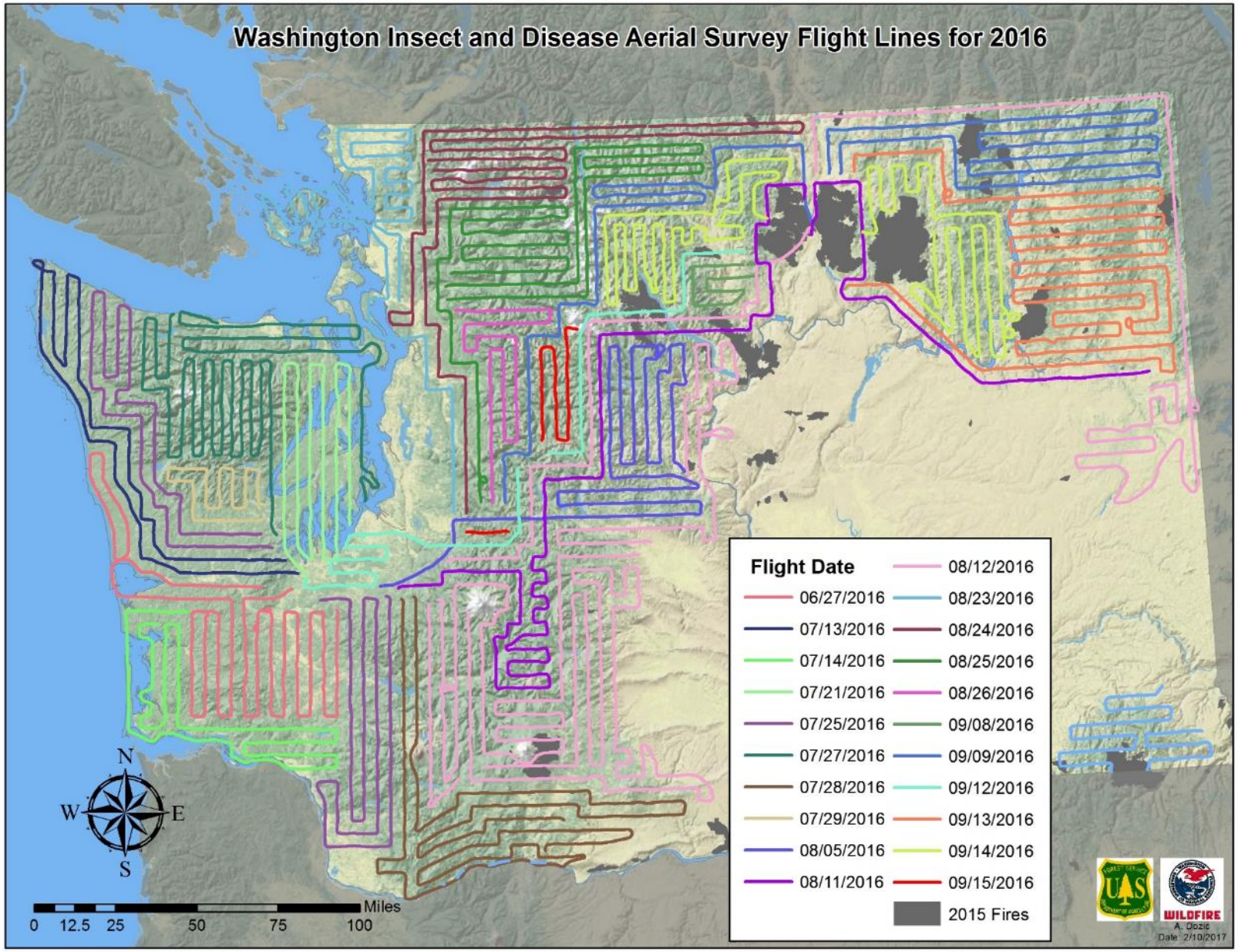
2016 Forest Health Highlights in Washington and Oregon

Glenn Kohler, Forest Entomologist
Washington Department of Natural Resources

Annual Aerial Survey for Insect and Disease Damage in WA & OR

Annual “bugs & crud” aerial survey



Annual reports on aerial survey data and other forest health monitoring activities. www.fs.usda.gov/goto/r6/fhp/highlights

USDA
United States Department of Agriculture

Forest Health Highlights in Oregon—2016

Pacific Northwest Region
Forest Health Protection

Oregon Department of Forestry
Forest Health Program

for the greatest good

USDA
United States Department of Agriculture

Forest Health Highlights in Washington—2016

COOPERATIVE AERIAL SURVEY
Pacific Northwest
1947 - 2016

Celebrating 70 years
of Aerial Survey

Washington State Department of Natural Resources
Forest Health Program
March 2017

WILDFIRE

for the greatest good

Pacific Northwest Region
Forest Health Protection

Aerial survey maps and data available online

USDA United States Department of Agriculture
Forest Service

Pacific Northwest Region

Forest Service Home | About the Agency | Contact the National Office

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Region 6

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- Recreation
- Passes & Permits
- Maps & Publications
- Fire & Aviation
- Climate Change
- Land & Resource Management
- Forest & Grassland Health
  - Invasive Species
  - Insects & Diseases

Aerial Detection Survey Quad Maps

Aerial detection survey (ADS) maps are available for the following years:

2016 2015 2014 2013 2012 2011 2010

2009 2008 2007 2006 2005 2004 2003

Forest Health Protection (FHP)

- FHP Home
- Forest Health Monitoring
- Publications and Reports

Aerial Detection Survey (ADS)

- ADS Home
- ADS Quad Maps
- ADS Data
- ADS Fact Sheet

Contacts and Links

- R6 FHP Contacts
- Forest Insect & Disease Leaflets (FIDLs)
- Western Forest Insects & Diseases
- Organizations & Partners
- FHP International Activities

