USFS Region 6 Forest Insect and Disease Aerial Detection Survey Data Dictionary Date: 12/2013

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Region Six Insect and Disease Layers Available:

r6id1947.shp	r6id1959.shp	r6id1971.shp	r6id1983.shp	r6id1995.shp	r6id2007.shp
r6id1948.shp	r6id1960.shp	r6id1972.sh p	r6id1984.shp	r6id1996.shp	r6id2008.shp
r6id1949.shp	r6id1961.shp	r6id1973.shp	r6id1985.shp	r6id1997.shp	r6id2009.shp
r6id1950.shp	r6id1962.shp	r6id1974.shp	r6id1986.shp	r6id1998.shp	r6id2010.shp
r6id1951.shp	r6id1963.shp	r6id1975.shp	r6id1987.shp	r6id1999.shp	r6id2011.shp
r6id1952.shp	r6id1964.shp	r6id1976.shp	r6id1988.shp	r6id2000.shp	r6id2012.shp
r6id1953.shp	r6id1965.shp	r6id1977.shp	r6id1989.shp	r6id2001.shp	r6id2013.shp
r6id1954.shp	r6id1966.shp	r6id1978.shp	r6id1990.shp	r6id2002.shp	
r6id1955.shp	r6id1967.shp	r6id1979.shp	r6id1991.shp	r6id2003.shp	
r6id1956.shp	r6id1968.shp	r6id1980.shp	r6id1992.shp	r6id2004.shp	
r6id1957.shp	r6id1969.shp	r6id1981.shp	r6id1993.shp	r6id2005.shp	
r6id1958.shp	r6id1970.shp	r6id1982.shp	r6id1994.shp	r6id2006.shp	

Data Description:

Theme keywords: insect, disease, tree mortality, tree defoliation, tree damage, disturbance.
Place keywords: Oregon and Washington
Temporal keywords: 1947-2013
Feature Class: polygon
Data source and date: various (see narrative below)
Data extent: all forested lands in Oregon and Washington (all ownerships)
Data Confidence: fair (see narrative)
Locational Confidence: fair (see narrative)
Scale: 1:100,000
Date data transferred to base: various/none (see narrative)
Projection: Albers
Horizontal Datum: NAD 83
Units: Meters
Spheroid: GRS 1980
1st standard parallel: 43 0 0.000
2nd standard parallel: 48 0 0.000
Central Meridian: -120 0 0.00
Latitude of projection's origin: 34 0 0.00
False Easting (meters): 600000.00000
False Northing (meters): 0.00000
Primary contact: R6 Forest Health Protection Aerial Survey Program Manager
Secondary contact: R6 Forest Health Protection GIS Analyst
Originator/publisher: USFS/R6/RO/State and Private Forestry/Forest Health Protection

Availability for download: http://www.fs.usda.gov/detail/r6/forest-grasslandhealth/insects-diseases/?cid=stelprdb5448186

Download format: ArcGIS shapefiles

Field	Definition	Description
AL	30,30,C	Summary of the damaging agent(s) and the total number of current dead trees and/or severity level of the defoliation affecting that polygon; there are 1-3 damaging agents/polygon.
AGENT1	4,4,C	First damaging agent code
DAM1C	6,6,C	Number of dead trees/acre or severity level associated with the first damaging agent; character field
AGENT2	4,4,C	Second damaging agent code
DAM2C	6,6,C	Number of dead trees/acre or severity level associated with the second damaging agent; character field
AGENT3	4,4,C	Third damaging agent code
DAM3C	6,6,C	Number of dead trees/acre or severity level associated with the third damaging agent; character field
DAM1	10,10,N,4	Number of dead trees/acre (if present in DAM1C); numeric field
DAM2	10,10,N,4	Number of dead trees/acre (if present in DAM2C); numeric field
DAM3	10,10,N,4	Number of dead trees/acre (if present in DAM3C); numeric field

Attribute Example:

If **AL** = '4-10!BS-L!1-.25A' and the polygon is 20 acres, then:

AGENT1: 4
DAM1C: .5 (10 dead trees / 20 acre polygon = .5 dead trees/acre)
AGENT2: BS
DAM2C: L
AGENT3: 1
DAM3C: .25 ('A' indicates dead trees/acre; no conversion needed)
DAM1: .5
DAM2: .0
DAM3: .25

Attribute Code Lists:

