
Egg mass sampling was conducted at 25 sites. High numbers of egg masses were observed near 2021 defoliation in the Owyhee Mountains, and moderate numbers were observed near defoliation in the Hitt Mountains.

The Owyhee Mountains will be the most important area to watch for 2022 defoliation in southern Idaho. Defoliation in the Hitt Mountains, if it materializes in 2022, will likely be limited. It is likely that the defoliation in the Hitt Mountains area is associated with the Oregon outbreak cycle rather than the recent southern Idaho outbreak near Cascade. Data from across the border in Oregon suggest this population is crashing. Due to unconfirmed ground reports, the southeastern corner of the state is another area to watch for 2022 defoliation.

Background and History

Douglas-fir tussock moth (DFTM) is a native defoliator of true firs, Douglas-fir, and occasionally other conifers in western North America. Adult males are common-looking gray-brown moths with feathery antennae (figure 1). Females are heavy-bodied and flightless, and release sex pheromones that attract males to mate. After mating, females lay egg masses (figure 2) on host tree branches in late summer or fall. Egg hatch coincides with bud burst the following spring and developing larvae (figure 3) feed on host foliage (figure 4). Development timing can vary with temperature and elevation, but pupation typically occurs in late July or August, and new adult moths emerge in late summer or fall.

In most years, DFTM populations are low and do not cause visible defoliation, but populations can periodically irrupt in cyclical outbreaks. During the outbreak phase of the cycle, DFTM populations build rapidly over a few years, then quickly collapse within one to two years as starvation, predation, parasitism, and infection by a DFTM-specific nuclear polyhedrosis virus (NPV) cause high levels of DFTM mortality. In northern Idaho, there is a long history of periodic outbreaks causing widespread defoliation (figure 5). In southern Idaho, large outbreaks have also occurred, but on a less consistent basis. Tree defoliation during a DFTM outbreak can appear very dramatic, but trees with light or moderate defoliation usually recover following the outbreak.

Since 1977, Idaho has participated in the DFTM Early Warning System (EWS), which uses a series of permanent pheromone trap sites in recorded historic outbreak areas to identify increasing populations prior to undesirable tree defoliation (system adapted from Daterman *et al.*, 1979) (figure 6). Pheromone lures that mimic sex pheromones produced by female moths are placed in sticky traps before the DFTM flight period and the number of captured adult males caught throughout the flight period is recorded each year (figure 7). Sharp increases in trap catches provide land managers advance warning of building populations. Over the decades, some sites have been dropped or moved due to fires or other disturbances, but the overall concept remains the same and priority areas have been monitored.

North Idaho Outbreaks and EWS trapping

In northern Idaho, four periods of DFTM outbreaks have been detected since implementing the EWS just after major outbreaks in the mid-1970s.The first outbreak detected by EWS traps occurred in the 1980s in Latah County and McCroskey State Park (figure 5). According to records, outbreaks of DFTM have occurred in this general area approximately every 8-10 years since at least the late 1940s when aerial detection surveys became common. The 1980s outbreak was preceded by high numbers of moth captures, but defoliation was only recorded by aerial observers in 1986 (figure 8).

The next documented northern Idaho outbreak occurred in the early 2000s and resulted in three years of defoliation on state and private lands between Plummer and Moscow, and on adjacent Clearwater National Forest lands. Similar to the 1980s outbreak, trap captures averaged over 40 moths per trap prior to visible defoliation (figure 8).

A third outbreak occurred between 2010 and 2012 and did not follow the same trends in location or moth captures. Defoliation was centered farther north than previous outbreaks, with limited

defoliation near Moscow Mountain. Most of the defoliation was in Kootenai County near Signal Point, in Benewah County near Plummer, and in McCroskey State Park. The average number of moths per trap captured prior to observed defoliation was much lower relative to the two earlier periods of outbreaks. In 2010, the average number of moths per trap was 11.8, a slight decrease from 11.9 the previous year, but over 8,500 acres of defoliation were mapped in aerial surveys. Defoliation peaked in 2011 at over 106,000 acres (approximately 68,000 acres on state and private ownership in Latah and Benewah counties, with the remaining defoliation occurring on the Nez Perce-Clearwater National Forest in the South Fork of the Clearwater River drainage). An average of 43.8 moths per trap were captured that same year. Averages greater than 40 moths per trap would normally be expected the year prior to observed defoliation. In 2012, only 6.3 moths per trap were captured and approximately 31,000 acres of defoliation were detected (figure 8).

Finally, a fourth northern Idaho outbreak is ongoing. Aerial surveyors detected approximately 16,700 acres of DFTM-caused defoliation in northern Idaho in 2020 (the 13,700 acres published in last year's report were generated from draft data), with additional defoliation in western Montana (figure 9). In 2021, over 9,500 acres were mapped. Trap catch has been rising since 2017, but defoliation occurred further east of the historic recorded outbreak areas, where EWS traps have mostly not been established. Additional information on the current northern Idaho outbreak is outlined in the Results section.

South Idaho Outbreaks and EWS trapping

Records of EWS trapping date back to 1980 in southern Idaho, but trapping has been carried out inconsistently over the decades, and early aerial survey data is not consolidated in this region. Trap catch records indicate there may have been DFTM outbreaks in the early 1980s in USFS Region 4 portion of Idaho, but there were no acres of defoliation recorded through aerial survey at that time. From 1990-1992, a major DFTM outbreak in southern Idaho caused defoliation on over 400,000 acres, primarily affecting areas east of Highway 21 on the Boise and Sawtooth National Forests. The Sagehen Reservoir area near Smiths Ferry and the Cuddy Mountain area were also defoliated in the early 1990s outbreak (figure 5). Smaller outbreaks in the early 2000s affected the most southern reaches of the state that included large areas in the Owyhee Mountains. Trap catch numbers began increasing significantly again in 2014, and in 2017, heavy defoliation was noted in stands of Douglas-fir in Craters of the Moon National Monument (figures 10A and 10B) and several other areas. Beginning in 2018 and continuing in 2019, a large outbreak affected the forests surrounding the Long Valley and Round Valley areas (figures 5 & 11). In 2020, defoliation subsided in most locations in southern Idaho, with the exception of the Cuddy Mountain and Hitt Mountain areas west of Cambridge (Payette National Forest) and the Big Hole mountains west of Driggs. In 2021, there were additional small and scattered areas of defoliation around Hitt and Cuddy Mountain (over 400 acres), as well as nearly 3,000 acres of defoliation in the Owyhee Mountains west of Mountain Home.

Outbreak Forecasting

Early Warning System trapping is often effective for predicting when DFTM outbreaks will occur, but it is not intended to predict the location or extent of tree defoliation. Therefore, additional population sampling methods for other life stages are needed to improve outbreak forecasting.

Egg mass and larval sampling are two additional methods to supplement EWS monitoring for predicting DFTM outbreak intensity and pinpointing precise locations of expected defoliation (Mason and Torgersen, 1983, Kegley *et al.*, 2004). Observations of damage to ornamental trees in landscaped settings are another indicator that outbreaks of DFTM will soon develop in forested settings (Tunnock *et al.*, 1985; Sturdevant, 2000). These 'sentinel trees' are often spruce. Although spruce are lesser-preferred DFTM host species during outbreaks in natural forests, these ornamental trees are often stressed from being planted off-site and are regularly evaluated for various issues. Prior to the 2010-2012 outbreaks in northern Idaho, defoliation of ornamental spruce was first observed at the USFS Coeur d'Alene nursery in 2007 and 2008, and grand fir yard trees were defoliated at Twin Lakes and Mica Flats in 2009 and 2010. Sentinel trees were also observed in Kootenai county and in Spokane County, Washington prior to 2020 defoliation.

Monitoring Methods

Pheromone Traps

The Idaho Department of Lands (IDL) and U.S. Forest Service Region 1 (USFS R1; northern Idaho) and Region 4 (USFS R4; southern Idaho) cooperatively manage EWS DFTM monitoring sites throughout the state (figure 6). In general, IDL maintains trap sites from Coeur d'Alene south to Moscow and east to Harvard. Six additional trap sites were installed by IDL on the Floodwood State Forest east of Clarkia in 2020 after defoliation was observed nearby. However, these additional sites were not able to be monitored in 2021 due to active wildfires. Additionally, 10 IDL-monitored sites were installed in 2020 near Smith's Ferry in southern Idaho on the Packer John State Forest. The Packer John State Forest was heavily defoliated in 2018 and 2019 and will be monitored for future outbreaks. Traps on the Packer John State Forest were not monitored in 2021, however, due to very low risk of DFM activity and staffing shortages.

Forest Health Protection, Coeur d'Alene Field Office (USFS-R1), generally maintains trap sites from Potlatch to Lucille. Due to prior defoliation by the western hemlock looper and high numbers of caterpillars observed in larval surveys, USFS R1 added five new DFTM trapping sites near Elk Summit in 2020. These five new sites were also monitored in 2021.

Forest Health Protection, Boise Field Office (USFS-R4), maintains most trap sites in southern Idaho.

Each year, five pheromone-baited sticky traps (figure 7) are installed along a transect at each trap site, with approximately 75 feet between traps. Traps are placed in young, open-grown host trees (grand fir or Douglas-fir) in late July to early August, to coincide with DFTM flight timing. Traps are collected in late September or October and the number of male moths captured in each trap is recorded. The common threshold used to predict defoliation the following year at a site is an average of 25 or more moths per trap, but we have learned over time that even 15 males on average per trap may indicate a potential outbreak with noticeable defoliation. EWS pheromone trapping is not designed to predict the exact location of future defoliation, but it is useful in identifying potential nearby drainages that may be impacted in the next year or two and follow up ground and aerial surveys are recommended.