www.fs.usda.gov/goto/r6/fhp/ads/maps

- Site Map

Region 6

- Home
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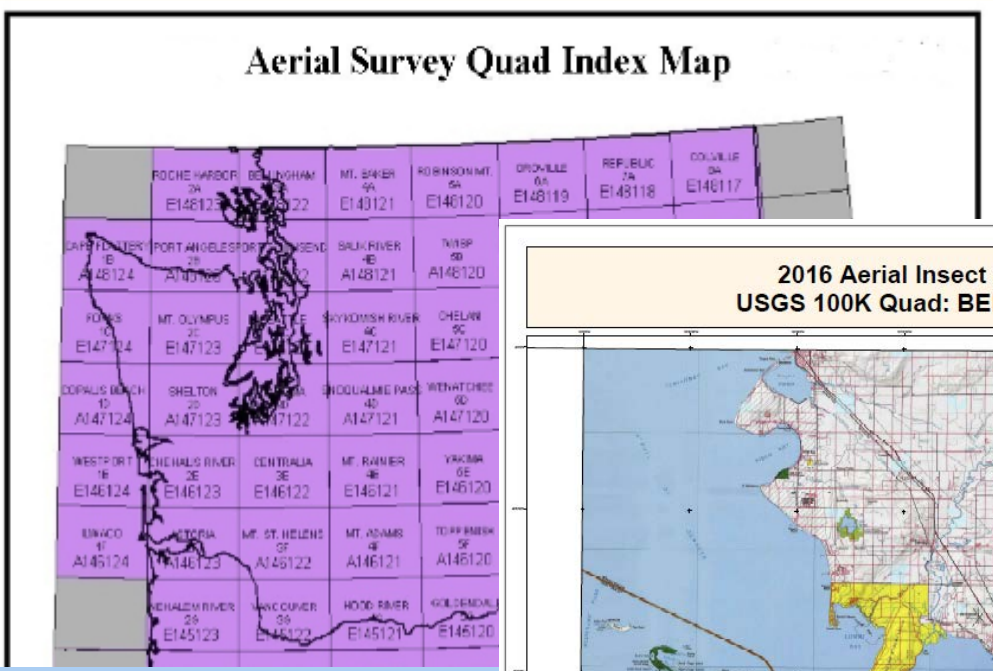
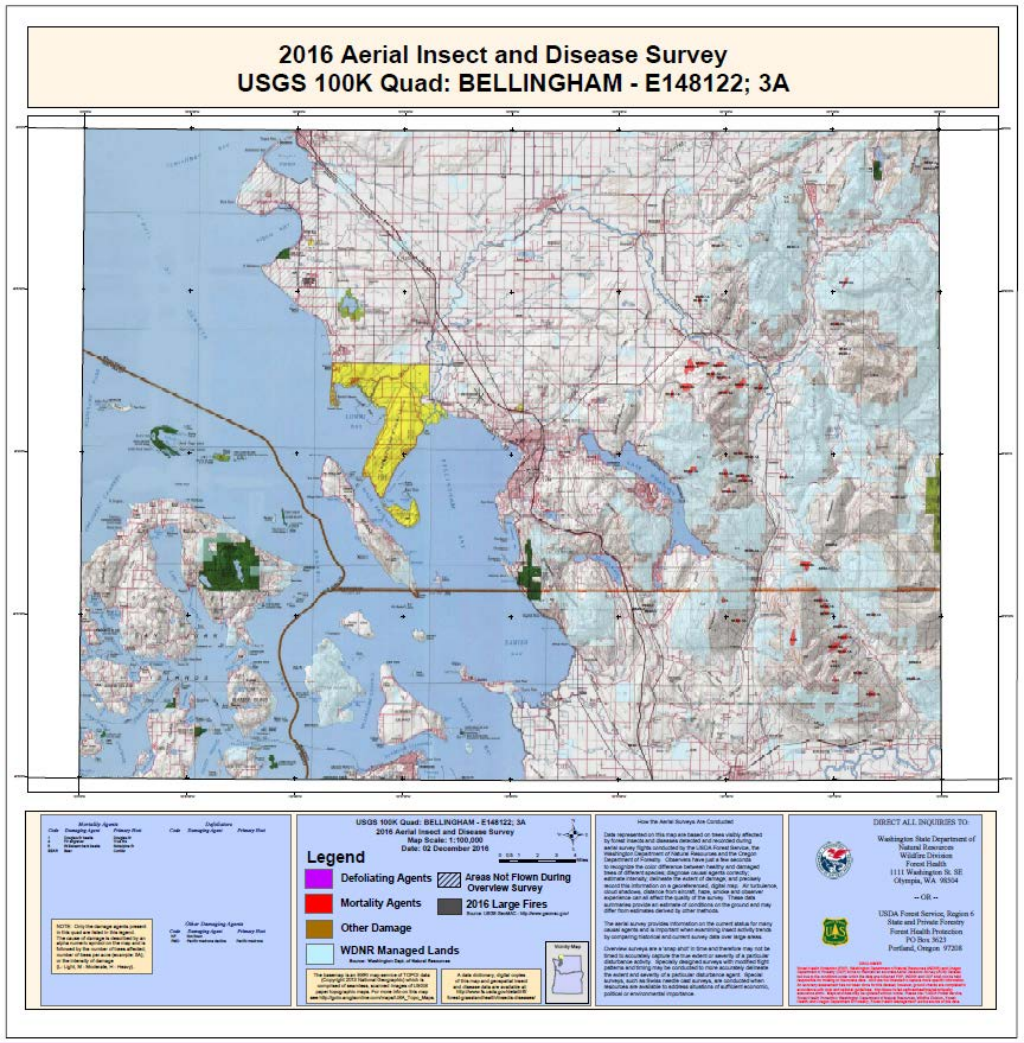
- Fire & Aviation
- Climate Change
- Land & Resource Management
- **Forest & Grassland Health**
  - Invasive Species
  - Insects & Diseases
- State, Private & Community Forests
- Plants & Animals