BEETLES

Code	Description	Severity
1-	Douglas-fir Beetle	# of dead trees
2-	Douglas-fir Engraver	# of dead trees
3-	Engelmann Spruce Beetle	# of dead tress
4-	Fir Engraver	# of dead trees
5-	Western Balsam Bark Beetle, Sub-Alpine Fir	# of dead trees
F-	Flathead fir borer	# of dead trees
F1-	Flatheaded borer; Douglas-fir; saplings (code used in the 70's)	# of dead trees
F2-	Flatheaded borer; Douglas-fir; mixed (used in the 70's)	# of dead trees
F3-	Flatheaded borer; Douglas-fir; saw timber (used in the 70's)	# of dead trees
P-	Flatheaded borer; Ponderosa pine	# of dead trees
P1-	Flatheaded borer; Ponderosa pine; saplings (used in the 70's)	# of dead trees
P2-	Flatheaded borer; Ponderosa pine; mixed (used in the 70's)	# of dead trees
P3-	Flatheaded borer; Ponderosa pine; saw (used in the 70's)	# of dead trees
6B-	Mountain Pine Beetle, Whitebark Pine	# of dead trees
6J-	Mountain Pine Beetle, Jeffrey Pine	# of dead trees
6K-	Mountain Pine Beetle, Knobcone Pine	# of dead trees
6L-	Mountain Pine Beetle, Lodgepole Pine	# of dead trees
6P-	Mountain Pine Beetle, Ponderosa Pine	# of dead trees
6S-	Mountain Pine Beetle, Sugar Pine	# of dead trees
6W-	Mountain Pine Beetle, Western White Pine	# of dead trees
7-	Pine Engraver (Historically, L/M/H was used as a modifier) ips	# of dead trees
8-	Western Pine Beetle	# of dead trees
88-	Western Pine Beetle, Pole-size Ponderosa Pine	# of dead trees
9-	Silver Fir Beetle	# of dead trees

OTHER INSECTS

Code	Description	Severity
AB-	Balsam woolly adelgid	# of dead trees - AND/OR - L/M/H*
AC-	Cooley spruce gall aphid	L/M/H
AM-	Maple discoloration	L/M/H
AS-	Spruce aphid	L/M/H
BB-	Western blackheaded budworm	L/M/H
BM-	Modoc budworm	L/M/H/V
BM-	Modoc budworm	1/2/3/4**
BP-	Sugar pine tortrix	L/M/H
BS-	Western spruce budworm	L/M/H/V
BS-	Western spruce budworm	1/2/3/4**
CH-	Larch casebearer/Hypodermella	L/M/H
FB-	Alder flea beetle	L/M/H
FM-	Fir mealybug	L/M/H
GP-	Gouty pitch midge	L/M/H
HL-	Western hemlock looper	L/M/H
LG-	Green striped forest looper	L/M/H
LL-	Larch looper	L/M/H
LS-	Black Pine needle scale	L/M/H
MD-	Douglas-fir budmoth	L/M/H
MF-	Pacific silver fir budmoth	L/M/H
ML-	Larch budmoth	L/M/H

MN-	Douglas-fir needle midge	L/M/H
MS-	Spruce budmoth	L/M/H
NM-	Needle miner	L/M/H
ND-	Needle miner, Douglas-fir	L/M/H
NJ-	Needle miner, Jeffrey Pine	L/M/H
NK-	Needle miner, Knobcone Pine	L/M/H
NL-	Needle miner, Lodgepole Pine	L/M/H
NP-	Needle miner, Ponderosa Pine	L/M/H
NS-	Needle miner, Sugar Pine	L/M/H
NT-	Needle miner, True Fir	L/M/H
NW-	Needle miner, Western White Pine	L/M/H
OL-	Western oak looper	L/M/H
PB-	Pine butterfly	L/M/H
PH-	Phantom hemlock looper	L/M/H
PM-	Pandora moth	L/M/H
PN-	Pine needlesheath miner	L/M/H
PS-	Pine needle scale	L/M/H
S-	Spider mite	L/M/H
SA-	Sawfly	L/M/H
SD-	Sawfly, Douglas-fir	L/M/H
SF-	Sawfly, True fir	L/M/H
SH-	Sawfly, Hemlock	L/M/H
SK-	Sawfly, Knobcone pine	L/M/H
SL-	Sawfly, Lodgepole pine	L/M/H
SM-	Satin moth	L/M/H
SP-	Sawfly, Ponderosa pine	L/M/H
SW-	Sawfly, Western Larch	L/M/H
TA-	Tent caterpillar, Alder	L/M/H
TC-	Tent caterpillar, Other	L/M/H
TM-	Douglas-fir tussock moth	L/M/H
TS-	Tent caterpillar, Aspen	L/M/H
XS-	Noctuid moth	L/M/H

*AB = Number of dead trees or L/M/H. Balsam woolly adelgid can have both mortality and severity reported because of differences in infestation.

