2022 Idaho Douglas-fir Tussock Moth Monitoring Report

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

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Report No. IDL 22-2

January 2023

2022 IDAHO DOUGLAS-FIR TUSSOCK MOTH MONITORING REPORT

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Executive Summary

Northern Idaho

In northern Idaho, Douglas-fir tussock moth (DFTM) activity has collapsed. The 2021 defoliation in the Floodwood area (over 9,500 acres recorded via aerial survey) was replaced with only 132 acres of scattered defoliation south of Avery in 2022. Most trees that were defoliated in the Silver Valley in 2020 are recovering, and there was no defoliation in the Silver Valley in 2022. There was no evidence of defoliation in the typical outbreak areas in Latah and Benewah counties in 2022.

Larval sampling was conducted at 43 sites in the spring and only 3 larvae were found. A total of 185 adult trap sites were monitored (145 by IDL and 40 by USFS-R1) in 2022. The overall mean trap capture was 1.02 moths per trap for IDL traps and 2.01 moths per trap for USFS R1 traps. Due to declining trap captures, egg mass sampling was only conducted at 15 sites. No viable egg masses were found.

Indications point to little or no defoliation in northern Idaho in 2023. There is the possibility that there may be scattered defoliation in the Fishhook area south of Avery and east of Clarkia.

Southern Idaho

In southern Idaho, only 184 total acres of defoliation were recorded in aerial surveys in 2022. The defoliation was recorded in the Owyhee mountains in the Silver City vicinity and west of Hayden Peak on mostly Bureau of Land Management and private lands.

A total of 34 adult trap sites were monitored during 2022, and the average number of captured males was 11.74 moths per trap. Six sites had average trap captures above 25 per trap; five of these sites were in Owyhee and Washington Counties, one was in Blaine County. Egg mass sampling was conducted at every site where the average trap catch was over 5 moths per trap (23 sites). However, despite high trap catches, no egg masses were observed.

Overall, populations appear to be declining. If any defoliation occurs in 2023 it is likely to be in the Owyhee Mountains.

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 recently collapsed. Aerial surveyors detected approximately 16,700 acres of DFTM-caused defoliation in northern Idaho in 2020, with additional defoliation in western Montana (figure 9). Trap catches began rising in 2017, but defoliation occurred further east of the historic recorded outbreak areas, where EWS traps have mostly not been established. In 2021, over 9,500 acres were mapped, but only 132 acres in scattered polygons were observed in 2022. The 2022 defoliation was south and southwest of Avery in the St. Joe National Forest.

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 approximately 3,000 acres in the Cuddy Mountain and Hitt Mountain areas west of Cambridge (Payette National Forest) and some additional defoliation in 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. No defoliation was observed in the Cuddy or Hitt Mountain areas in 2022. The only DFTM defoliation observed in southern Idaho in 2022 was 184 acres in the Owyhee Mountains.

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. 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 2022, 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 the Elk City vicinity in 2020. These five new sites were also monitored in 2021 and 2022.

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 2022 Survey Season

Trapping

A total of 185 sites were monitored in northern Idaho (145 by IDL and 40 by USFS-R1), and 34 sites were monitored in southern Idaho by USFS-R4 during 2022 (figures 13, 14, & 15). The 10 trap sites installed by IDL on the Packer John State Forest in 2020 were not monitored in 2022 due to very low risk of an outbreak and staffing shortages.

The overall mean trap capture for the IDL traps in 2022 was 1.02 moths per trap, compared with 7.68, 9.95, 7.28, and 1.51 moths per trap in 2021, 2020, 2019, and 2018, respectively. An average of 2.01 moths per trap were caught in USFS-R1 traps in 2022, compared with 12.38, 10.58, 4.44, and 1.15 moths per trap in 2021, 2020, 2019 and 2018, respectively.

The 2022 USFS-R4 average for southern Idaho was 11.74 moths per trap compared to 14.04, 10.89, 18.31, and 19.73 moths per trap in 2021, 2020, 2019 and 2018, respectively.

Increased trap captures were noted in northern Utah in 2022 (Logan and Ogden Ranger Districts), with some high trap captures just south of the Idaho border. Defoliation has not been recorded in northern Utah since the 1990s.

Larval Surveys

In northern Idaho, larval sampling was conducted (using sequential survey methods outlined in Mason, 1979) at 43 sites in 2022 (figure 16). Sites were selected for larval sampling because they had high numbers of moths per trap relative to other IDL-monitored sites in 2021, they were located in areas where outbreaks had historically occurred, or they were located near 2021 defoliation. Only three larvae were found at two locations, and all populations at these locations were considered low. One location was at Lovell Valley, south of Plummer and the other was at Copper Saddle in the Floodwood State Forest.

Egg Mass Sampling

Egg mass sampling was conducted at 38 sites in 2022 (three sites by IDL, 12 sites by USFS R1, and 23 sites by USFS R4) (figure 17). In northern Idaho, no egg masses were found, although a few old egg masses (figure 18) were observed near Elk city. No egg masses were observed in southern Idaho either, despite high trap captures.

Defoliation

Only 132 acres of defoliation were observed in northern Idaho in 2022, as compared to 9,500 acres of defoliation recorded in 2021. This defoliation was located in the same general area as the 2021 defoliation, east of Clarkia and south of Avery, but only made up a few scattered pockets in 2022. The outbreak appears to be collapsing. Trees that were defoliated in the Silver Valley and east of Clarkia in 2020 and 2021 are mostly recovering (figure 19).

The 2020 – 2022 northern Idaho 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.

In southern Idaho, only 184 acres of defoliation was observed in 2022, compared to 3,300 acres recorded in aerial surveys in 2021. This defoliation was recorded in the Owyhee mountains surrounding Silver City on mostly Bureau of Land Management and private lands. The large outbreak that occurred in southern Idaho from 2017 – 2019, primarily around Cascade, crashed in 2020. Although additional DFTM activity has not been observed in the Cascade area, the area is currently experiencing an increase in tree mortality due to bark beetles as a result of prior defoliation.

Conclusions

In northern Idaho, DFTM activity in 2022 was minimal. Survey data suggests that activity in 2023 will be limited to none in 2023. Douglas-fir tussock moth outbreaks in Idaho typically last three years, and 2022 was the third year of defoliation in this outbreak.

In southern Idaho, predictions are less certain. Although there was limited defoliation and egg masses were not observed, trap captures were still high in some areas. This could be a delayed effect from outbreaks in the area over the past several years, but it is unclear. Outbreaks in southern Idaho tend to originate from various DFTM populations on different outbreak cycles. Increased trap captures in northern Utah, just south of the Idaho border, may indicate rising DFTM populations in parts of Idaho as well. While pheromone traps are effective for predicting when DFTM populations are rising, they are not very useful for predicting where defoliation may occur.

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

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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.