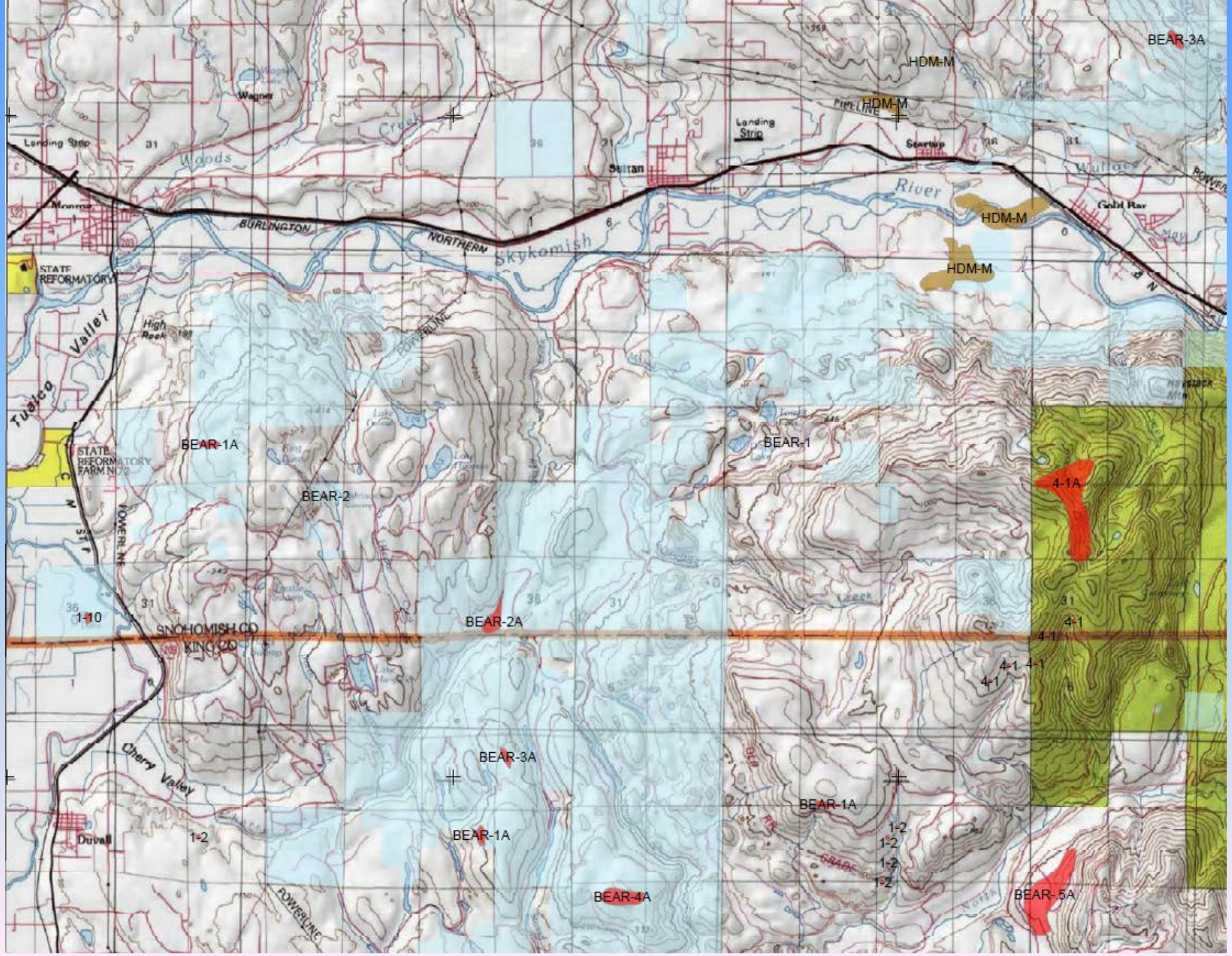
2016 ADS Quads

Click on a rectangle (below) to view a quad map; each map is a 1-5 MB .pdf file.
View quad maps for **other years** (2003-present).





Now geo-referenced for mobile apps!


BEAR-3A
HDM-M
HDM-M
Landing Strip
Startup
Sultan
Wagner
Woods Creek
Wallace River
Gold Bar
Monroe
BURLINGTON NORTHERN
Skykomish
HDM-M
HDM-M
STATE REFORMATORY
Tualco Valley
High Rock
STATE REFORMATORY FARM NO2
BEAR-1A
BEAR-1
BEAR-2
4-1A
POWERLINE
1-10
SNOHOMISH CO
KING CO
BEAR-2A
4-1
4-1
4-1
4-1
4-1
BEAR-3A
Cherry Valley
Duvall
1-2
BEAR-1A
BEAR-1A
1-2
1-2
1-2
1-2
BEAR-4A
BEAR-5A
POWERLINE

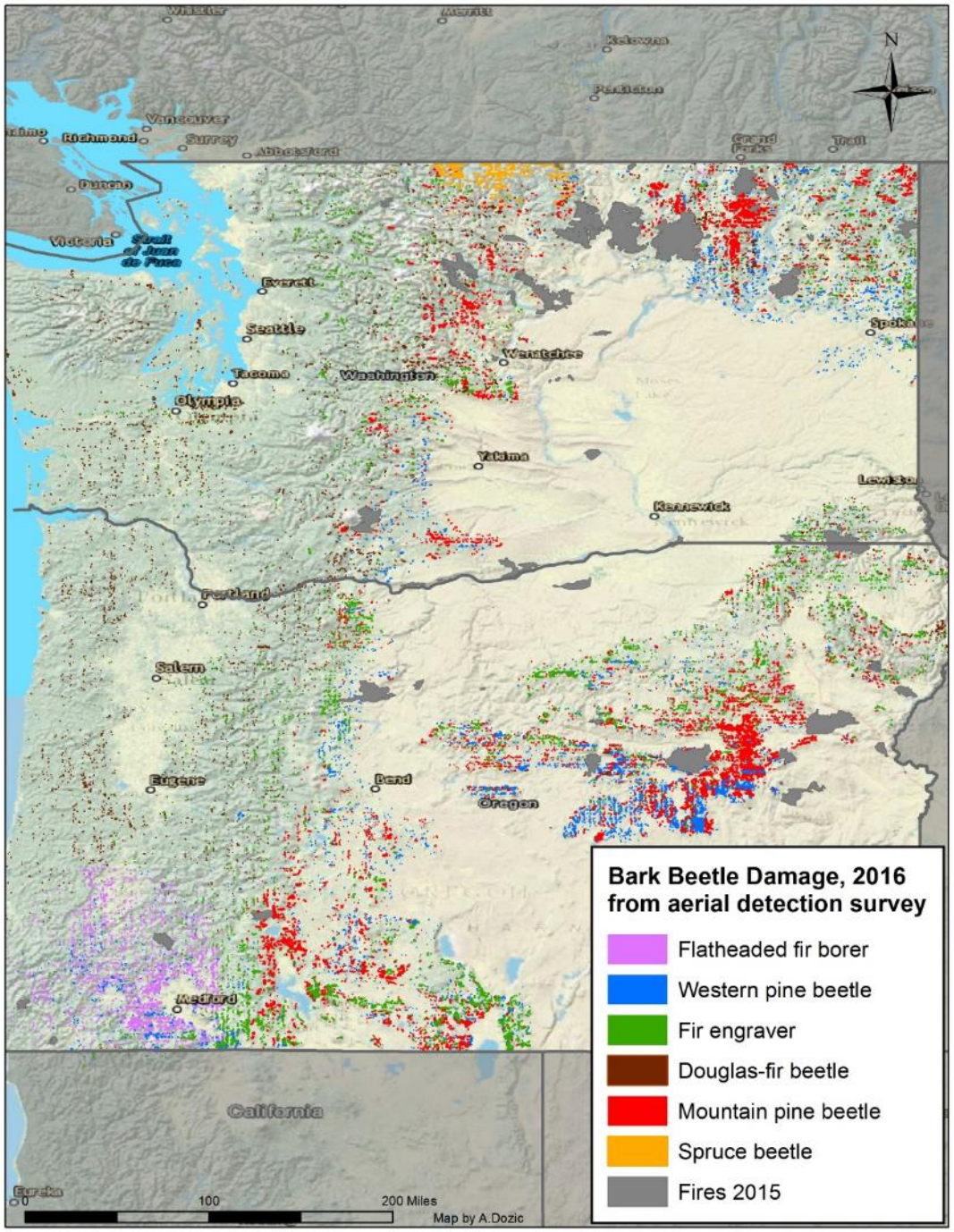
41 million acres flown in 2016 aerial survey.