1) Branch infestation causes flagging and is reported as L/M/H.
2) Bole infestation can cause tree mortality, which is reported by the estimated number of current dead stems observed during the survey.

One polygon may have both types of damage recorded (example: AB-L!AB-15).

**The numbering system used in parts of Oregon (1985-1998) and parts of Washington (1991-1998) to reflect current budworm defoliation severities, while indicating relative cumulative damage.

1 = Current year's defoliation is visible from the air.
2 = Current year's defoliation with some bare tops visible (very little gray and still a lot of green foliage).
3 = Current year's defoliation visible with a lot of bare tops (both some gray foliage and some green foliage visible in host trees).
4 = Current year's defoliation with bare crowns (very gray in color, no visible green foliage in tree).

OTHER DAMAGING AGENTS

Code	Description	Severity
BEAR-	Bear damage	# of dead trees
BR-	Blister rust	# of dead trees - OR – L/M/H
BY-	Bynum's blight/Lophodermella mordida, host Ponderosa pine	L/M/H
CC-	Cytospora canker	L/M/H
DH-	Dying hemlock	# of dead trees
FIRE-	Fire damage	# of dead trees -OR- No modifier
HAIL	Hail damage	L/M/H
HD-	Hardwood decline	# of dead trees - OR - L/M/H
HDA-	Hardwood decline in quaking aspen (code introduced in 2011)	# of dead trees -OR- L/M/H
HDO-	Hardwood decline in oak (code introduced in 2011)	# of dead trees -OR- L/M/H
LC-	Needle cast, lodgepole pine	L/M/H
LW	Black Stain Root Disease (If another agent is present, no modifier is used with the LW code.)	# of dead trees -OR- no modifier
NFH	Areas not flown – have host species.	
NFN	Areas not flown – have no host species.	
OUT	No damage detected (in the middle of a polygon with activity)	
PC-	Needle cast in Ponderosa pine	L/M/H
PL-	Port orford cedar root disease, Phytophthora lateralis	# of dead trees
PMD-	Pacific madrone decline	L/M/H
PR-	Leaf rust in poplars	L/M/H
RB-	Red belt	L/M/H
RC-	Needle cast, larch	L/M/H
RD-	Root disease (If another agent is present, no modifier is used with the RD code.)	# of dead trees - OR – No modifier
SNC	Swiss needle cast	L/M/H/S
SLID-	Slide	# of dead trees -OR- No modifier
UNKD-	Unknown defoliation	L/M/H
UNKM-	Unknown mortality	# of dead trees
WATR-	Water damage	# of dead trees - OR – No modifier
WIND	Wind-throw	# of dead trees -OR- No modifier
WNTR	Winter damage	L/M/H - OR- no modifier

Process Record/Narrative:

Each year, all forested federal, state and private land in Oregon and Washington are aerially surveyed for insect and disease activity. This survey is flown cooperatively by Region 6 USDA Forest Service, Forest Health Protection (FHP); Oregon Department of Forestry (ODF), Forest Health Management Section; and Washington Department of Natural Resources (WDNR), Forest Health. These data are collected to determine regional insect and disease trends and to serve as an indicator to land owners/managers on insect and disease activity in their area.

Data are collected during annual surveys that are generally flown from early July through September. Historically, the surveys were flown in fixed-wing aircraft on various grid patterns. The accuracy of polygon placement and polygon attributes may be limited by several factors, including: surveyor experience, weather, time of day, time of year and visibility. Areas of activity were sketched on 1:126,720 or 1:100,000 USGS quad, paper maps by two flight observers, each one sketching approximately a two mile swath out their side of the plane. After the flight, the two observer's maps were combined and overlapping polygons were resolved on a final map. The data was then manuscripted on a stable base and scanned; it was edited and attributed using Arc/Info software. All data was forced into a UTM Zone 10 projection.