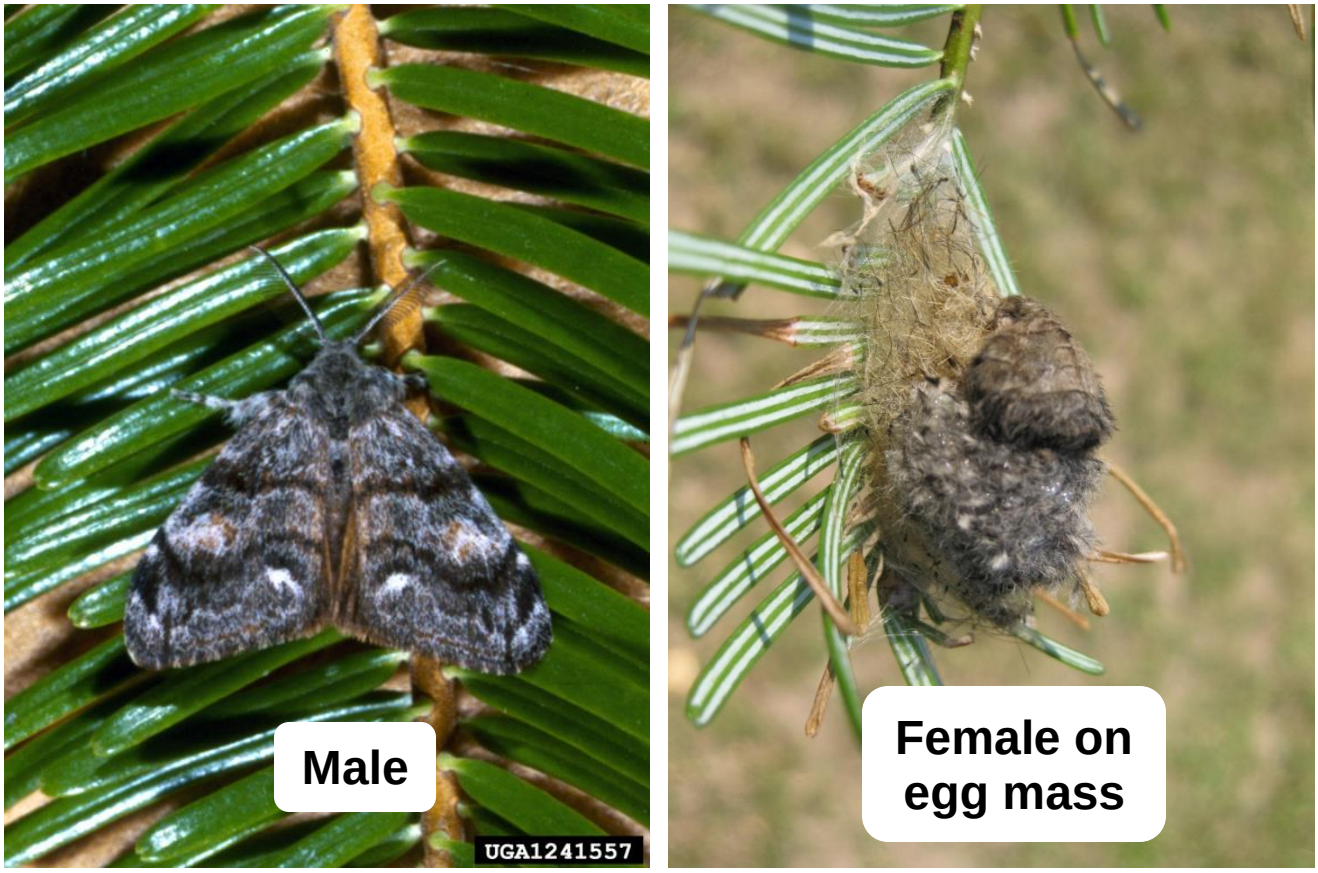

Figure 2. Douglas-fir tussock moth egg mass.

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

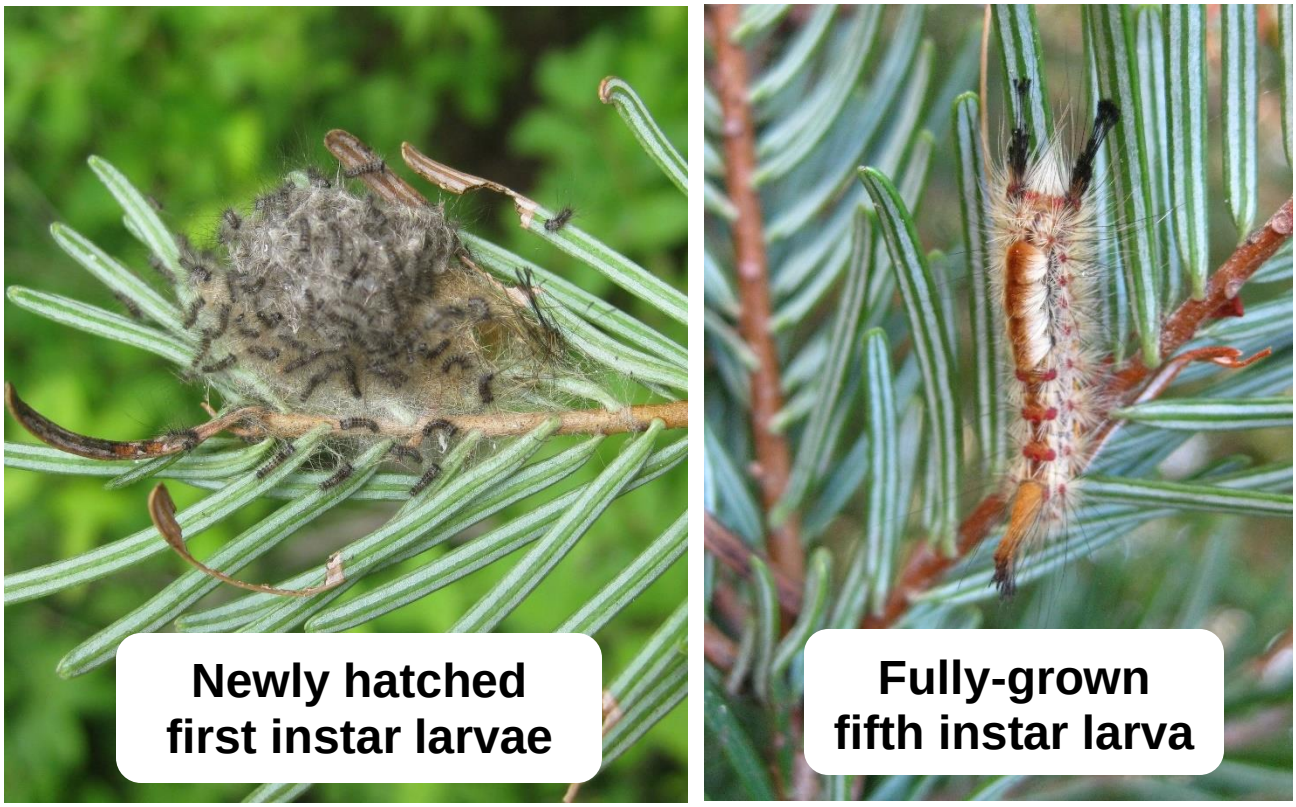

Figure 4. Douglas-fir tussock moth (DFTM)-caused tree defoliation.

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Figure 5. Aerially mapped defoliation by Douglas-fir tussock moth for the 1940s to 2022. Outbreaks often occur in the same general areas in north Idaho.

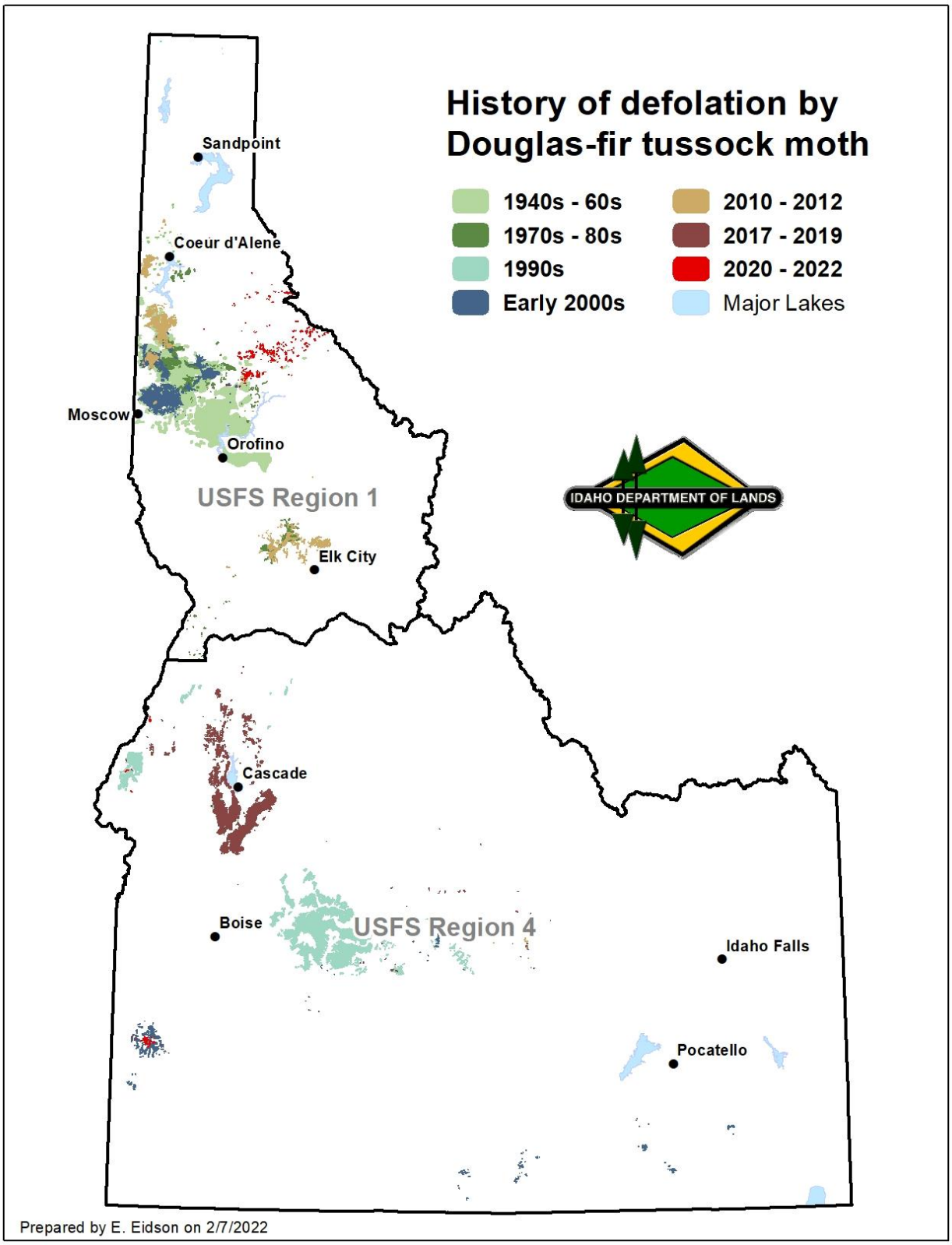

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Figure 6. Early Warning System trap distribution in Idaho in 2022.