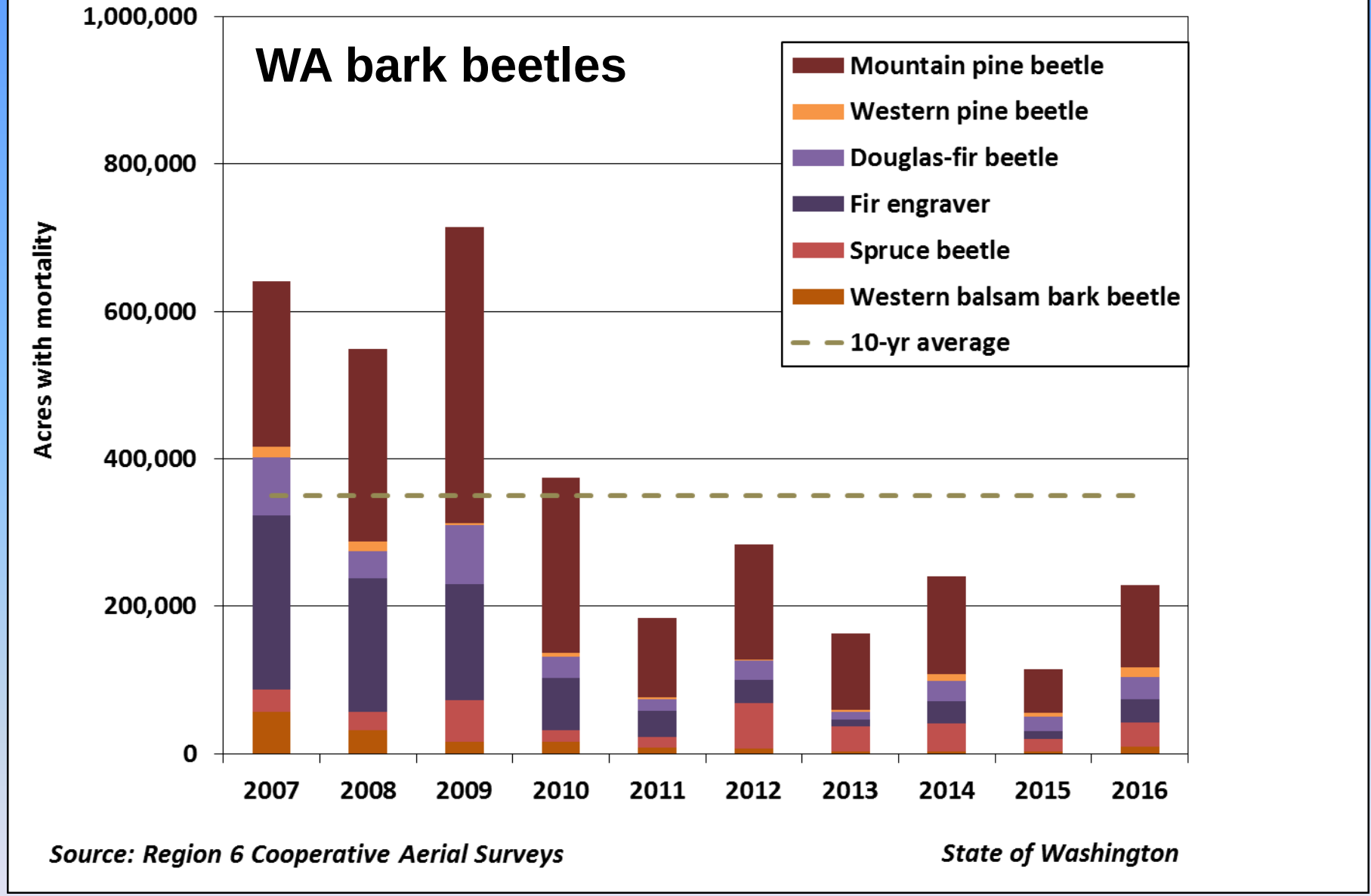
1 million acres not flown due to 2015 large fires.

805,000 acres with mortality from bark beetles and flatheaded fir borer (645,000 in 2015).