Egg Mass Sampling

When trap captures are high (near the 25 average moths per trap threshold), fall egg mass sampling may be used to estimate the potential for defoliation in a specific area the following year. Two egg mass sampling methods are used in Idaho: (1) the "timed plot technique" and (2) methods described in Shepherd *et al.*, 1985 ("sequential sampling"). The timed plot technique works well for smaller crews and is conducted by examining grand fir and Douglas-fir trees for a total of ten working minutes (i.e., 10 minutes for a single person, 5 minutes for two people working simultaneously), and counting the number of egg masses observed. The sequential sampling method works well with larger crews and involves sampling three branches each on between 20 and 82 trees, depending on the cumulative number of egg masses found (figure 12). The mean number of egg masses per tree is then calculated. Areas where high numbers or densities of egg masses are observed during sampling are considered to be likely locations of defoliation the following year. However, it is important to note that egg masses are exposed to winter injury, predation, and parasitism prior to hatching the following spring, and first instar larvae may be susceptible to starvation if many egg masses are observed in areas that have already been heavily defoliated.

Larval Sampling

At sites where the EWS average moths per trap threshold (25 moths per trap) is reached, larval sampling may be conducted the following spring to pinpoint injurious population densities (Daterman *et al.*, 1979) and locate areas for treatment, if necessary. Larval sampling may also be useful at sites with a history of DFTM-caused defoliation occurring before trap counts reach the threshold. Sequential sampling for DFTM larvae in the lower crown is performed according to procedures outlined in Mason, 1979. A stretched canvas 'beat sheet' is placed below a host tree branch and the branch is hit several times with a stick. Larvae that fall from the branch onto the sheet are inspected and counted. Sequential larval surveys are most useful before widespread defoliation occurs and are of limited use during an outbreak (Mason, 1979). Larval sampling may also be conducted toward the end of an outbreak cycle to confirm DFTM population collapse.

Results of 2021 Survey Season

Trapping

A total of 169 sites were monitored in northern Idaho (132 by IDL and 37 by USFS-R1), and 30 sites were monitored in southern Idaho by USFS-R4 during 2021 (figures 13, 14, & 15). In northern Idaho, there were 18 trap sites that were inaccessible this year due to wildfires (13 IDL sites and 5 USFS R1 sites). These sites were located in the Floodwood area (Scott Fire), east of Harvard (Sand Mountain Fire Closure), and south of Lewiston (Snake River Complex). The 10 trap sites installed by IDL on the Packer John State Forest in 2020 were also not monitored in 2021 due to very low risk of an outbreak and staffing shortages.

The overall mean trap capture for the IDL traps in 2021 was 7.68 moths per trap, compared with 9.95, 7.28, and 1.51 moths per trap in 2020, 2019, and 2018, respectively. An average of 12.38

moths per trap were caught in USFS-R1 traps in 2021, compared with 10.58, 4.44, and 1.15 moths per trap in 2020, 2019 and 2018, respectively.

The 2021 USFS-R4 average for southern Idaho was 14.04 moths per trap compared to 10.89, 18.31, and 19.73 moths per trap in 2020, 2019 and 2018, respectively. The highest trap captures occurred near the small areas of defoliation around Cuddy and Hitt Mountains, as well as around the defoliation recorded in the Owyhee Mountains. It is likely that the populations in these outlying areas are on a different outbreak schedule than the population in the Smiths Ferry area that caused extensive defoliation in 2018 and 2019.

Larval Surveys

In northern Idaho, larval sampling was conducted (using sequential survey methods outlined in Mason, 1979) at 63 sites in 2021 (figure 16). Sites were selected for larval sampling because they had high numbers of moths per trap relative to other IDL-monitored sites in 2020, they were located in areas where outbreaks had historically occurred, or they were located near 2020 defoliation. Most sites had no or low populations of larvae. The highest larval populations (intermediate and sub outbreak levels) were found (1) south of Avery, (2) east of Clarkia on the northern part of the Floodwood State Forest, and (3) northwest of Elk City. Defoliation south of Avery was mapped in aerial surveys later in the season, but the Elk City area was not flown in 2021. In southern Idaho, USFS Region 4 staff conducted larval sampling west of Driggs, where DFTM-caused defoliation had occurred in 2020, and did not find any DFTM larvae. However, many western spruce budworm larvae were noted, as well as old DFTM pupae from 2020.

Egg Mass Sampling

Egg mass sampling was conducted at 69 sites in 2021 (14 sites by IDL, 25 sites by USFS R4, and 30 sites by a contractor on private industry ground east of Clarkia) (figure 17). In northern Idaho, only one egg mass was found at McCroskey State Park, although many old egg masses (figure 18) were observed east of Clarkia. In southern Idaho, high numbers of egg masses were observed near 2021 defoliation in the Owyhee Mountains, and moderate numbers were observed near defoliation in the Hitt Mountains. The presence of egg masses in fall generally correlates with defoliation the following season.

Defoliation

Last year (2020), defoliation in northern Idaho was centered in two main areas: the Silver Valley area around the I-90 corridor, and the Floodwood area east of Clarkia and south of Avery. In 2021, there was no defoliation detected in the Silver Valley area, suggesting that the defoliation that was recorded in 2020 was correlated with the end of a DFTM outbreak cycle that was centered around the Missoula, Montana area. Most trees that were defoliated around the Silver Valley last year are recovering (figure 19). However, over 9,500 acres of DFTM-caused defoliation were recorded via aerial survey in the Floodwood area in 2021. The defoliation in this area was centered just north of the defoliation recorded there in 2020. This is the second year of defoliation in the Floodwood area, and DFTM outbreaks typically last three years in Idaho.

The current Floodwood outbreak is further east of the typical outbreak areas. Records dating back to the 1940s show that in northern Idaho, defoliation due to DFTM outbreaks is typically centered in Latah and Benewah counties (figure 5). Defoliation is not, however, unprecedented in the Floodwood area, since early records from the 1940s and 1950s show that defoliation occurred during outbreaks in those decades as well, although it was a bit further south than the defoliation in 2021. Light defoliation was also noted in ground surveys in the Sheep Mountain Range on the Clearwater National Forest, and forest health staff received reports of moderate to heavy defoliation and topkill that may be attributed to DFTM from private landowners in the Twin Lakes area. It is possible that additional defoliation occurred elsewhere in northern Idaho in 2021, since not all areas were able to be flown in aerial surveys due to Covid-related problems. Notably, Moscow Mountain (typical outbreak area) and the Elk City area were not flown in 2021, but no defoliation was noted in ground surveys. In 2019, Douglas-fir tussock moth defoliation in the Elk City vicinity was likely masked by western hemlock looper outbreak. Larval sampling and subsequent defoliation indicated DFTM presence in 2020; however, estimating defoliation levels proved difficult to measure against previous year's defoliation.

In southern Idaho, over 3,300 total acres of defoliation were recorded in aerial surveys in 2021. Although defoliation was noted west of Driggs in ground surveys in 2020, follow up surveys in 2021 found no additional DFTM activity, only western spruce budworm. The area is an isolated stand of Douglas-fir, so the host resource may have been exhausted. There were credible ground reports of DFTM-caused defoliation occurring in the southeastern corner of the state, but due to the timing of the report they were not able to be confirmed by forest health staff. Similar reports of defoliation in that area were also received by Forest Health Protection staff at the Ogden Field Office in Utah. There continued to be small areas of defoliation near the Oregon border in the Cuddy and Hitt mountain ranges, similar to the defoliation pattern in 2020. A majority of the defoliation, approximately 3,000 acres, was recorded in the Owyhee mountains in the drainages surrounding Silver City on mostly Bureau of Land Management and private lands. The defoliation recorded in the Owyhee mountains was severe. Draft aerial survey data for Oregon from USFS Region 6 shows that DFTM-caused defoliation was also recorded in Oregon across the border from the Idaho defoliation. Forest health staff in Oregon have noted that the draft aerial survey data is likely an overestimate of the extent of current damage in Oregon (it included 2020 and 2021 damage areas), and no new cocoons or egg masses were found in Oregon outbreak areas in 2021. It is likely that the defoliation in southern Idaho in 2021, which was all located on the far western edge of the state, is associated with the Oregon outbreak cycle. The large outbreak that occurred in southern Idaho from 2017 – 2019, primarily around Cascade, crashed in 2020.

Conclusions

In northern Idaho, DFTM activity in the 2021 season roughly followed predictions made in 2020. Activity in the Silver Valley crashed, and there was additional defoliation in the Floodwood area, although it was centered a bit further north than anticipated. It was uncertain whether the typical outbreak areas in Latah and Benewah counties would see defoliation in 2021, and although not all areas were included in aerial surveys, there was no evidence of defoliation in those counties this year. Notably, the Elk Summit area near Elk City experienced defoliation in 2020 and had very high trap captures in 2021. However, this area was not flown in aerial surveys and defoliation was difficult to quantity in ground surveys due to recent western hemlock looper

damage. Egg mass surveys were not conducted here in 2021, but it is an area to watch for defoliation in 2022.

Predictions for north Idaho in 2022 are unclear. Many areas, including the Floodwood, east of Harvard, and south of Lewiston were unable to be trapped in 2021 due to wildfires. Although there were still some areas of high trap captures in the typical outbreak areas of Latah and Benewah counties, egg mass surveys only found one egg mass in McCroskey State Park. Egg mass surveys in the Floodwood area also did not turn up any current egg masses, although there was not good survey coverage south of Avery where the majority of the defoliation was centered. Egg mass surveys were conducted in the defoliated area of the Sheep Mountain Range on the Clearwater National Forest in October, but no egg masses were found. A lack of current egg masses in fall usually suggests limited defoliation the following season. Nonetheless, the Sheep Mountain Range, along with the Twin Lakes area (where landowners reported defoliation but egg mass surveys were not conducted in 2021) are two additional areas to watch for defoliation in 2022.

Douglas-fir tussock moth outbreaks in Idaho typically last three years, and 2021 was the second year of defoliation in this outbreak. One hypothesis is that this outbreak may be shorter than usual due to high predator and parasitoid populations in the Floodwood area. The Floodwood experienced a landscape scale outbreak of the western hemlock looper in 2019. Western hemlock looper is another defoliator that is preyed upon and parasitized by many of the same insects that kill DFTMs. Although the western hemlock looper outbreak crashed in 2020, elevated populations of predators and parasitoids may have persisted and could help to crash DFTM populations. However, one of the main elements in crashing DFTM populations is NPV, a virus that is specific to DFTM. Evidence of NPV presence in the Floodwood DFTM population was noted in August, 2021, but the extent to which it will impact DFTM populations is still unclear.