In 2000, Region 6 aerial surveyors began beta-testing a digitally assisted sketchmapping system. GeoLink software allows the surveyor to digitize and attribute the damage polygons in real time using gps and a geo-referenced, digital base map on a computer. After the flight, the data is converted to ArcGIS shape files and processed. Since 2000, portions of the regional surveys have been flown using this software. Since 2003, 100% of the surveys have been flown using GeoLink. Details about the digitally assisted sketchmapping systems can be found at: http://www.fs.fed.us/foresthealth/technology/dasm.shtml.

Feature datasets showing when areas were flown, which data capture method was used, and who flew the areas are available on request.

Since 2003, the insect and disease data haves also been posted as 100k quad .pdf maps on the web. They are best used when plotted at 36"x36", but users can also zoom in, on screen, and print a small area of interest. The 95 quad maps cover the forested areas in Oregon and Washington that are surveyed each year. The base map data is the TOPO! 100K quad series from National Geographic. Finalized survey maps and spatial survey data are generally posted on the website by November of the survey year. Links to these maps and data can be found at: http://www.fs.usda.gov/detail/r6/forest-grasslandhealth/insects-diseases/?cid=stelprdb5294941.

Draft maps of the survey data are posted anywhere from one day to one week after the flight (between July and September) for use during the current year's field season. No draft spatial data is made available during this timeframe. Feedback from field personnel is used to help clean up the current-year data for final posting.

Disclaimer:

The insect and disease data should be used only as an indicator of insect and disease activity, and should be ground-verified for actual causal agent and location. Polygons indicate areas of tree mortality and/or defoliation; intensity of damage is variable and not all trees indicated by polygons are dead or defoliated. The joint cooperators reserve the right to correct, modify, update or replace the data as necessary. Using this data for purposes other than those for which it was intended may yield inaccurate or misleading results.

The agencies which cooperatively conduct this survey (FHP, WDNR and ODF) strive to maintain an accurate Aerial Detection Survey (ADS) dataset, but due to the conditions under which the data are collected, FHP, WDNR and ODF shall not be held responsible for missing or inaccurate data. ADS are not intended to replace more site-specific information.

An accuracy assessment has not been done for this dataset; however ground checks are completed in accordance with local and national guidelines (http://www.fs.fed.us/foresthealth/aviation/resources/docs/ADS_grdchk_guide_formV2.pdf):

> "Aerial survey polygons are sketch-mapped and intended to be used as a detection tool and are not intended to replace more specific, on-the-ground information. Ground truthing is completed to the extent necessary for entomologists, pathologists, and aerial observers to ensure appropriate coding on the sketch maps for host forest type and damage causing agent. Accuracies and ground truth information are not retained in these data layers."

Maps and data may be updated without notice.

Please cite USDA Forest Service, Forest Health Protection; Washington Department of Natural Resources, Resource Protection Division, Forest Health; and Oregon Department of Forestry, Forest Health Management" as the source of this data in maps and publications.

Other Insect and Disease Spatial Data Sources:

- National insect and disease maps and information are available via the Forest Health Protection Mapping and Reporting website: http://foresthealth.fs.usda.gov/portal
- Special Swiss Needle Cast Survey data in Oregon are available from Oregon Department of Forestry (1996-Present) here: http://www.oregon.gov/odf/privateforests/pages/fhmaps.aspx
- Spatial data showing areas flown/not flown in R6 are available upon request; 1996-present.

Conversion factors used for a 2007 decision to bring 1947-2006 data to 2007 standards:

I. Historical context: Aerial surveys in the Pacific Northwest began in the Blue Mountains in 1947 to map the extent and severity of a budworm outbreak. By 1949, all 49 million acres of the coniferous forest type in Oregon and Washington were flown and a variety of forest disturbances were mapped. These surveys have been conducted every year since then.

Two different methods have been used to report the severity of tree mortality. Prior to 1969, tree mortality was categorized as light, moderate, heavy or very heavy. These mortality intensities were associated with a range of trees killed per section or a number of trees in a group (see table 6 below). Standards employed since 1968 require the reporting of the number or density of trees killed for all mortality agents except bear, Port-Orford cedar root disease, balsam woolly adelgid and Ips, for which mortality was reported as light, moderate or heavy in some years. Comparison of tree mortality across all aerial survey years (1947 – 2006) will require conversion of at least some mortality data to common units or categories.