<u>WA:</u> all bark beetle species increased

<u>OR:</u> FFB & all bark beetle (except MPB) increased

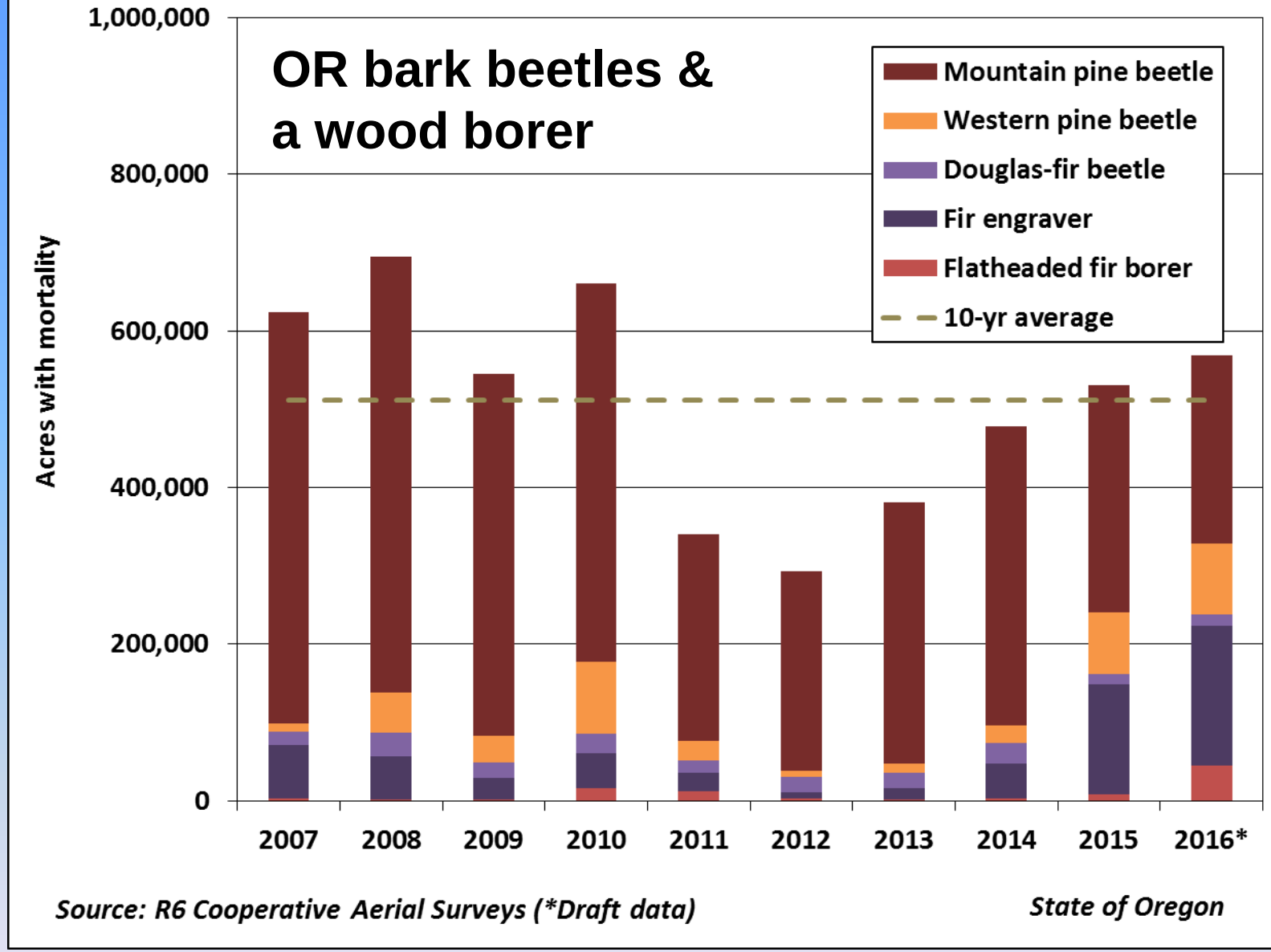




Pine bark beetles: 126,000 acres (65,200 in 2015)
Douglas-fir beetle: 30,600 acres (highest since 2009)
Fir engraver: 30,800 acres (11,700 in 2015)

Fir engraver, Ellensburg, WA 2016

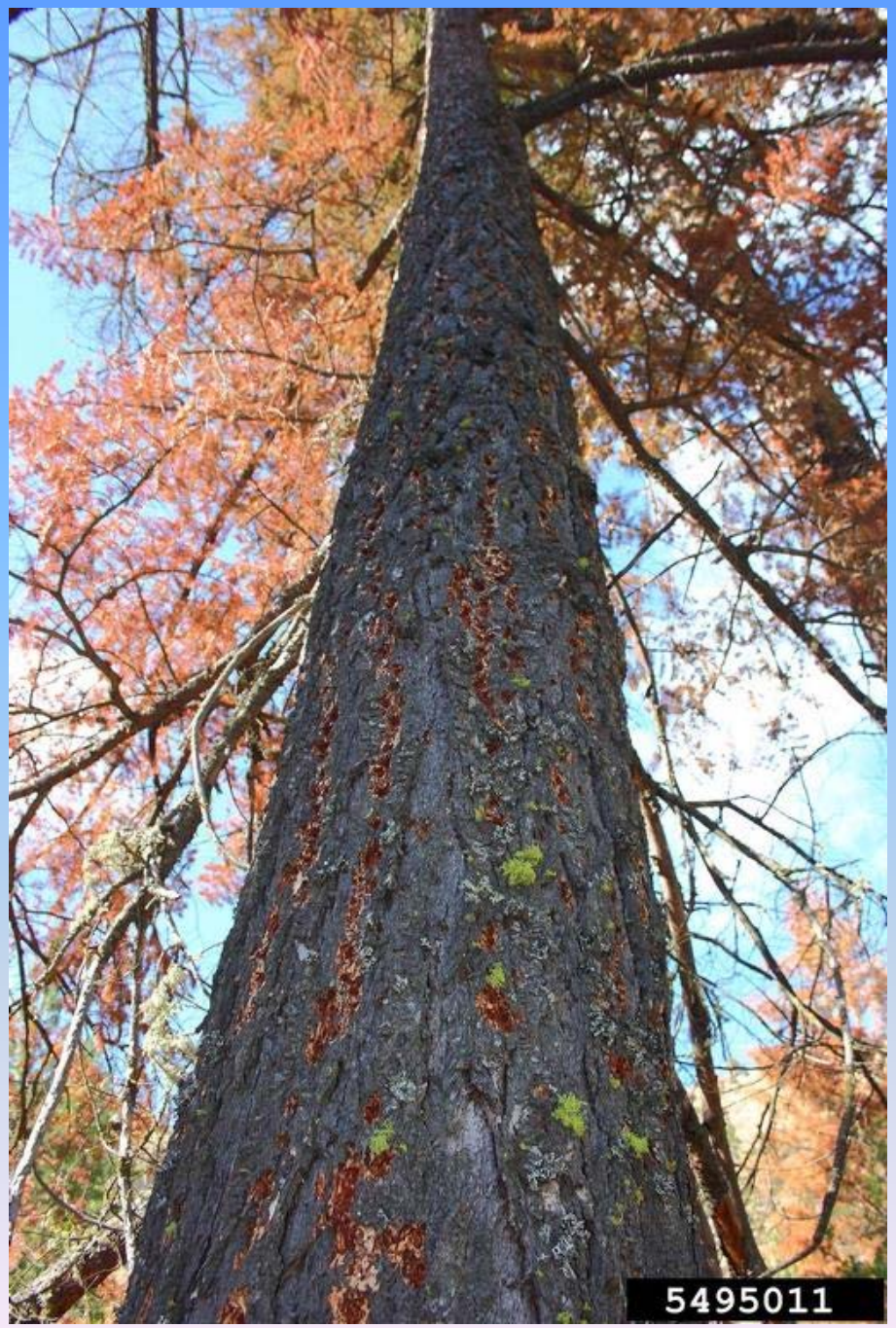
Western pine beetle, Deer Park, WA 2016



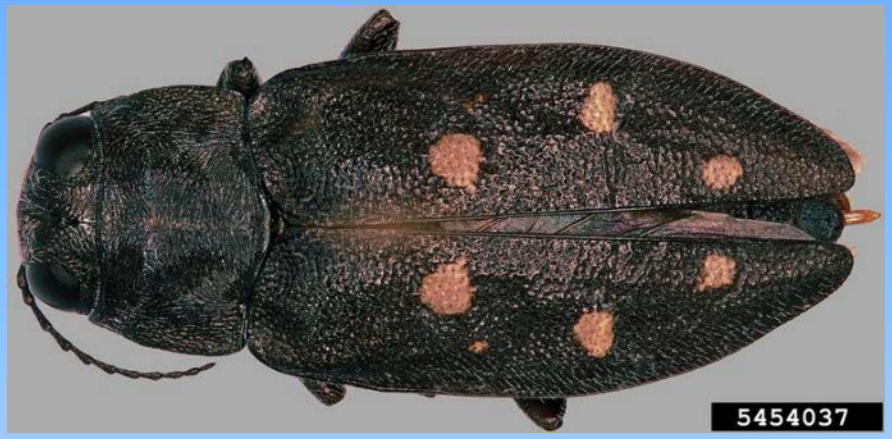
Pine bark beetles: 344,000 acres

Flatheaded fir borer: 45,000 acres (8,000 in 2015)