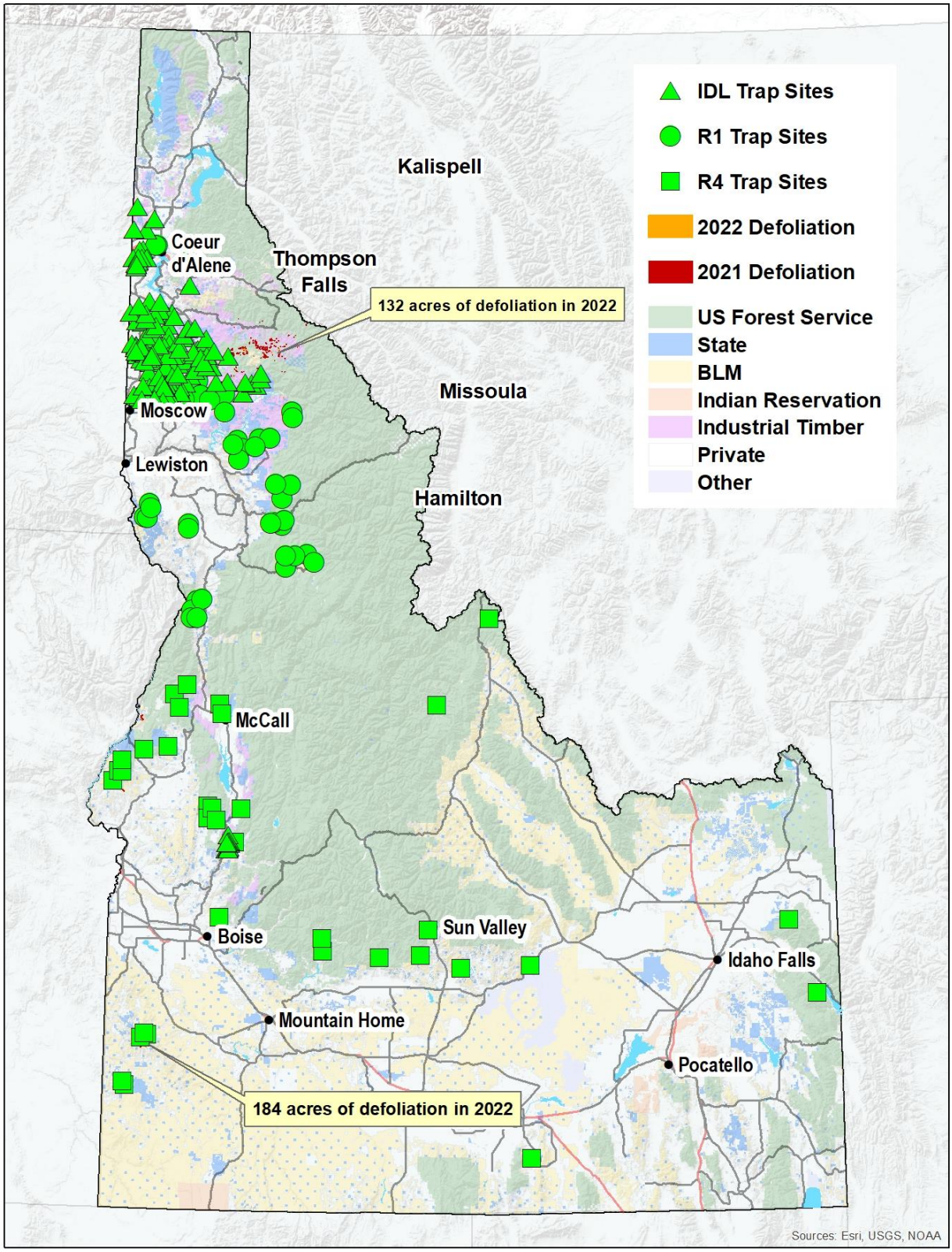

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Figure 7. Early Warning System (EWS) pheromone-baited sticky trap and captured adult male moths.

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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 – 2022.

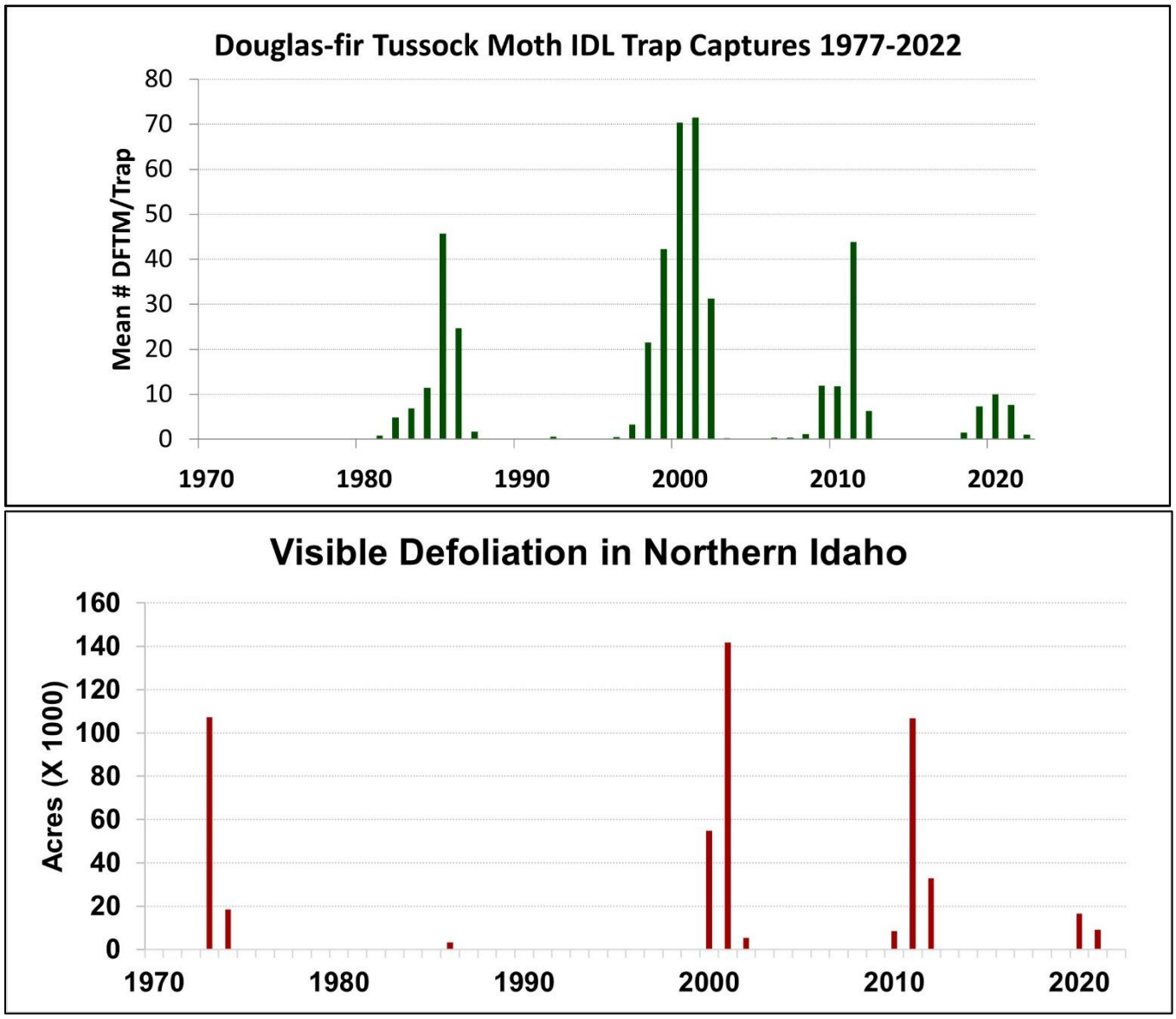

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Figure 9. Douglas-fir tussock moth-caused defoliation in northern Idaho and western Montana in 2020 - 2022.