In southern Idaho, it appears that the DFTM population near Driggs has crashed, and current defoliation in that area is attributed to western spruce budworm instead. There were high trap captures of adult males near Driggs in 2021, but this is not unusual following a population crash. Female moths are more heavily affected by natural enemies than males, so high numbers of male moths may temporarily persist. The Owyhee Mountains will be the most important area to watch for 2022 defoliation in southern Idaho, since high numbers of egg masses were recorded there. Some egg masses were also found in the Hitt Mountains, suggesting there may be further defoliation there in 2022. Defoliation in the Hitt Mountains, if it materializes in 2022, will likely be limited. Next year would be the third year that this area has seen defoliation, and natural enemies of DFTM have already been recorded there. Furthermore, data from across the border in Oregon suggest this population is crashing. Due to unconfirmed ground reports, the southeastern corner of the state is another area to watch for 2022 defoliation.

In all parts of Idaho, trees with light or moderate defoliation typically recover. However, trees that are heavily defoliated or defoliated for multiple years in a row may die from defoliation alone. Especially in areas where there have been consecutive years of defoliation, increased bark beetle activity may result, leading to additional tree mortality in the area.

For additional information (including data, maps, reports, photos, or videos) please contact the Idaho Department of Lands Forest Health Program

Idaho Department of Lands, 3284 W Industrial Loop, Coeur d'Alene, ID 83815 (208) 769-1525

Literature Cited

Daterman, G.E., R.L. Livingston, J.M. Wenz, and L.L. Sower. 1979. Douglas-fir tussock moth handbook. How to use pheromone traps to determine outbreak potential. USDA Agriculture Handbook No. 546. 11 p.

Kegley, S.J., D. Beckman, and D.S. Wulff. 2004. 2003 North Idaho Douglas-fir tussock moth trapping system report. USDA Forest Service, Northern Region, Forest Health Protection Rpt. 04-6. 7 p. (Link)

Mason, R.R. 1979. How to sample Douglas-fir tussock moth larvae. USDA Agriculture Handbook 547. 15 p.

Mason, R.R. and T.R. Torgersen. 1983. Douglas-fir tussock moth handbook. How to predict population trends. USDA Agriculture Handbook No. 610. 7 p.

Shepherd, R.F., I.S. Otvos, and R.J. Chorney, 1985. Sequential sampling for Douglas-fir tussock moth egg masses in British Columbia (Vol. 15).

Sturdevant, N. 2000. Douglas-fir tussock moth in northern Idaho and western Montana, current activity and historical patterns. USDA Forest Service, Northern Region, Forest Health Protection Rpt. 00-12. 6 p. (Link)

Tunnock, S., M. Ollieu, and R.W. Thier, 1985. History of Douglas-fir tussock moth and related suppression efforts in the Intermountain and Northern Rocky Mountain Regions 1927 through 1984. USDA Forest Service Intermountain and Northern Regions. Rpt. 85-13. 51 p. (Link-*Very large file*)

This survey and report was partially funded by the USDA Forest Service.

Figure 1. Adult Douglas-fir tussock moth male (left) and female (right). Female moth is pictured on an egg mass.

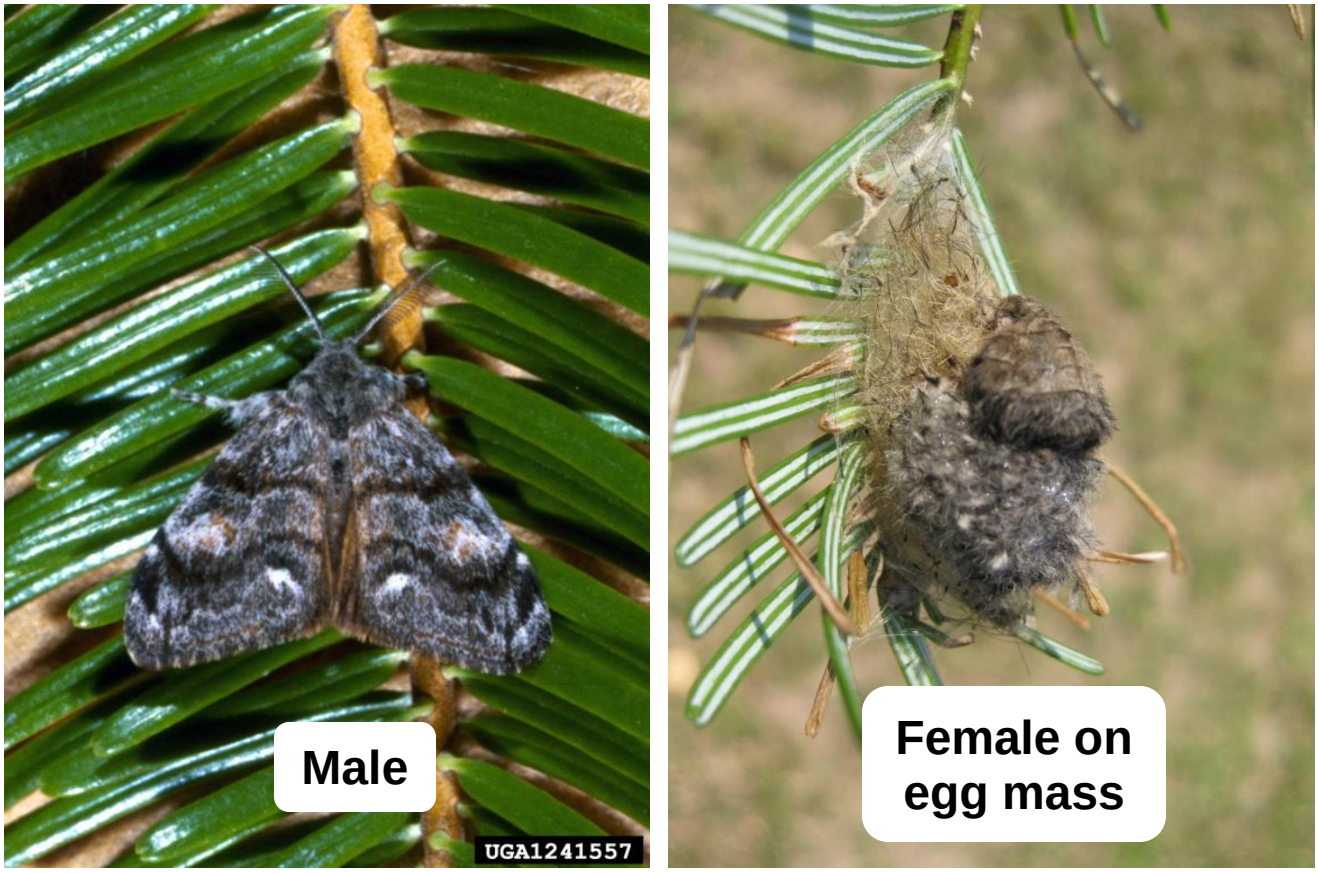


Figure 2. Douglas-fir tussock moth egg mass.

Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 3. Newly hatched (left) and fully grown (right) Douglas-fir tussock moth larvae.