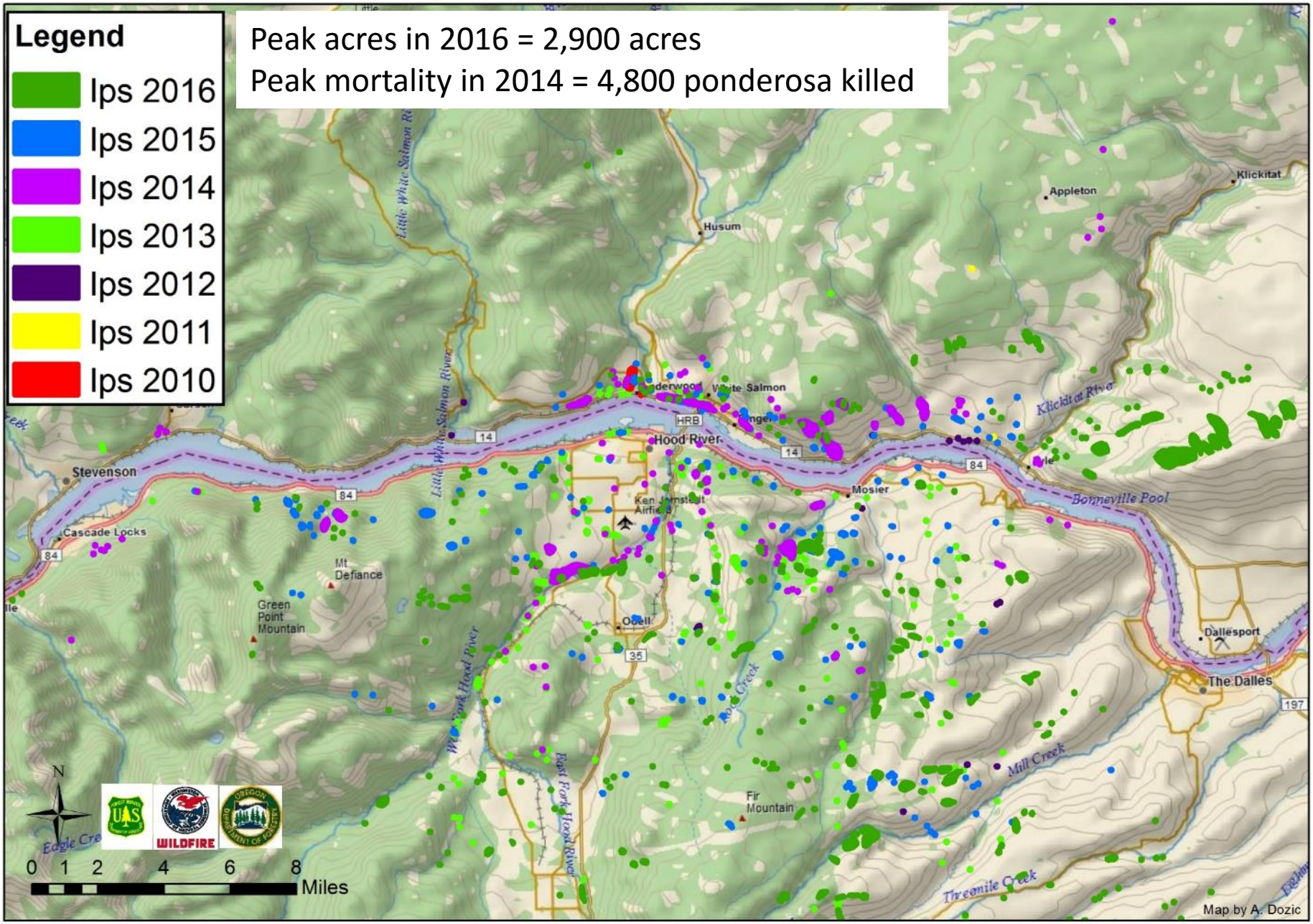
Fir engraver: 177,700 acres (20x increase since 2012)



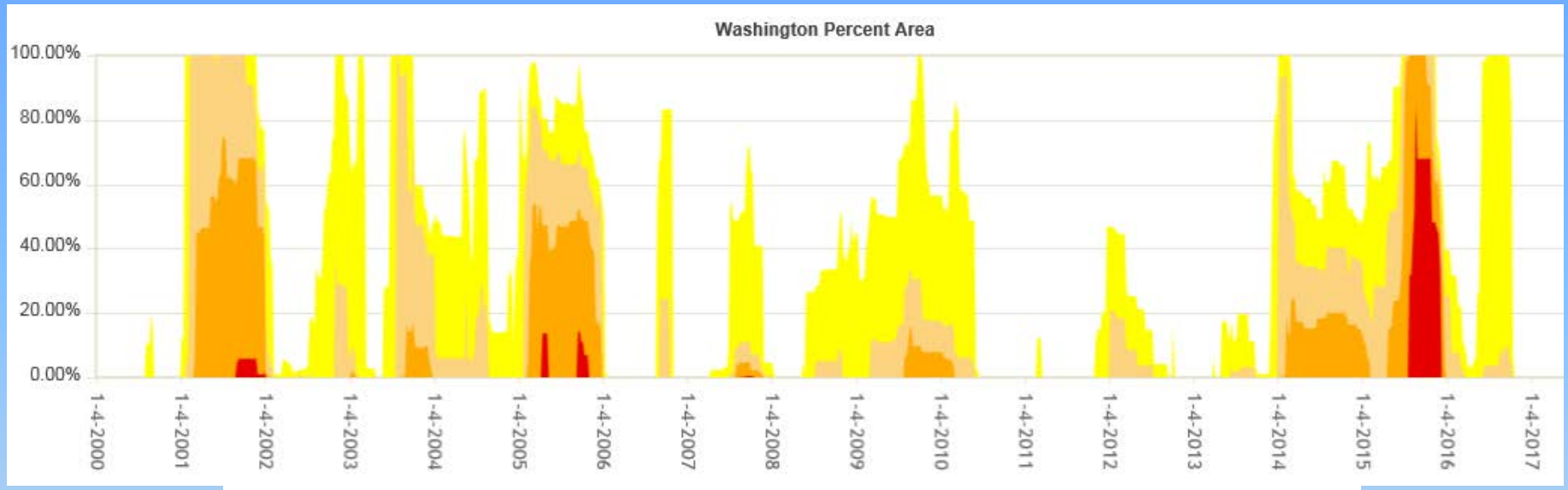
Flatheaded fir borer
Buprestidae:
Phaenops drummondi