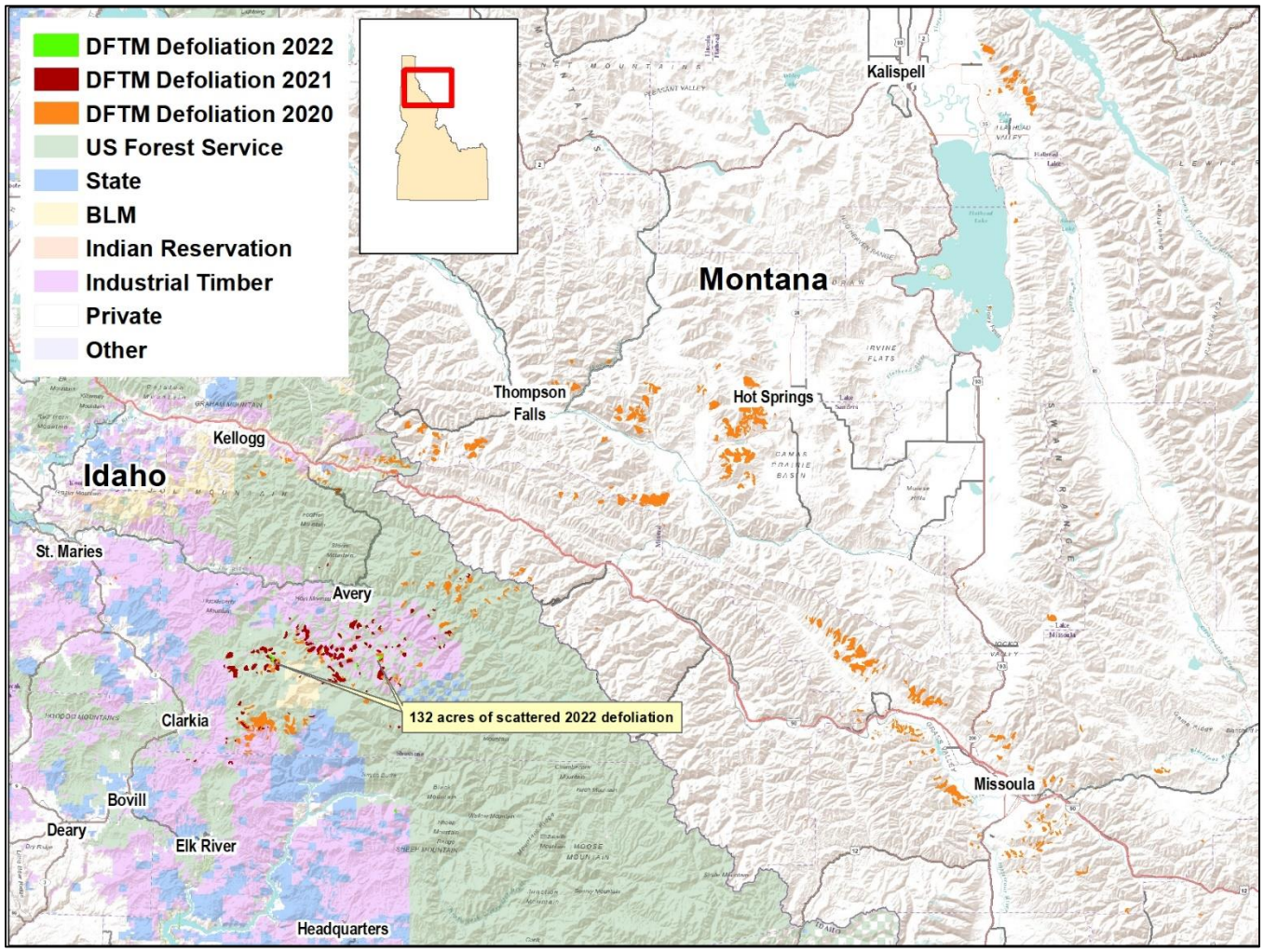

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Figure 10A: Photos of severe tree defoliation by Douglas-fir tussock moth at Craters of the Moon National Monument in 2017.

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.

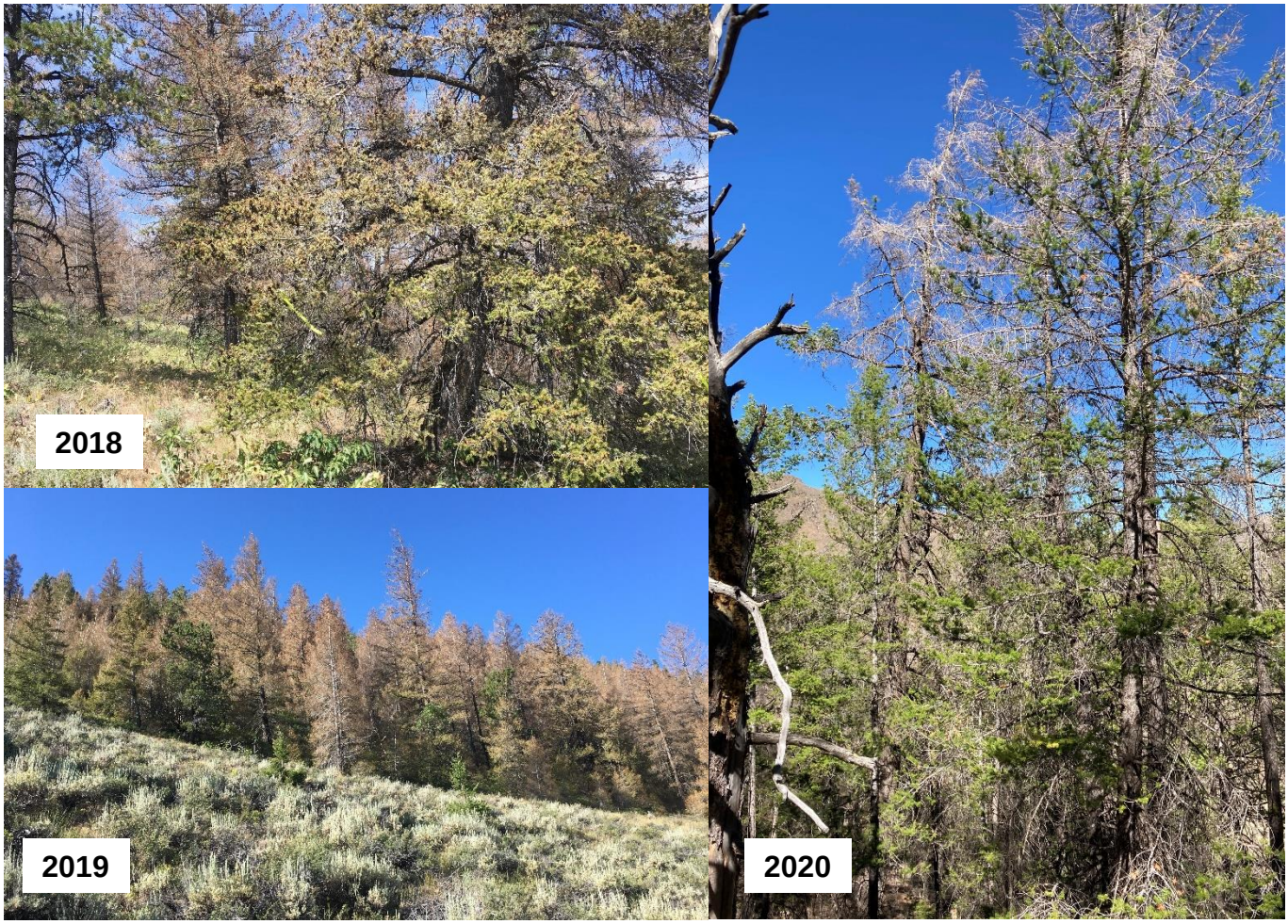

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Figure 11. Douglas-fir tussock moth-caused defoliation recorded by Aerial Detection Survey in southwestern Idaho, 2018 - 2022.