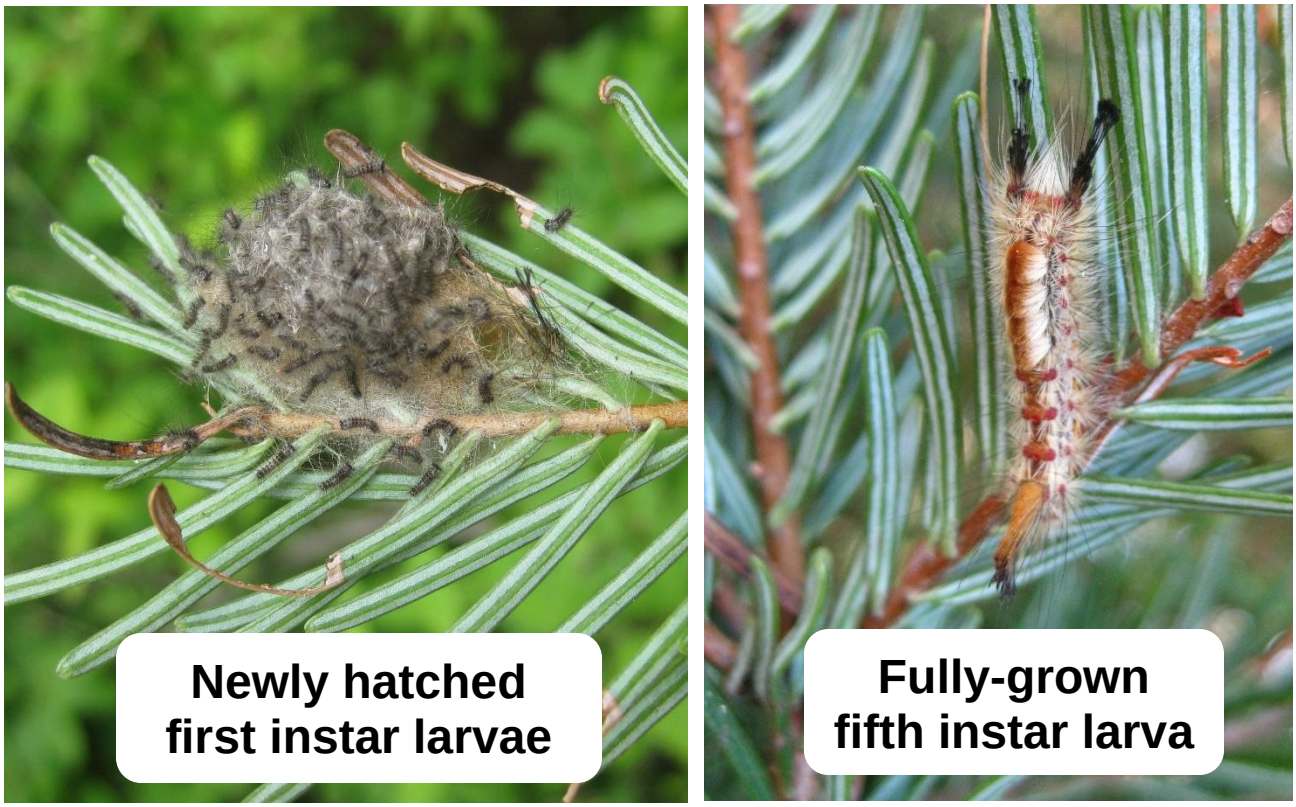
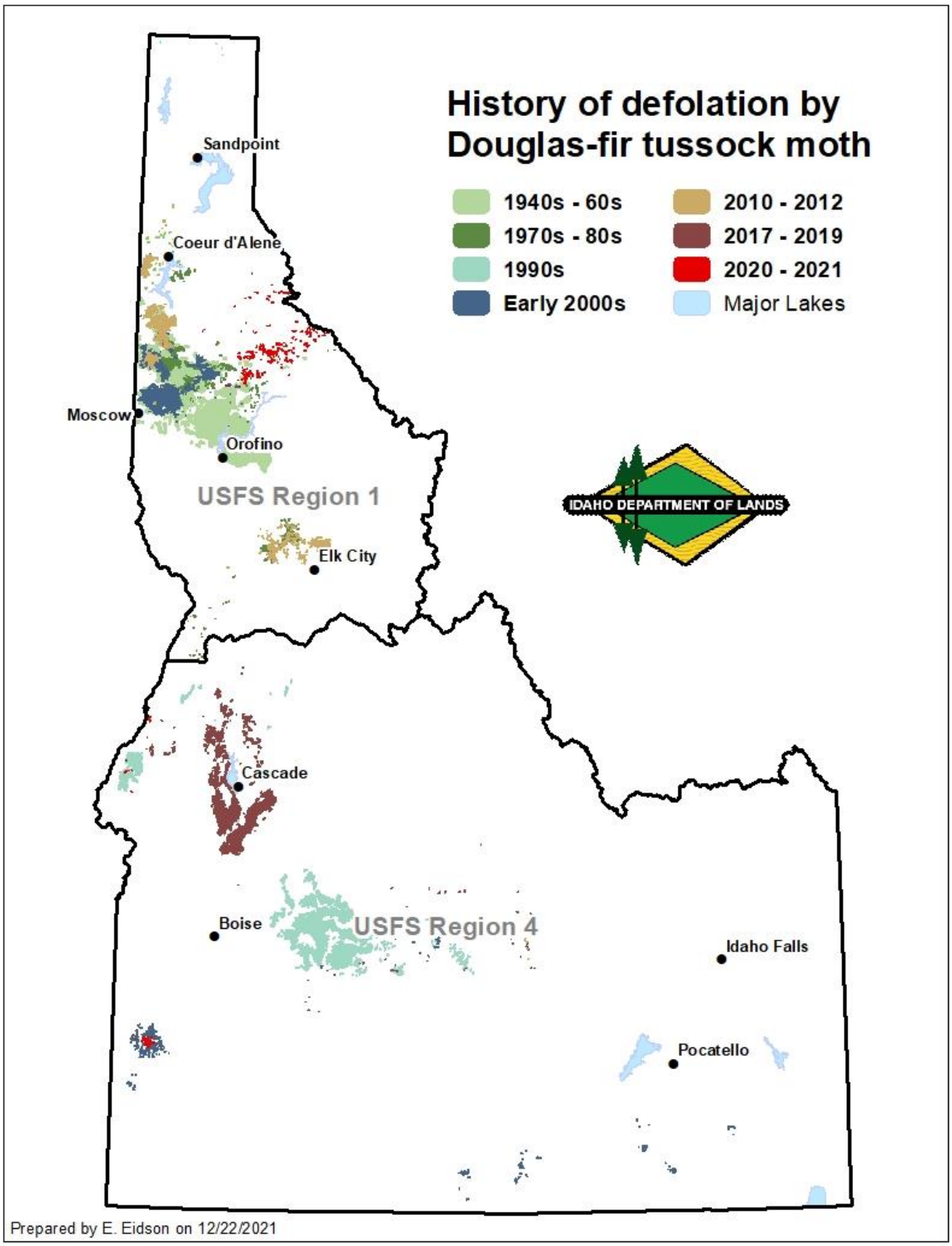


Figure 4. Douglas-fir tussock moth (DFTM)-caused tree defoliation.

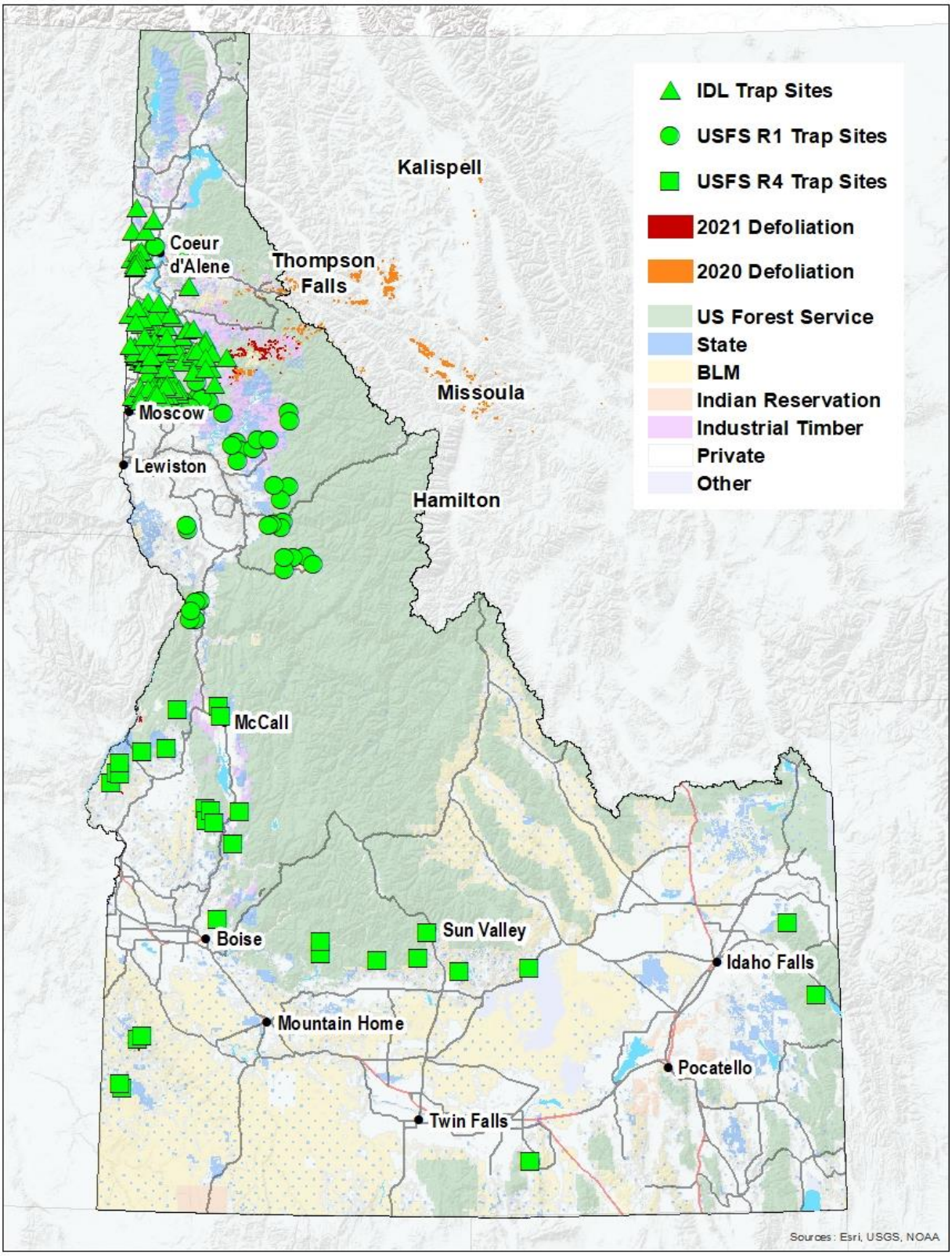
Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 5. Aerially mapped defoliation by Douglas-fir tussock moth for the 1940s to 2021. Outbreaks often occur in the same general areas in north Idaho.



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 6. Early Warning System trap distribution in Idaho in 2021.