II. Rationale for conversions: A team consisting of Kathy Sheehan, Julie Johnson, David Bridgwater and Keith Sprengel assembled in March, 2007, to review the different standards used from 1947-2006 and recommend tree mortality conversions where appropriate. The team supported conversion of the mortality categories used in earlier aerial surveys (light, moderate, heavy and very heavy mortality) - to the current mortality density standard (trees killed per acre, either by direct estimate or by recording the number of dead trees per polygon and later calculating mortality density based on polygon size). Tree mortality densities calculated for each category based on Table 6 (Wear and Buckhorn 1955) generally ranged from ~0.05 trees per acre (light) to ~4.0+ trees per acre (very heavy). These calculated densities are somewhat lower than currently found in some situations; however, tree density was generally much lower historically (Hessburg, Mitchell, and Filip 1994); and the mortality densities calculated from Wear and Buckhorn (1955) are consistent with other mortality densities reported during that era (see Appendix I for additional references).

III. Options reviewed:

a. Leave the tree mortality intensity data in the format as it was collected. Pro: integrity of original data is maintained; users can apply whatever conversion factors best meet their needs. Cons: applying conversion factors will be technically difficult for many users: most users will consult FHP specialists to determine what conversion factors should be used – which may lead to inconsistent estimates.

b. Standardize the data to trees per acre format, generally using Wear and Buckhorn (1955) for 1947-1968 data and analysis of recent data (1969-present) to convert recorded aerial survey damage categories to tree mortality densities. Pro: will insure that conversions are done consistently; documents FHP specialists' consensus regarding the most appropriate conversion factors; users don't have to calculate and apply conversion factors for each analysis. Con: some original data may be "lost" (though it would still be on the original maps); previous analyses that used different conversion factors may have to be re-done.

IV. Protocols for conversion: The team recommends III-Option b. Tree mortality densities will be calculated for Table 6 using the upper limit of trees per section or trees per group, whichever yielded higher average TPA in each intensity category. The upper end of the range will be used because numerous ground checks and studies have shown that aerial surveys underestimate actual mortality (see Table 1, which derives conversion factors based on the standards on the standards published by Wear and Buckhorn). Analyses of data collected between 1969 and 2006 (i.e. the vast majority of recorded mortality was well distributed in the light to very heavy categories) supported the groupings of mortality agents by "timber type" with the following exceptions:

a. Spruce beetle – Historic patterns of mortality intensity are more similar to those seen in the "lodgepole" type; for example, only 29% of the 1969-2006 data would fall within the light to very heavy categories when analyzed in the intensity categories of the "true fir, Engelmann spruce, white pine" type, whereas 91% of the same data is well distributed in the light to very heavy categories when analyzed in the intensity categories of the "lodgepole, whitebark pines" type. Timber Types as listed in Table 6 identified the largest, dominant tree species (pers. Comm. John Wear). Spruce beetle outbreaks have been recorded in other timber types (ponderosa pine, lodgepole etc…)

b. Mountain pine beetle in ponderosa pine – Much of the mortality mapped in ponderosa pine before 1969 was in large old pines and was attributed to western pine beetle. Mortality patterns and intensities for younger ponderosa pines killed by mountain pine beetle more closely approximated that seen in western white pine (pers. Comm. David Bridgwater), therefore this was grouped with the "white pine" group. Analysis of the last 38 years of aerial survey data further substantiated assignment to this category (over 71% of the recorded mortality fell within the historic intensity categories of light to very heavy).

c. Bear – Patterns of mortality more closely approximates densities seen in the "lodgepole pine type" (pers. Comm. Mike McWilliams). This is further substantiated through analysis of mortality data collected from 1969-2006 (97% of this data falls within the historic light to heavy categories with the remaining 3% falling within the upper and lower limits of the very heavy category).

d. Ips – Patterns of mortality caused by Ips more closely approximates the densities seen in the "lodgepole pine type" (pers. Comm. David Bridgwater). This is further substantiated through analysis of mortality data collected from

1969-2006 (93% of this data falls within the historic light to heavy categories with the remaining 7% falling within the limits of the very heavy category).

e. Dying Hemlock – Although analyses of recent data did not clearly support mortality in the "true fir" type intensity category (65% of the 1969-2006 data was at densities in excess of the estimated upper limit of the very heavy category), we found that there were too few records in the recent records to remove it from the true fir category. Current standards allow sketchmappers to attribute this damage as light, moderate or heavy (to indicate branch flagging) or as trees per acre (to indicate mortality). Although early records are unclear, we believe that much of the mapping in the early years recorded mortality.