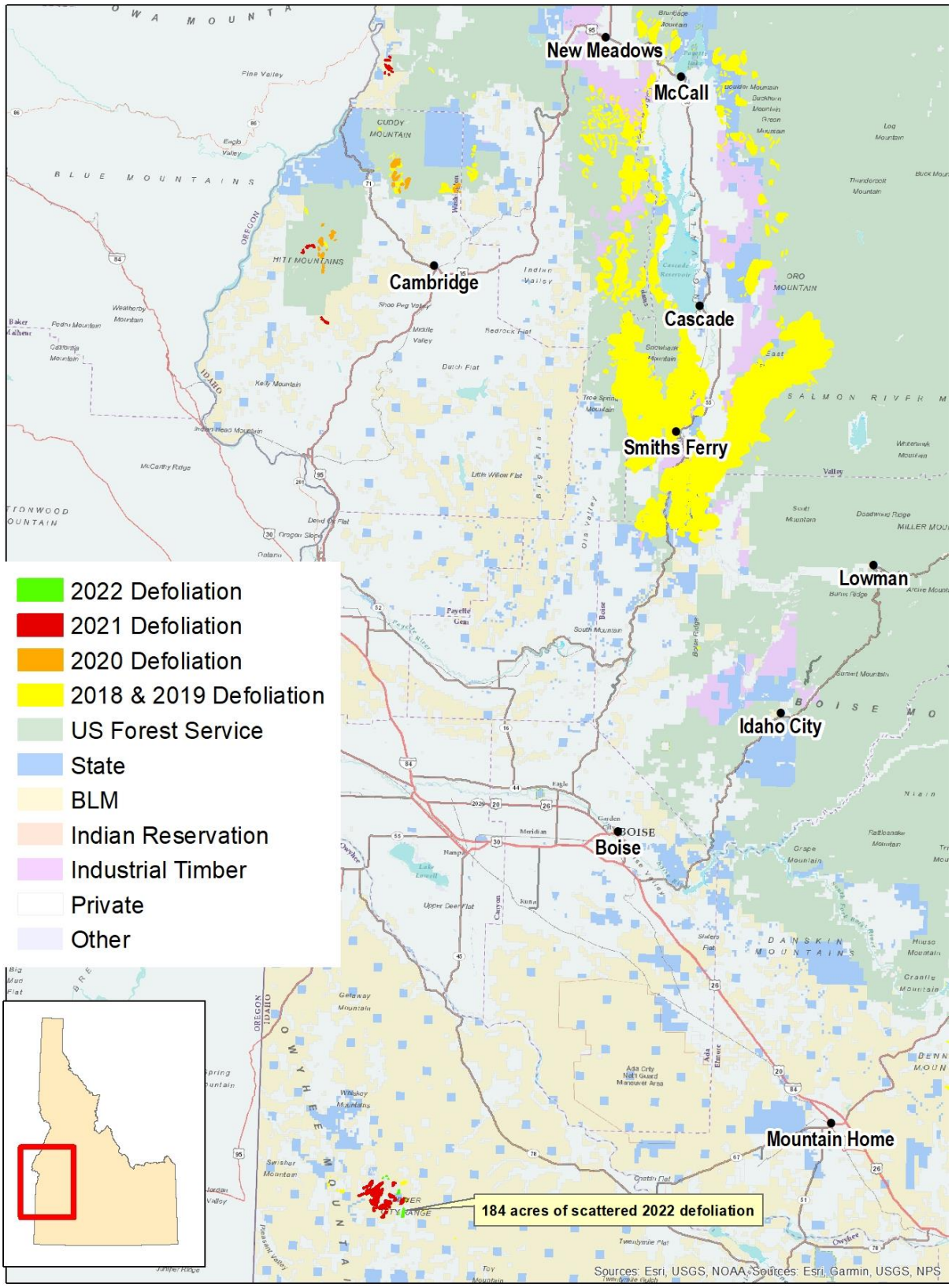

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Figure 12. Data sheet for Shepherd *et al*., 1985 Douglas-fir tussock moth egg mass sampling method. Data sheet shows number of host trees to be sampled (by inspecting three branches per tree) based on cumulative egg masses observed at a site. If the 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 2022.

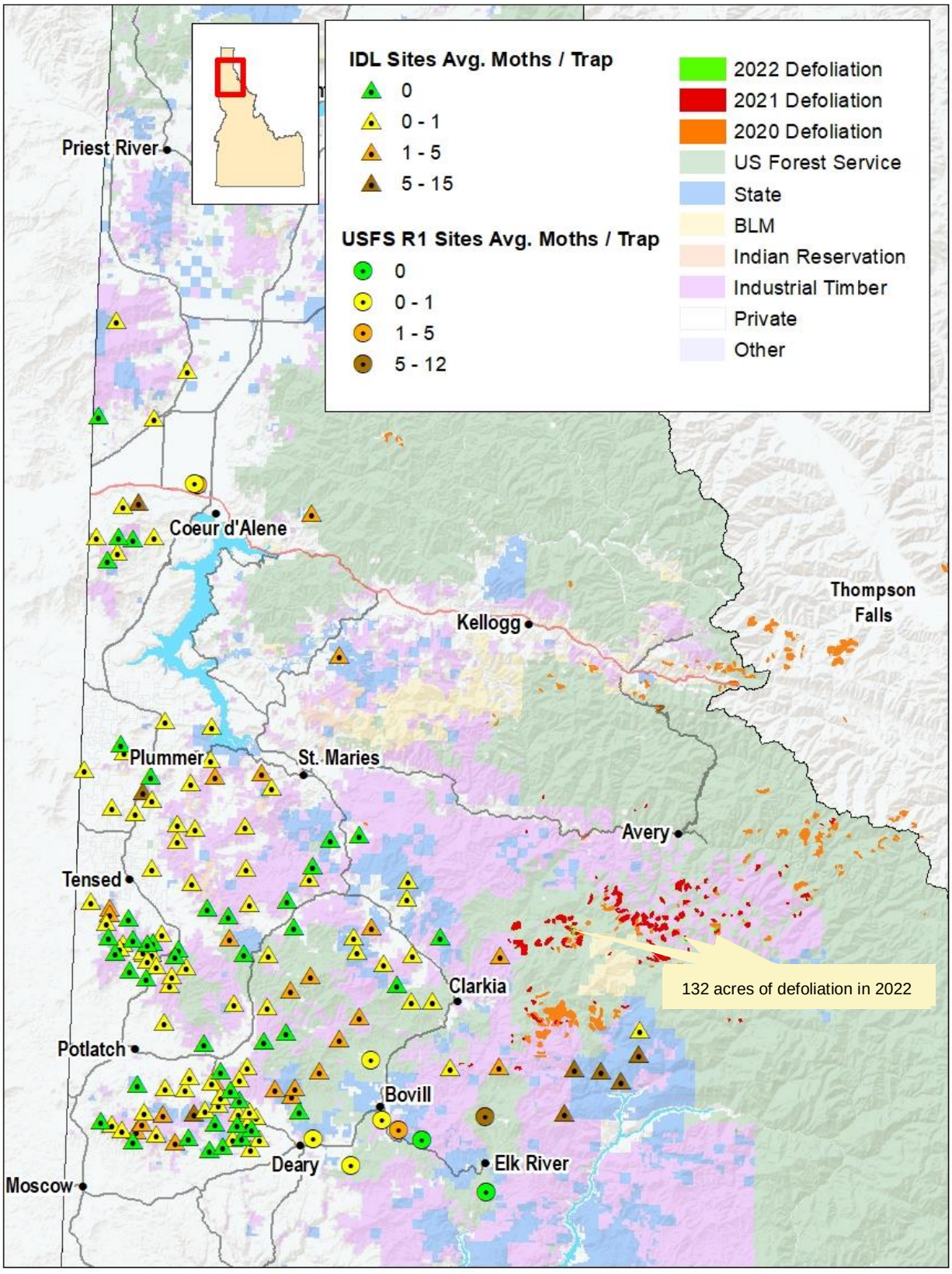

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Figure 14. Map of sites trapped by USFS Region 1 for Douglas-fir tussock moth in 2022. Additional trapping, not shown on this map, was conducted by USFS Region 1 in Coeur d'Alene at the USFS Forest Service Nursery (figure 13).