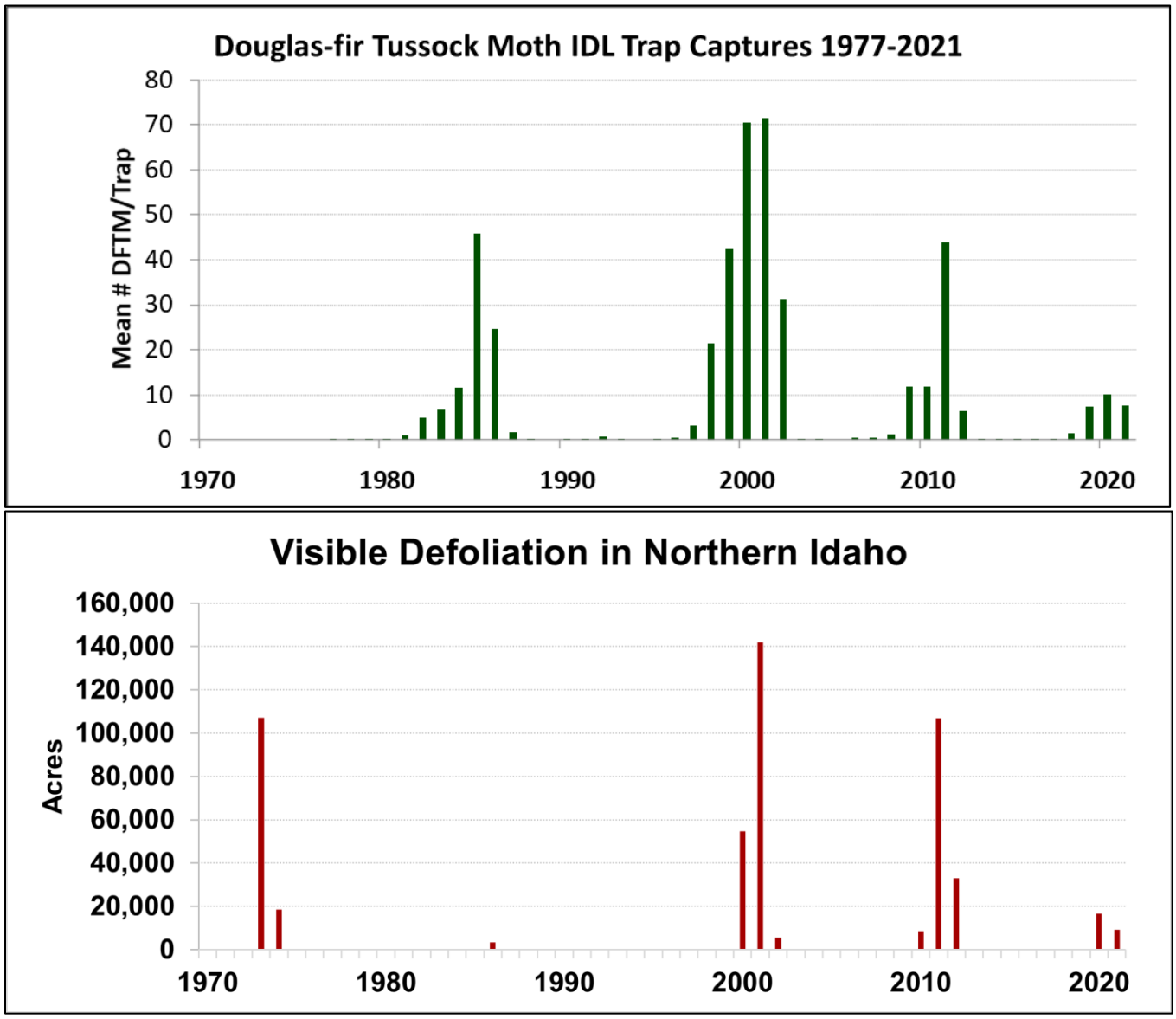


Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 7. Early Warning System (EWS) pheromone-baited sticky trap and captured adult male moths.

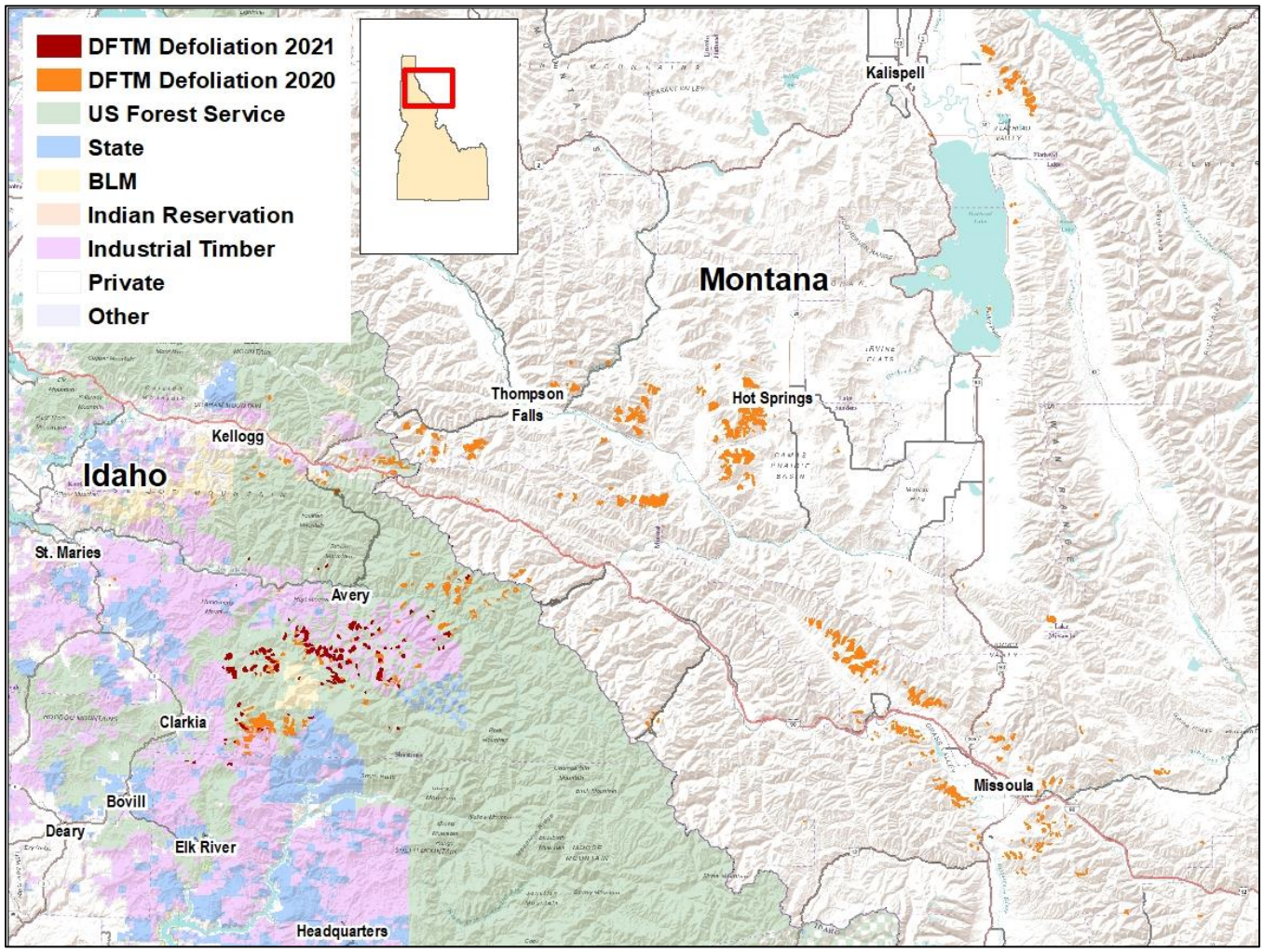
Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 8. Mean trap catches of Douglas-fir tussock moth on plots monitored by IDL (top) and visible defoliation in northern Idaho (bottom) from 1977 – 2021.



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

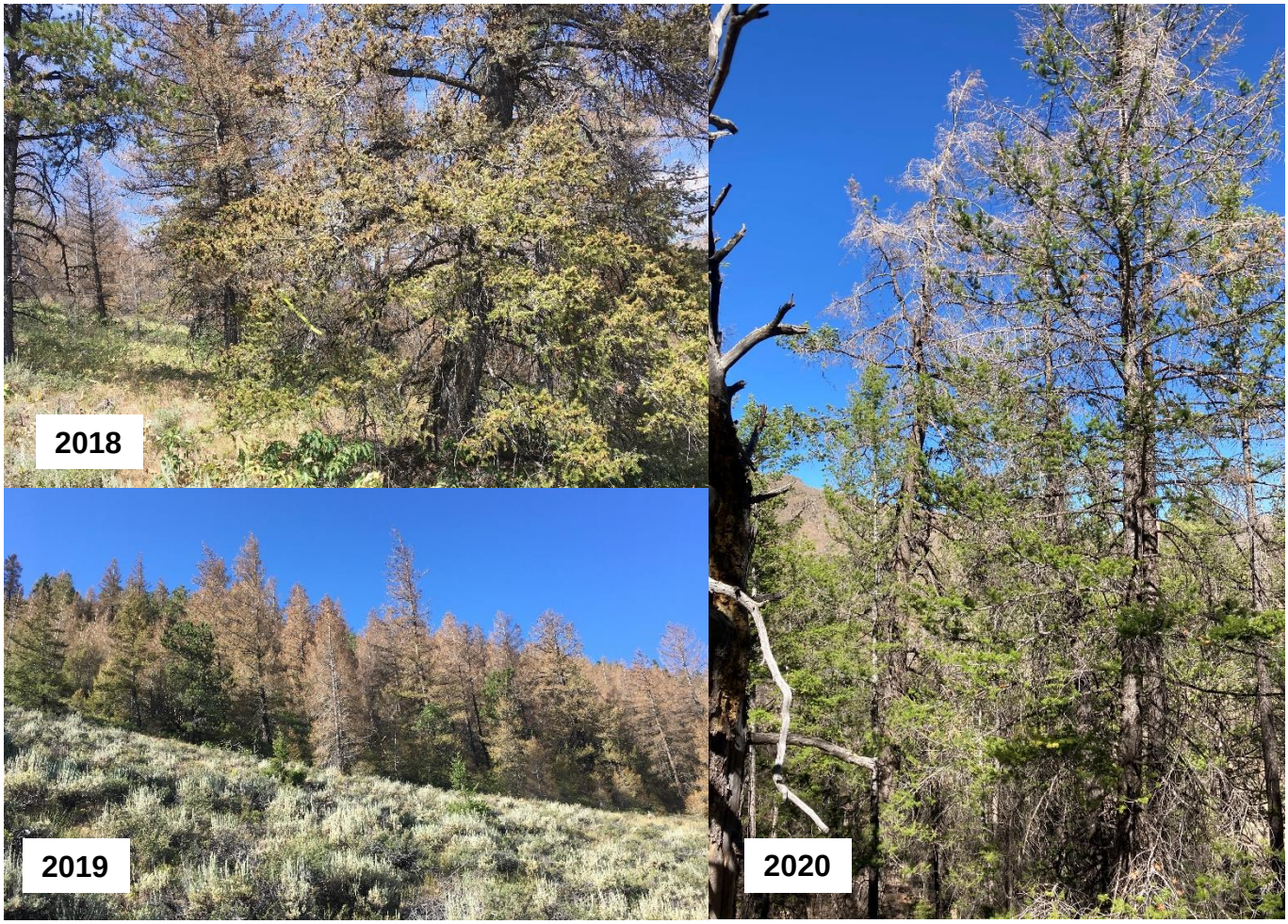
Figure 9. Douglas-fir tussock moth-caused defoliation in northern Idaho and western Montana in 2020 and 2021.