V. Additional protocols for standardization to be applied to all years of aerial survey data:

a. Missing attributes – Polygons with missing attributes will first be checked against the original survey map. If no "modifier" (i.e. intensity) is found, the polygon will be assigned the equivalent of "light", using the most conservative estimate in the absence of solid information.

b. Defoliator Attributes – The following conversions will be applied to the aerial survey data: Modifiers "1" and "VL (very light) will convert to "L" for light. Modifier "2" will convert to "M" for moderate. Modifiers "3", "4", "VH" (very heavy), and "Dead" will convert to "H" for heavy.

c. Mortality agents recorded after 1968 with light, moderate, or heavy attributes – Conversion factors listed in Table 1 will be applied. Affected agents include: Port-Orford cedar root disease, bear, and Ips.

		Table 1 Derived from information in Table 6		
		reported	calculated	polygon size for
		or estimated	or estimated	minimum # trees
		minimum	high	at calc. mort. rate
Code**	**Intensity**	**# trees/group***	**t/ac***	**(ac)**
1,2,F,F1, F2, F3, P, P1, P2, P3, PL 4,5,6P, 6J,6W,AB,DH, 9	L or 1	5	0.08	62.50
	M or 2	15	0.23	65.22
	H or 3	30	0.47	63.83
	VH or 4	75	1.18	63.56
8,6S	L or 1	5	0.08	62.50
	M or 2	10	0.16	62.50
	H or 3	20	0.31	64.52
	VH or 4	43	0.67	64.18
3, 6L,6B,7,Bear	L or 1	50	0.55	90.91
	M or 2	200	1.56	128.21
	H or 3	400	4.06	98.52
	VH or 4	1660	16.85	98.52

For polygons smaller than the size shown in the "polygon size for minimum # trees at calc. mort. Rate" column, applying the calculated mortality rate would result in fewer trees per group than the reported minimum number of trees per group. Therefore, for these smaller polygons we set the mortality rate = (minimum # trees)/(polygon size). The mortality rates for these smaller polygons will be higher than the calculated mortality rates shown in the "Calculated or estimated high t/ac" column.
** See Attribute Code List for definition of aerial survey “codes”.

The upper end of the "very Heavy" category was estimated by using the average multiplier of each of the preceding intensity categories. For example: Ponderosa/Sugar pine timber type has 20-50 trees per section (TPS) in the Light category (20X=50, therefore, the upper range is 2.5 times the lower range); 50-100 TPS in the Moderate category (50X=100, therefore the upper range is 2 times the lower range); 100-200 TPS in the Heavy category (100X=200, therefore the upper range is 2 times the lower range). The average "multiplier", therefore = (2.5 +2.0+2.0)/3=2.17; multiplying this factor times the lower end of the Very Heavy category derives the upper end of the very heavy category (e.g. 2.17 X 200 = 434 TPS or 0.67 TPA). This method was employed in each “timber” type.

Table 6 (from Wear & Buckhorn). Intensity classification of bark beetle infestations for aerial reconnaissance surveys in Oregon and Washington[2/]

Timber types[1/]	Light	Moderate	Heavy	Very Heavy
Ponderosa pine, Sugar pine	20-50 trees per section, 5 trees or less per group	50-100 trees per section, 10 trees or less per group.	100-200 trees per section, 20 trees or less per group	200 or more trees per section, large groups
Lodgepole pine, *whitebark pine*	50-350 trees per section, 50 trees or less per group.	350-1000 trees per section, 200 trees or less per group.	1000-2600 trees per section, 400 trees or less per group.	2600 or more trees per section, large groups
Douglas-fir	20-50 trees per section, 5 trees or less per group	50-150 trees per section, 15 trees or less per group	150-300 trees per section, 30 trees or less per group	300 or more trees per section, large groups
True firs, Engelmann spruce, white pine	20-50 trees per section, 5 trees or less per group	50-150 trees per section, 15 trees or less per group	150-300 trees per section, 30 trees or less per group	300 or more trees per section, large groups

[1/] Timber types are based on predominant species according to Forest Type Classification for the Pacific Northwest Region (U.S. Forest Service).

[2/] Wear, J.F., and Buckhorn, W.J. Organization and Conduct of Forest Insect Aerial Surveys in Oregon and Washington. U.S. Forest Service Pacific Northwest Forest and Range Experiment Station, 40 pp., illus. 1955. (Processed). p. 25.