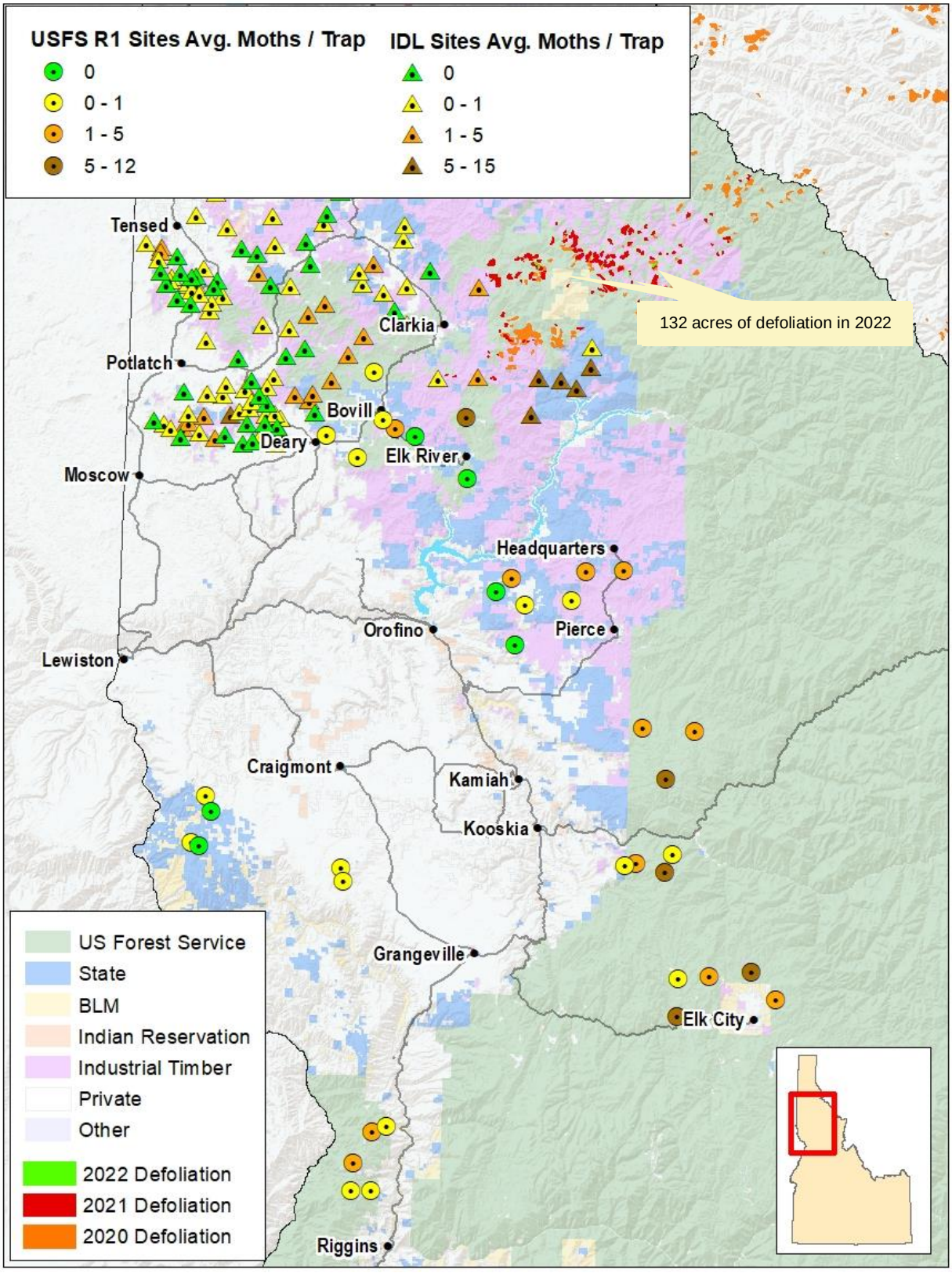

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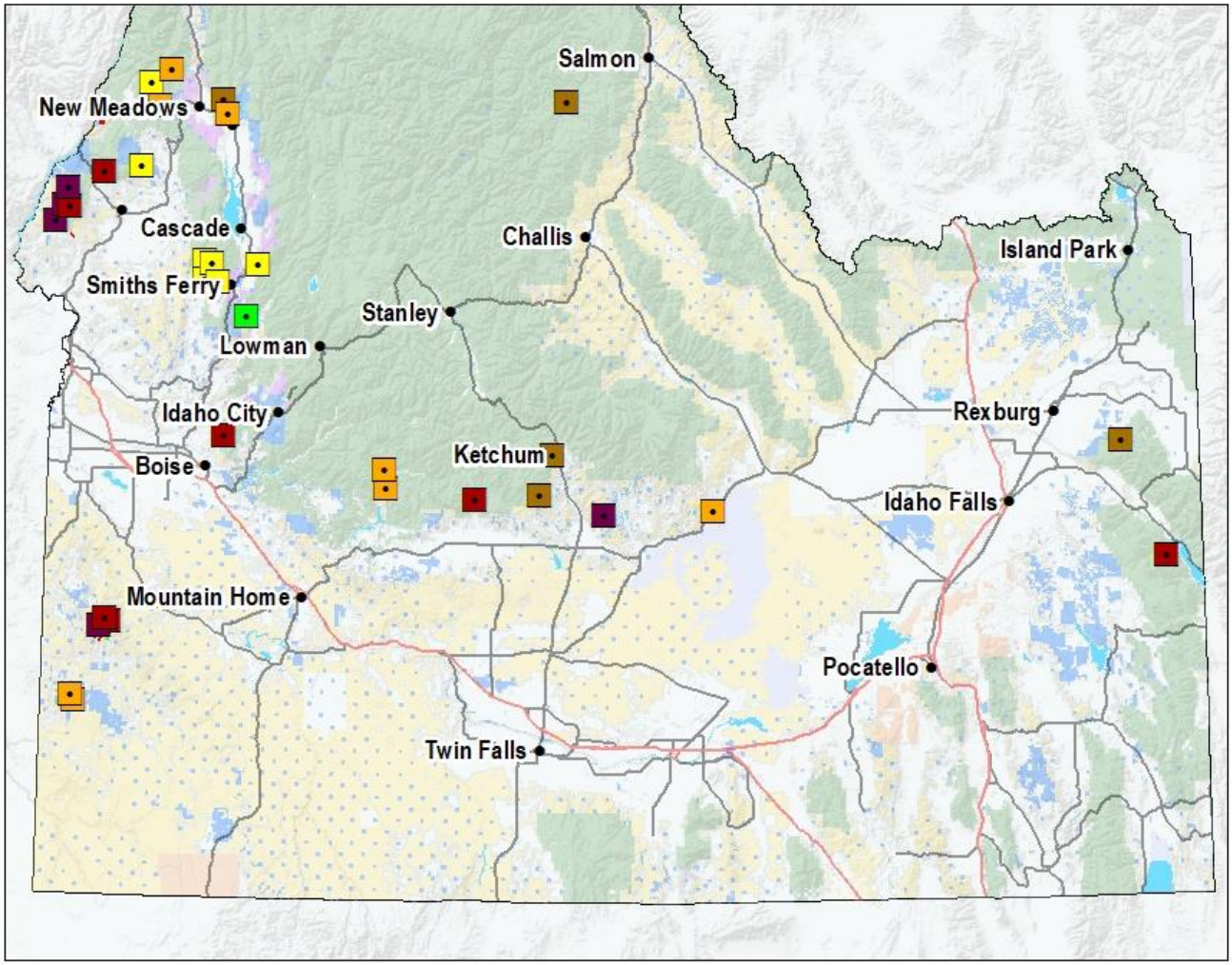
Figure 15. Map of sites trapped by USFS Region 4 for Douglas-fir tussock moth in 2022.



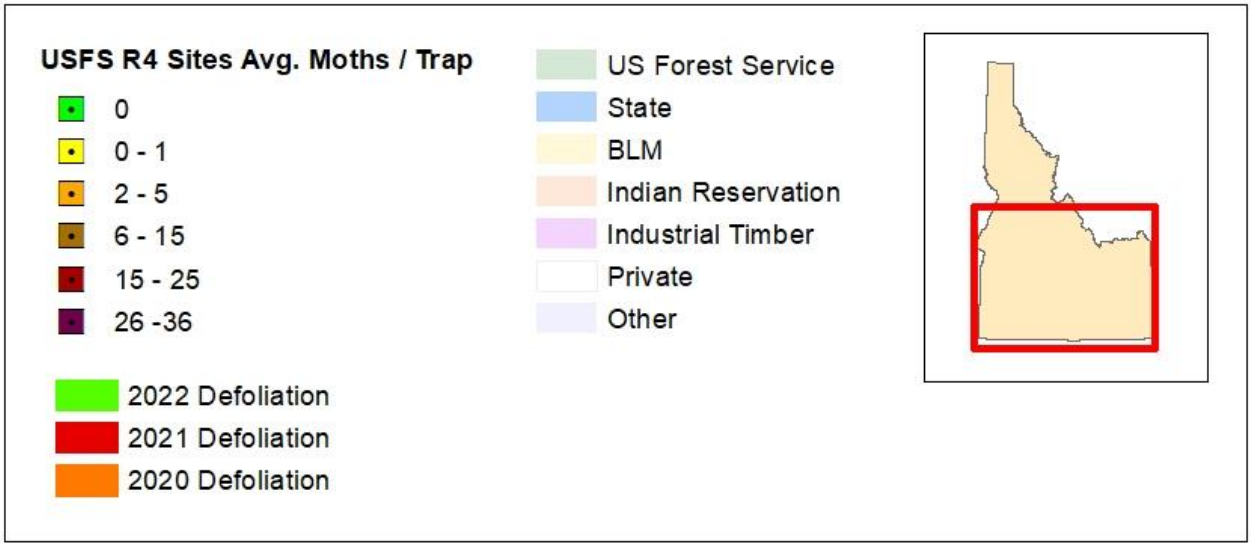


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Figure 16. Map of sites surveyed for Douglas-fir tussock moth larvae in 2022.