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

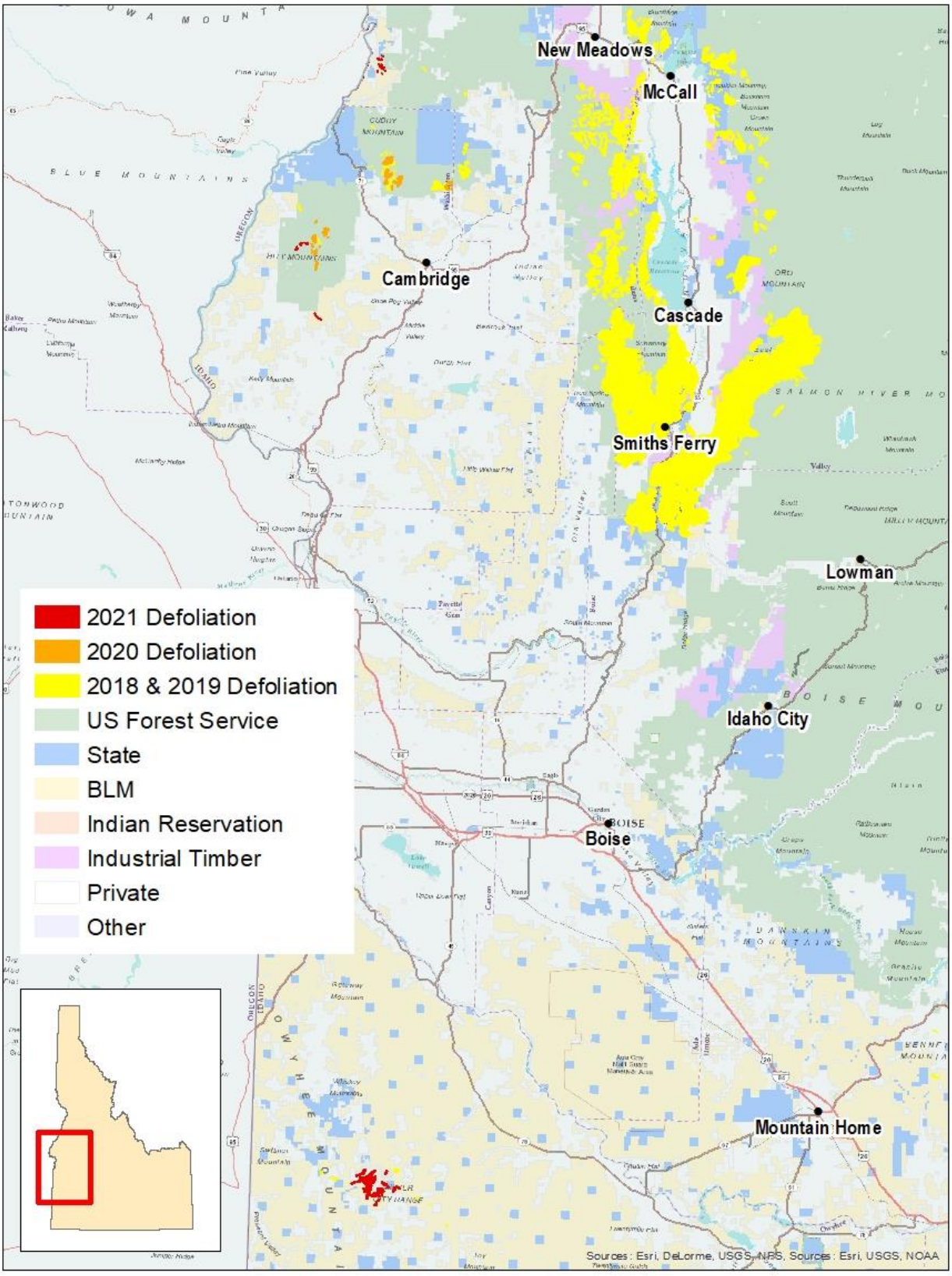
Figure 10A: Photos of severe tree defoliation by Douglas-fir tussock moth at Craters of the Moon National Monument in 2017.

Figure 10B: Photos of very limited tree recovery at Craters of the Moon National Monument in 2018, 2019, and 2020, following severe defoliation by Douglas-fir tussock moth in 2017.



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 11. Douglas-fir tussock moth-caused defoliation recorded by Aerial Detection Survey in southwestern Idaho, 2018 - 2021.



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 12. Data sheet for Shepherd *et al*., 1985 Douglas-fir tussock moth egg mass sampling method. Data sheet shows number of host trees to be sampled (by inspecting three branches per tree) based on cumulative egg masses observed at a site. If the Lower Stop number of cumulative egg masses has been observed when a given Tree # is reached, sampling at the site is complete and the average number of egg masses per tree is calculated.

Douglas-fir tussock moth egg-mass survey

Plot # _____ Location _____

Observer _____ Date _____

Tree #	# Egg Masses	Cumulative # Egg Masses	Lower Stop #	Tree #	# Egg Masses	Cumulative # Egg Masses	Lower Stop #
2			–	44			18
4			–	46			19
6			–	48			20
8			–	50			21
10			–	52			22
12			–	54			23
14			–	56			24
16			–	58			26
18			–	60			27
20			5	62			28
22			5	64			29
24			6	66			30
26			8	68			31
28			9	70			33
30			10	72			34
32			11	74			35
34			12	76			36
36			13	78			37
38			14	80			38
40			15	82			39
42			17				

Predicted Defoliation

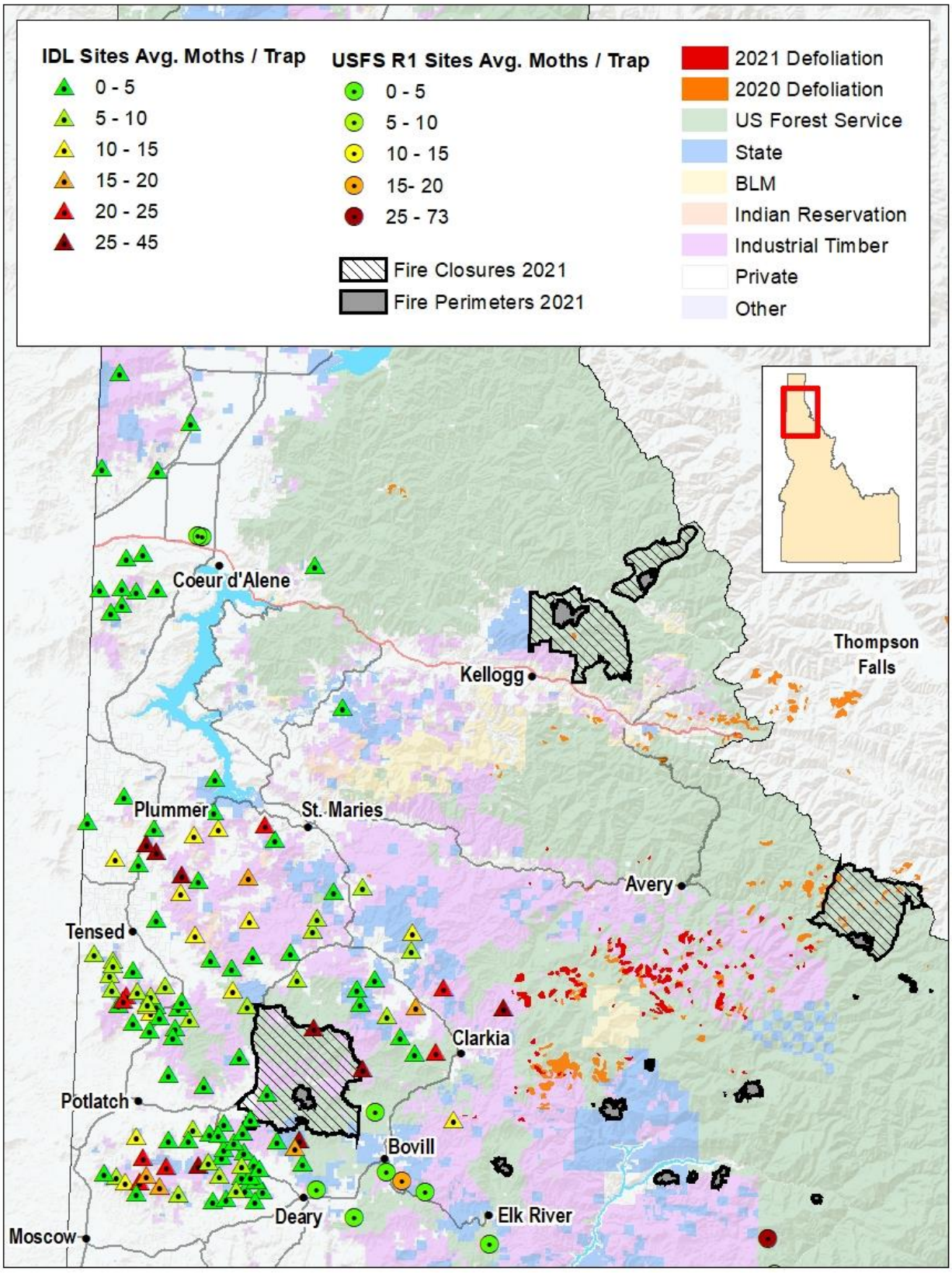
L M S

Map overleaf

Stop sampling when cumulative egg masses reaches 40 or is equal to or below lower stop number.