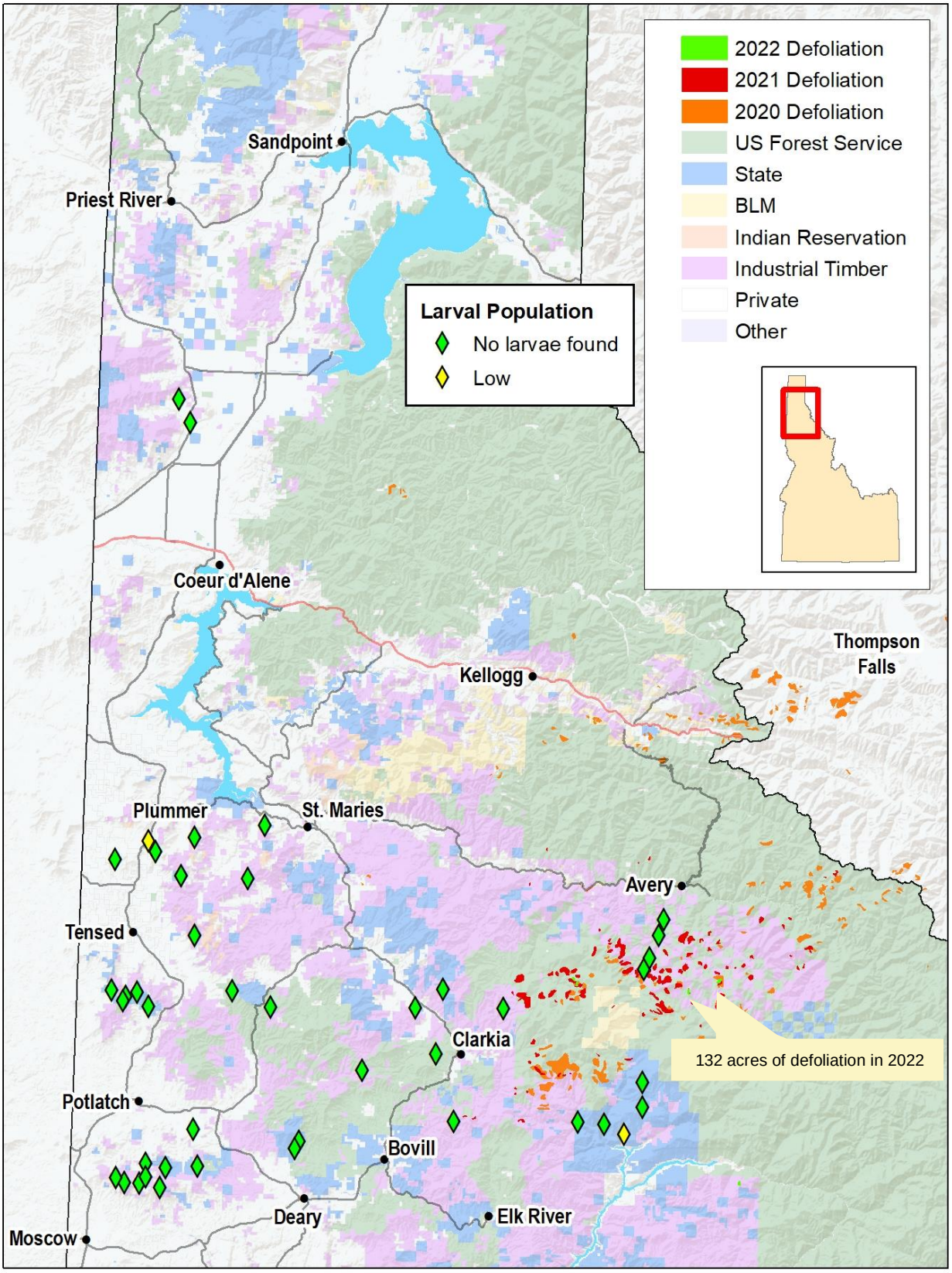

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Figure 17. Map of sites surveyed for Douglas-fir tussock moth egg masses in 2022.

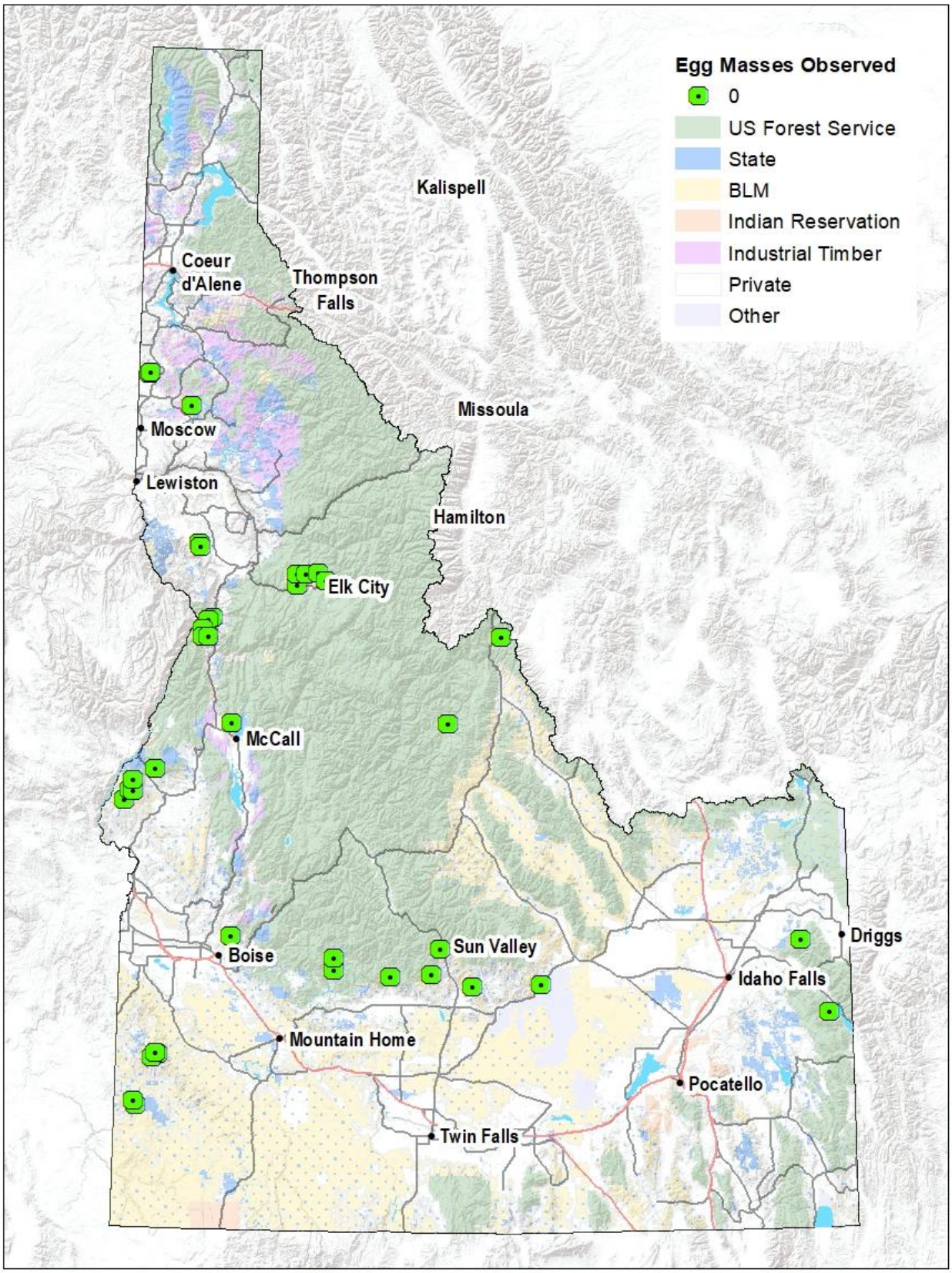

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Figure 18. Comparison of Douglas-fir tussock moth egg masses.
Only current egg masses that are potentially viable are counted during surveys. Old egg masses are not used for next year's estimation and are not counted in surveys. Current, unhealthy 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.

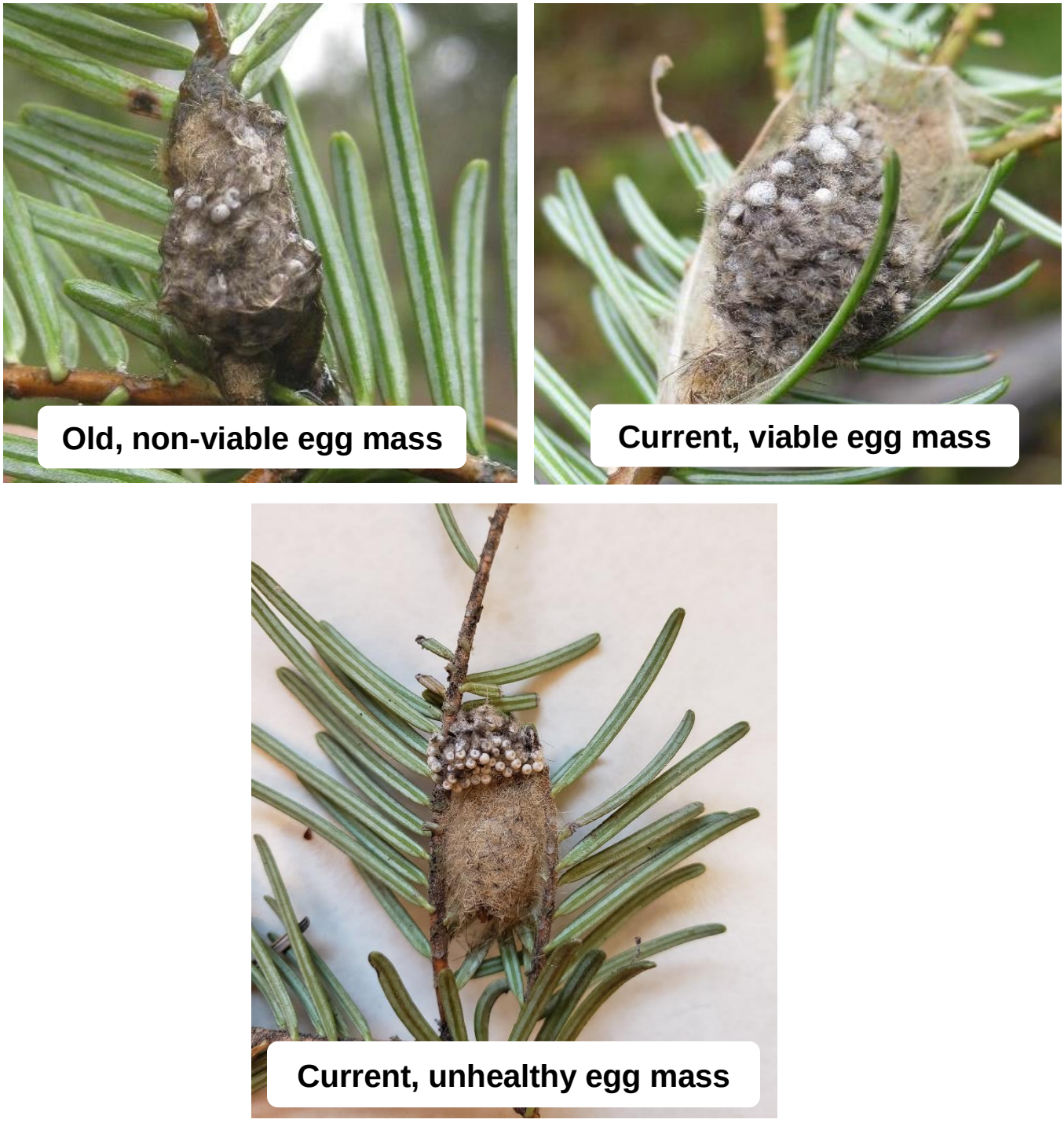

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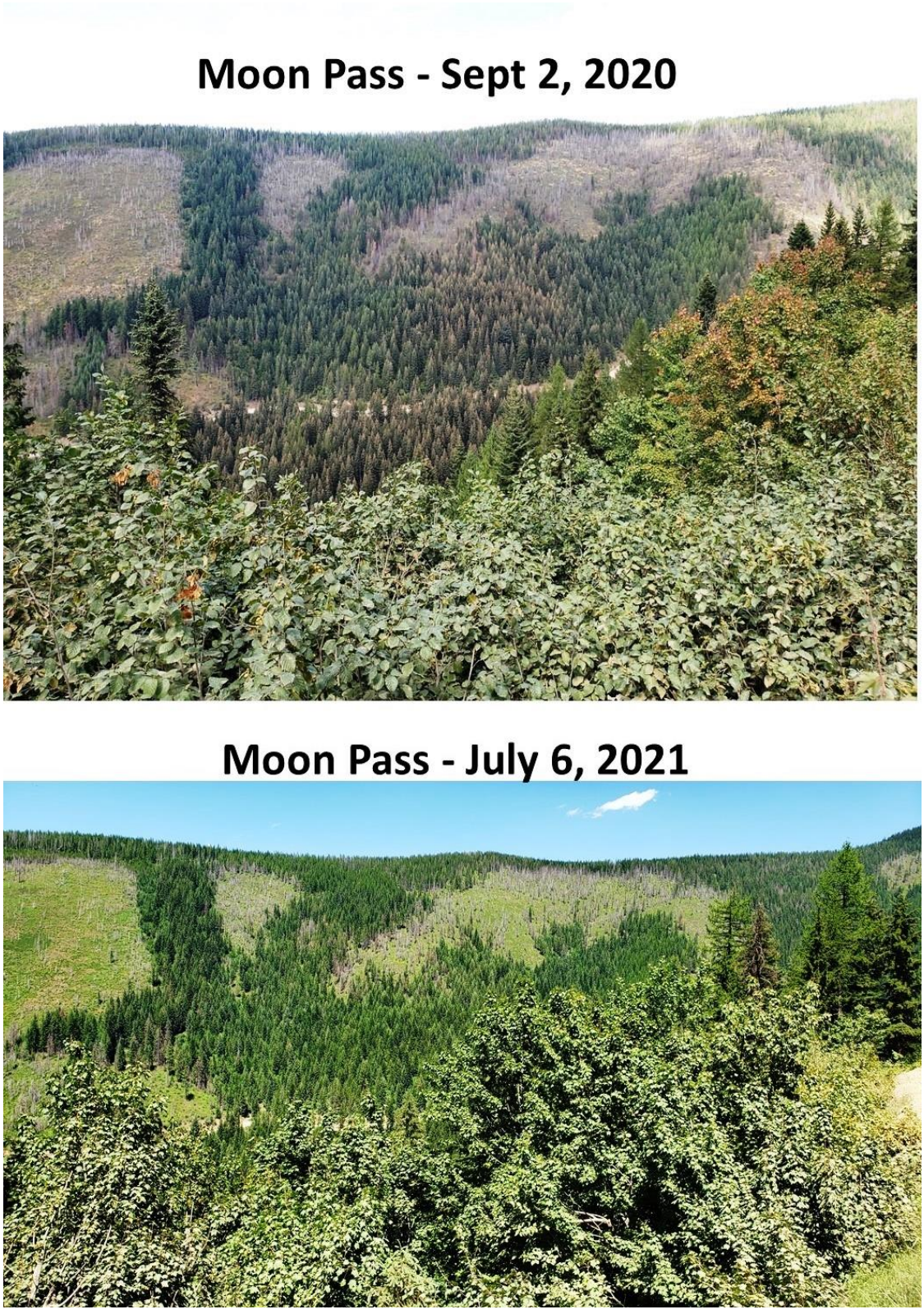
Figure 19. Moon Pass, Idaho. Tree defoliation in 2020 (top), and tree recovery in 2021 (bottom).



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