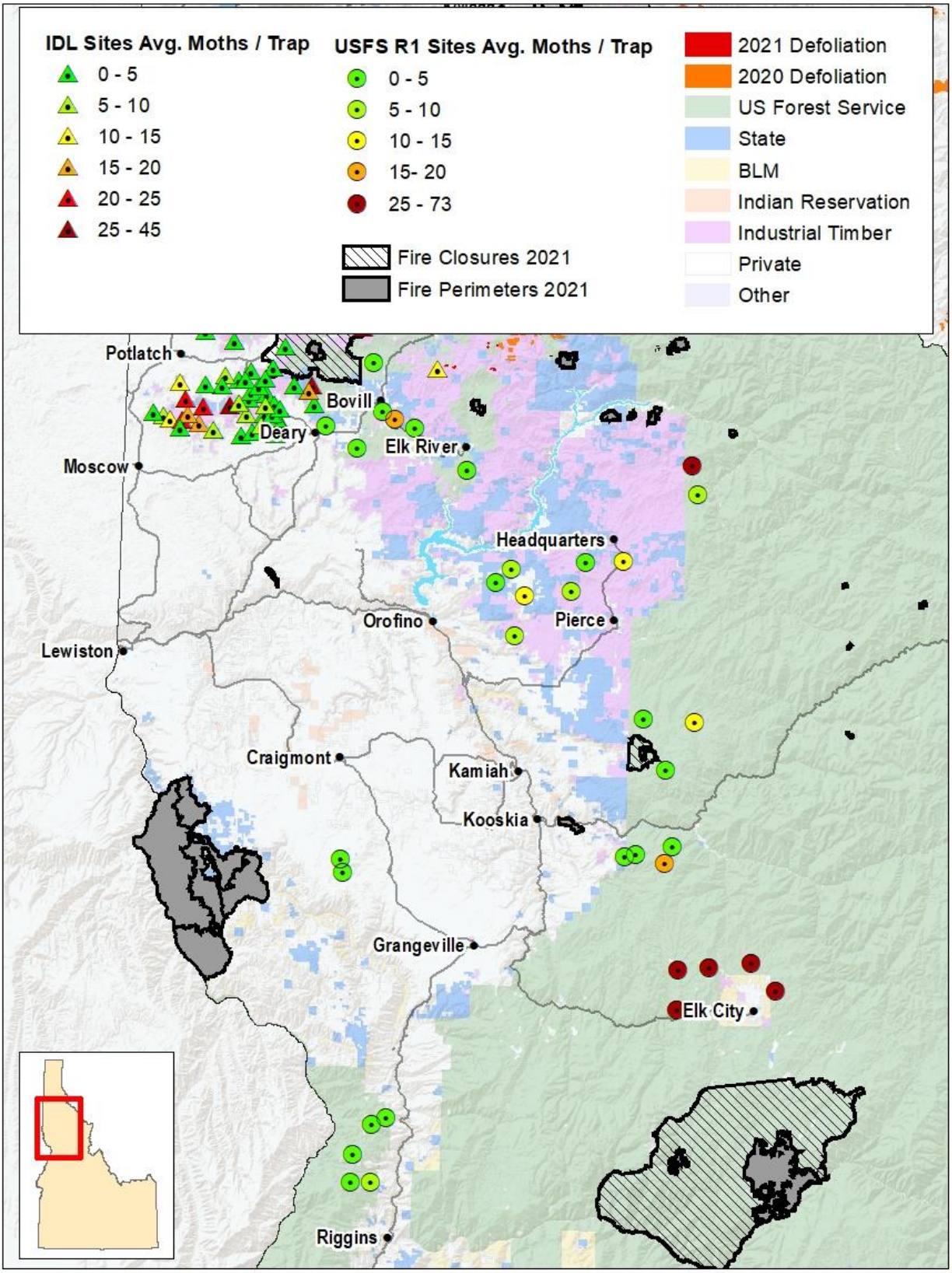
Total # egg masses / # trees = _____ = _____

Figure 13. Map of sites trapped by IDL for Douglas-fir tussock moth in 2021.



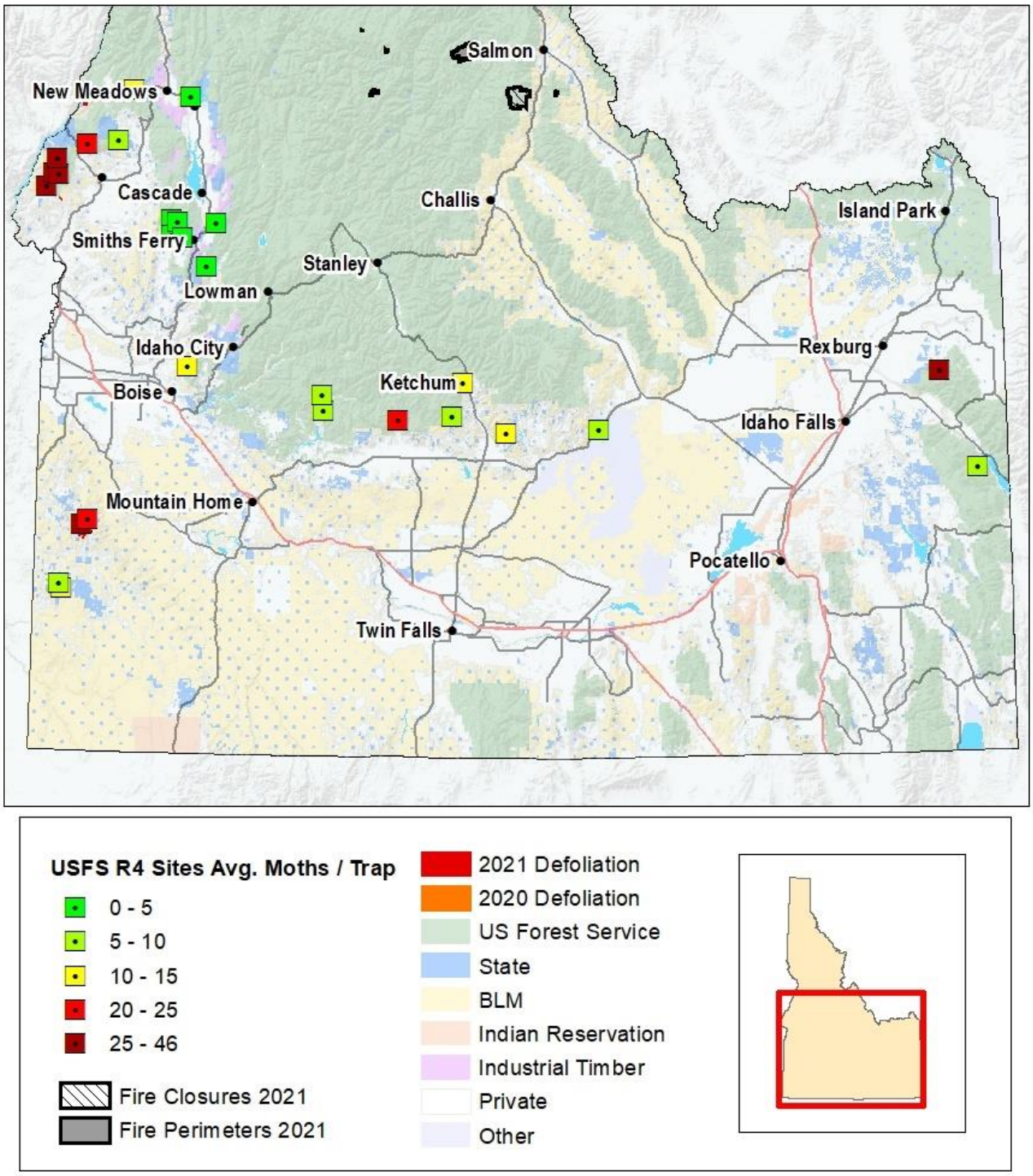
Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 14. Map of sites trapped by USFS Region 1 for Douglas-fir tussock moth in 2021. Additional trapping, not shown on this map, was conducted by USFS Region 1 in Coeur d'Alene at the USFS Forest Service Nursery (figure 13).



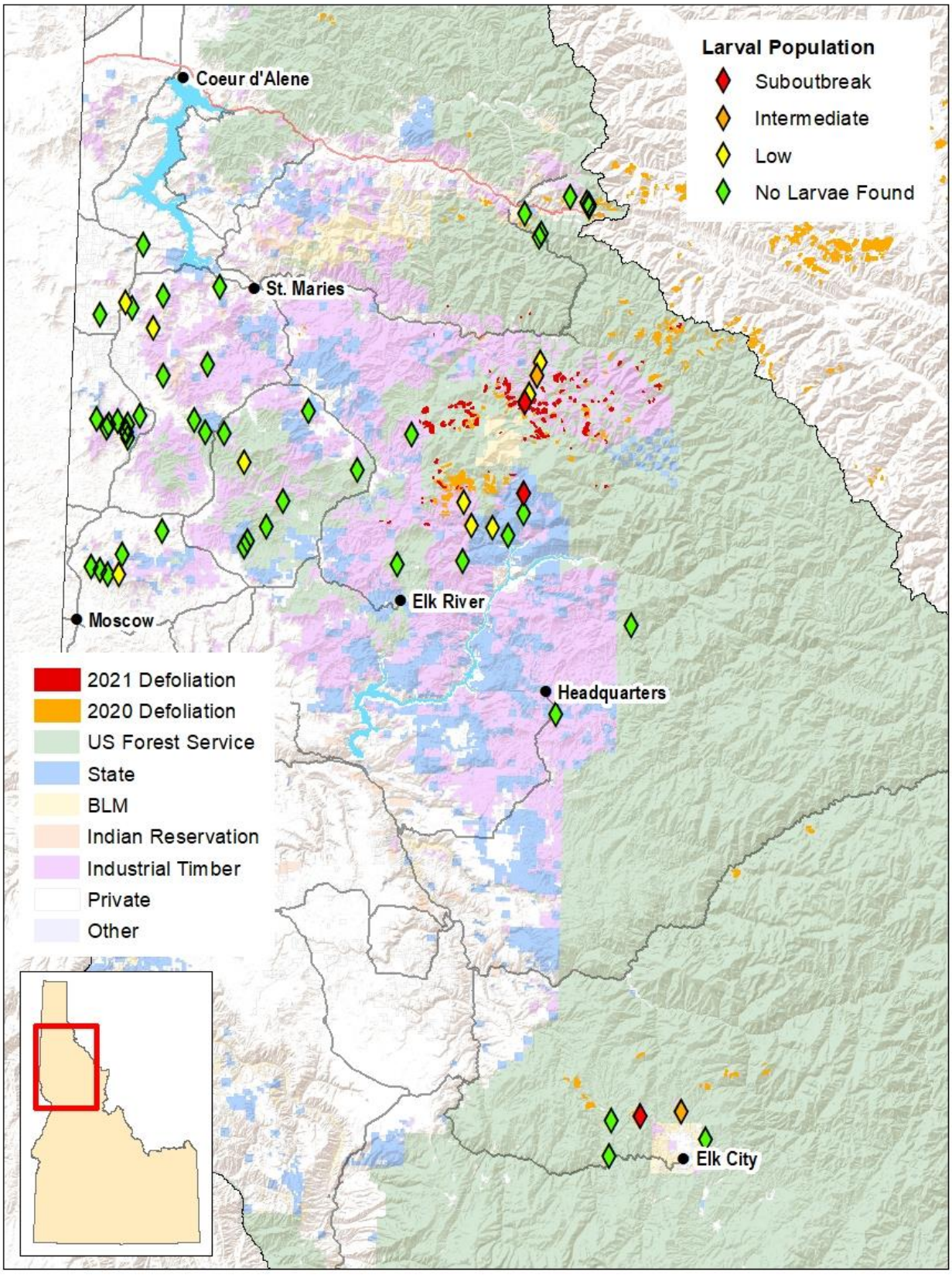
Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 15. Map of sites trapped by USFS Region 4 for Douglas-fir tussock moth in 2021.



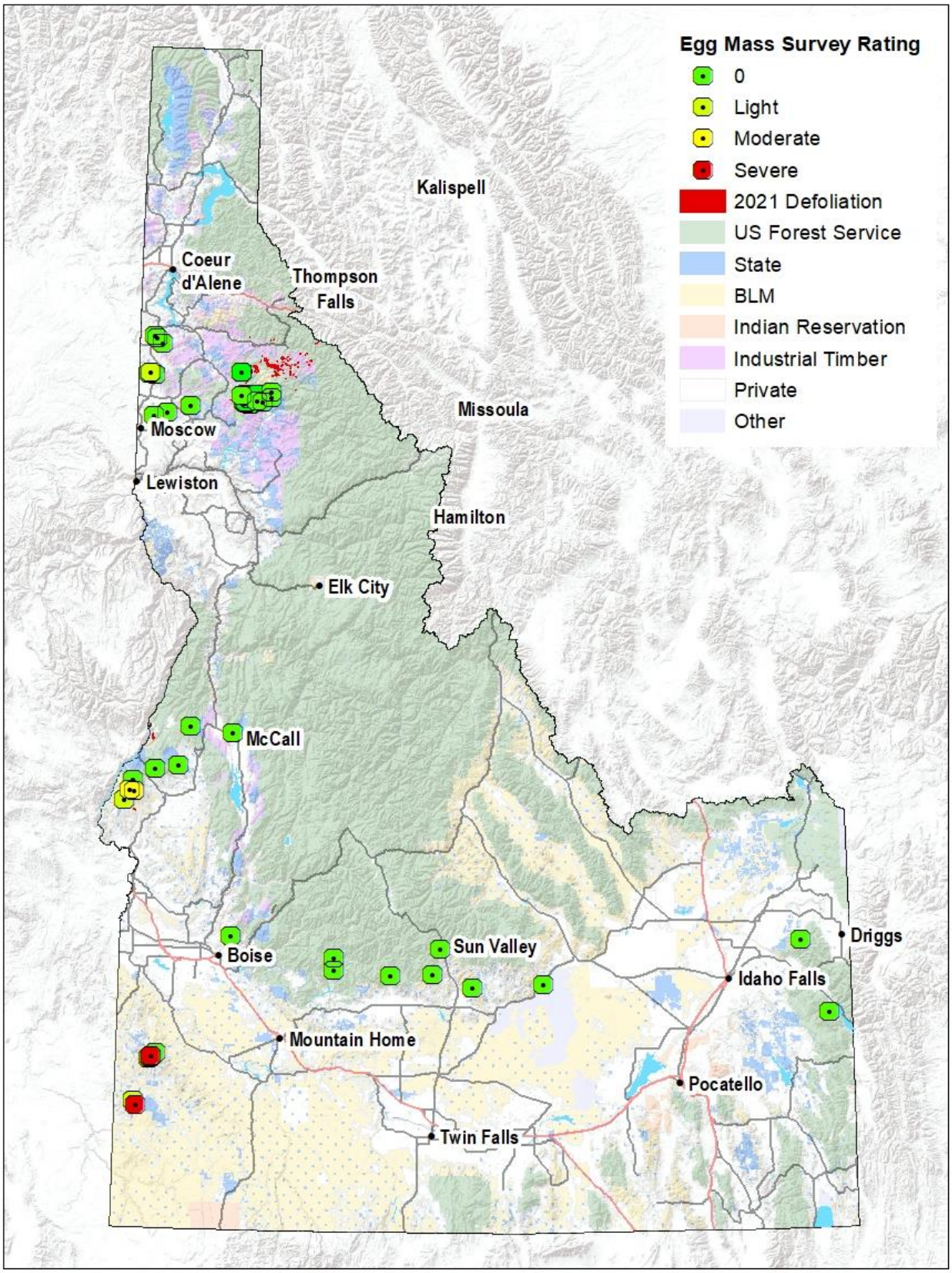
Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 16. Map of sites surveyed for Douglas-fir tussock moth larvae in 2021.
One additional site was surveyed for larvae by USFS R4 staff west of Driggs, and no larvae were found.



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 17. Map of sites surveyed for Douglas-fir tussock moth egg masses in 2021.

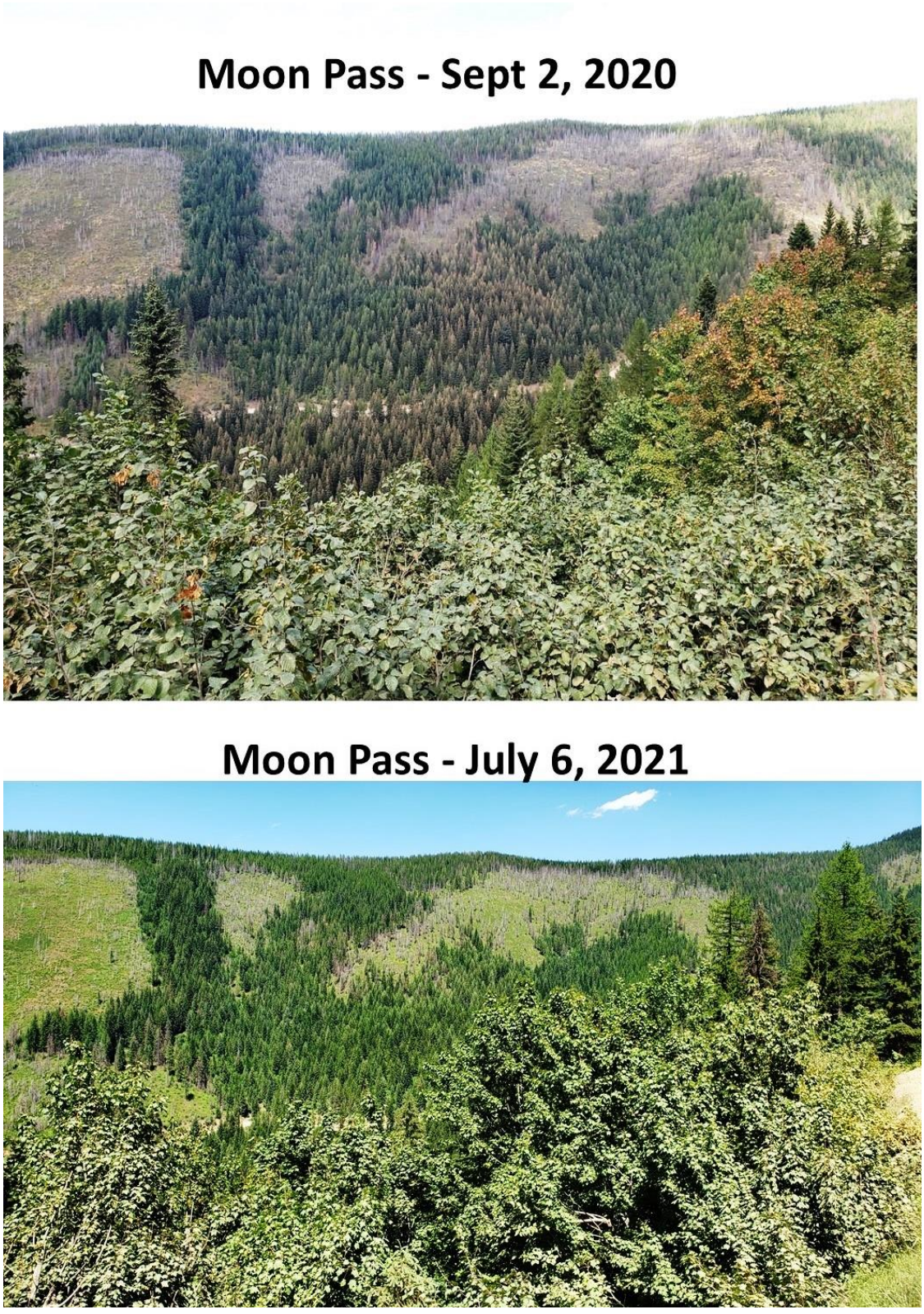


Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 18. Comparison of Douglas-fir tussock moth egg masses.
Only current egg masses that are potentially viable are counted during surveys. Old egg masses are not used for next year's estimation and are not counted in surveys. Current, unhealthy egg masses are counted in surveys, but are not likely to produce many offspring. Unhealthy egg masses suggest natural controls are acting on the population.

Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions

Figure 19. Moon Pass, Idaho. Tree defoliation in 2020 (top), and tree recovery in 2021 (bottom).



Back to: Table of Contents Background and History Monitoring Methods Results of 2021 Survey Season Conclusions