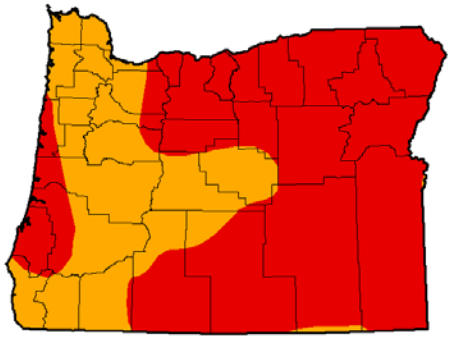


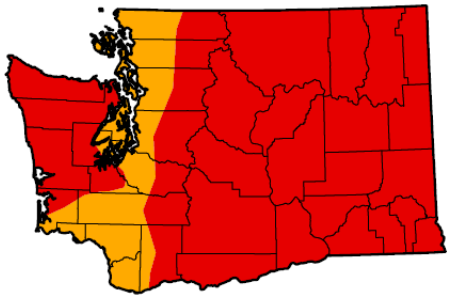
Areas With Mortality Caused by California Fivespined Ips Mapped in Oregon and Washington Using Aerial Survey 2010 - 2016



Summer drought often occurs somewhere in PNW, but 2015 was an extreme drought year.







August 25, 2015
(Released Thursday, Aug. 27, 2015)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	99.99	84.64	0.00
Last Week 8/18/2015	0.00	100.00	100.00	99.99	50.80	0.00
3 Months Ago 5/26/2015	9.77	90.23	51.81	23.76	0.00	0.00
Start of Calendar Year 12/30/2014	51.87	48.13	36.15	14.83	0.00	0.00
Start of Water Year 9/30/2014	34.22	65.78	40.27	20.17	0.00	0.00
One Year Ago 8/26/2014	32.61	67.39	40.32	19.99	0.00	0.00

Intensity:
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

Summer 2015

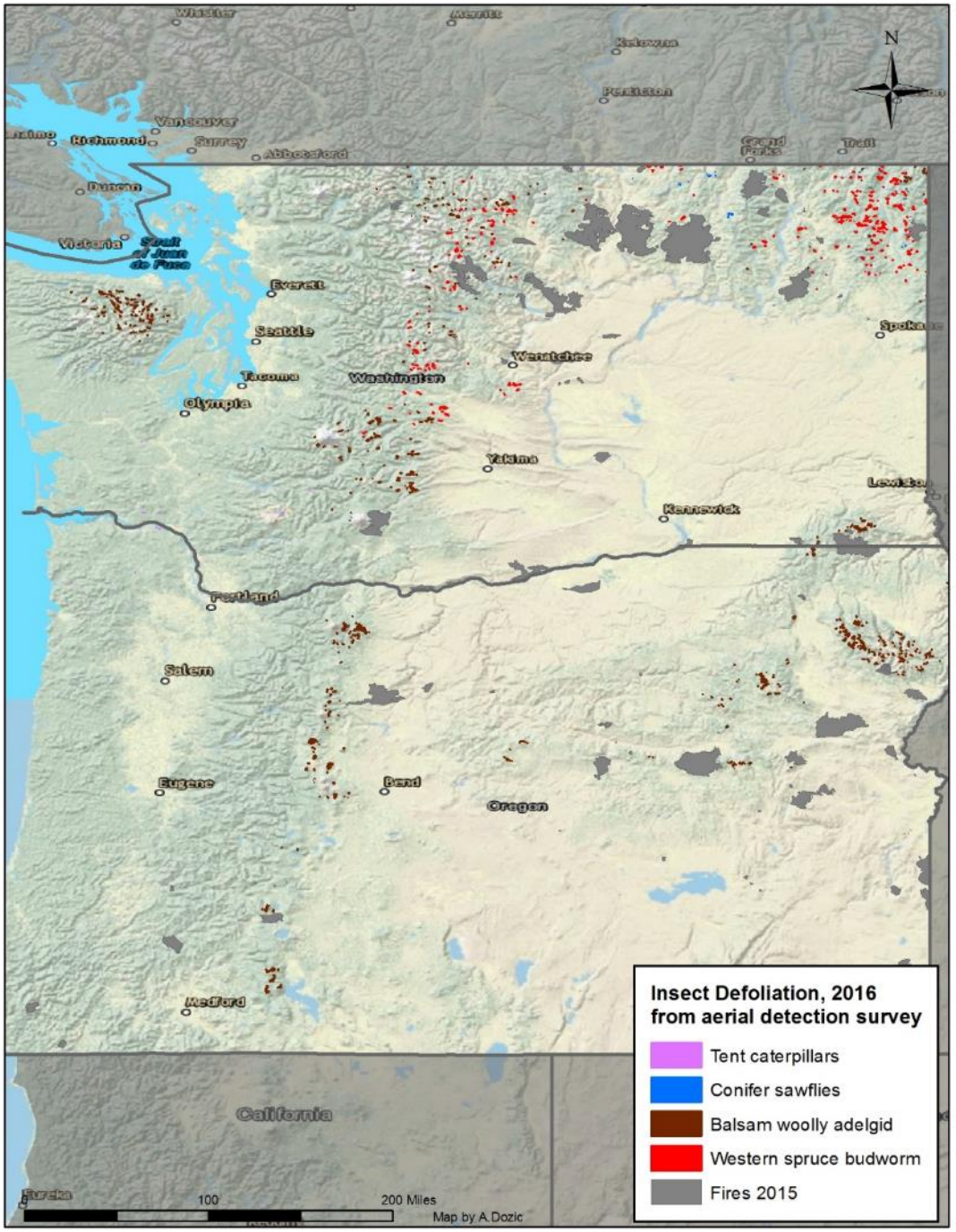
Drought damage in 2015 & 2016:

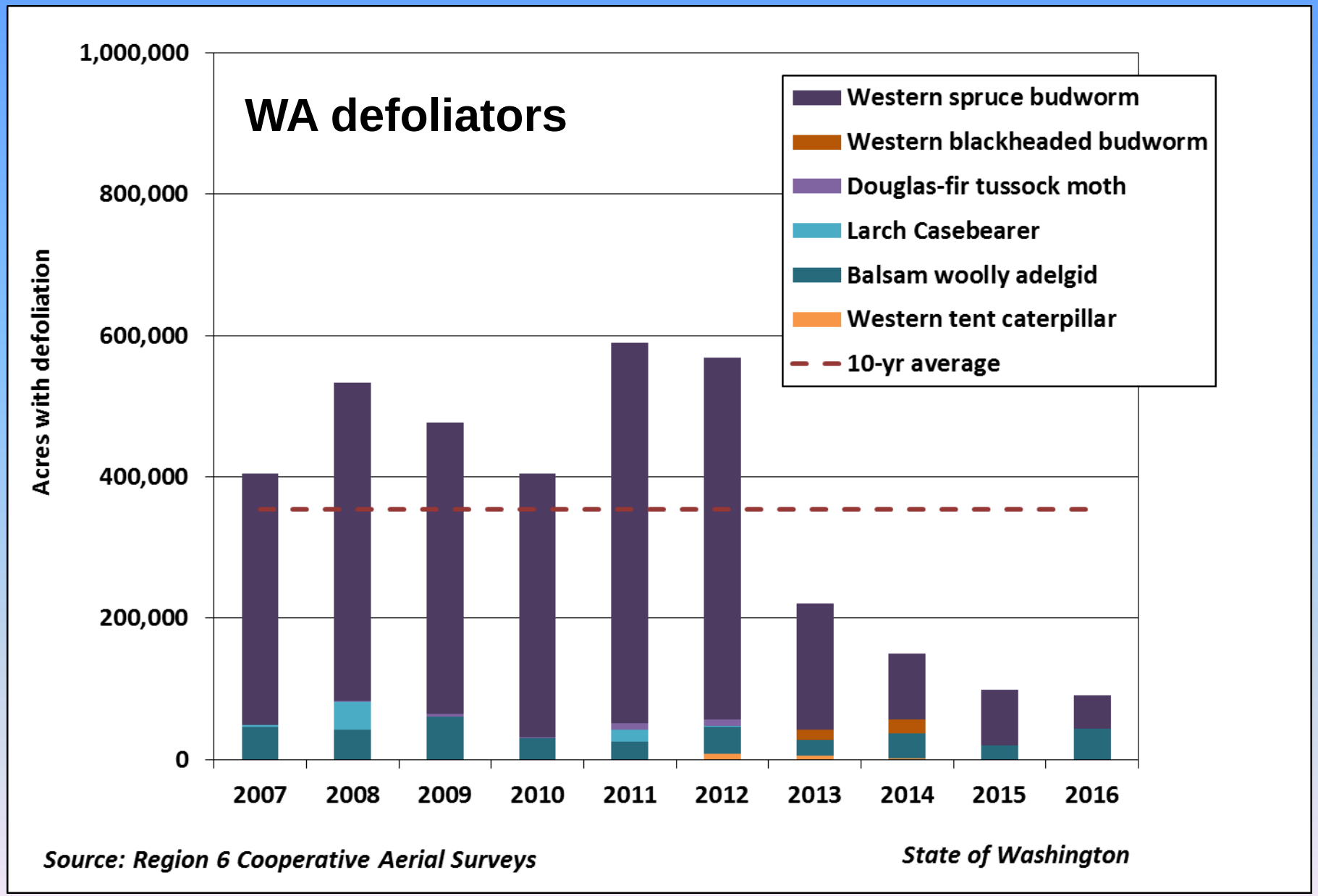
- Often more than one species affected
- Worse on marginal sites & well-drained soils
- Damage develops from top-down and outside-in

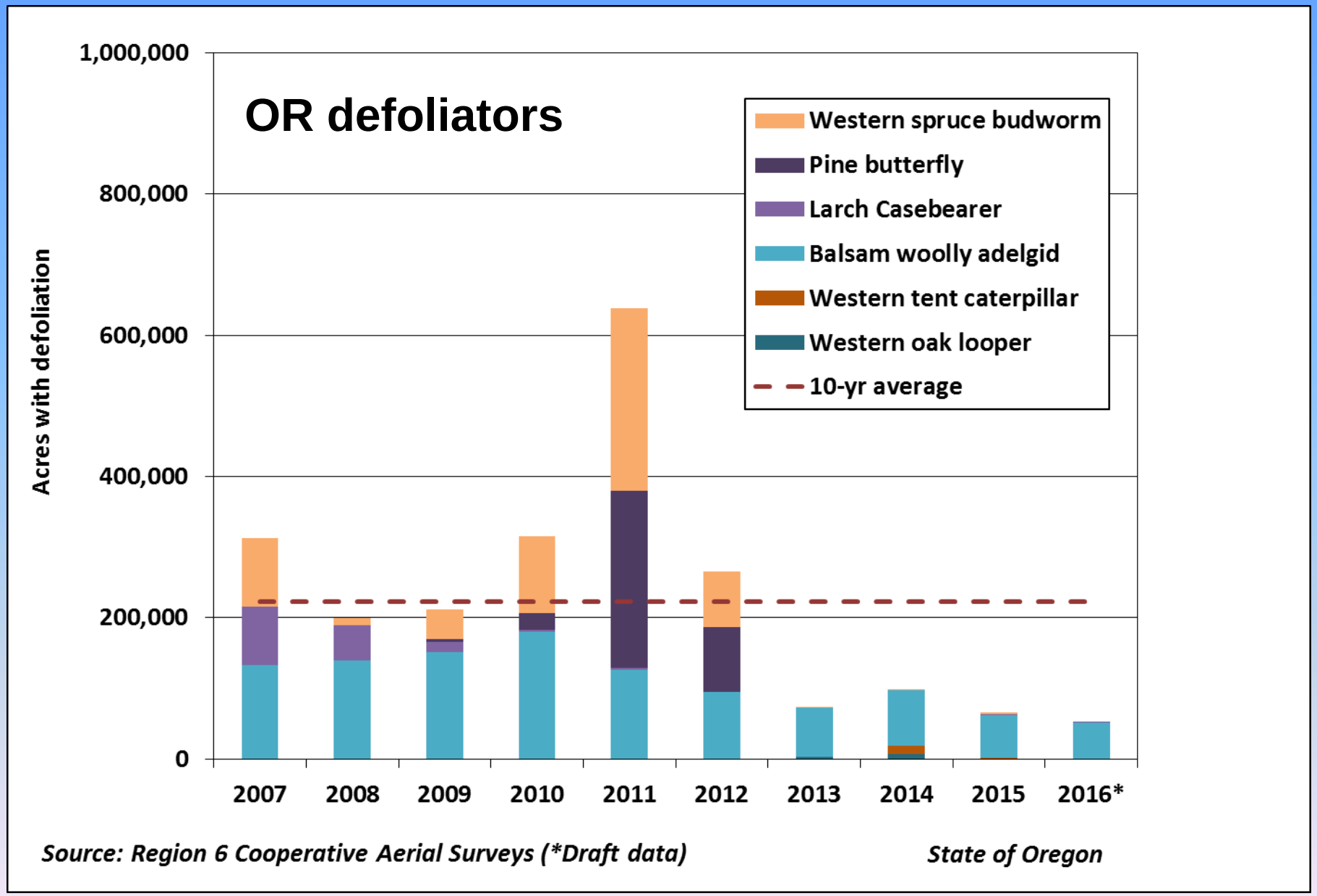
- Dead tops & branches (flagging)
- Some mortality without insect or pathogen signs
- Increase in secondary bark beetle activity

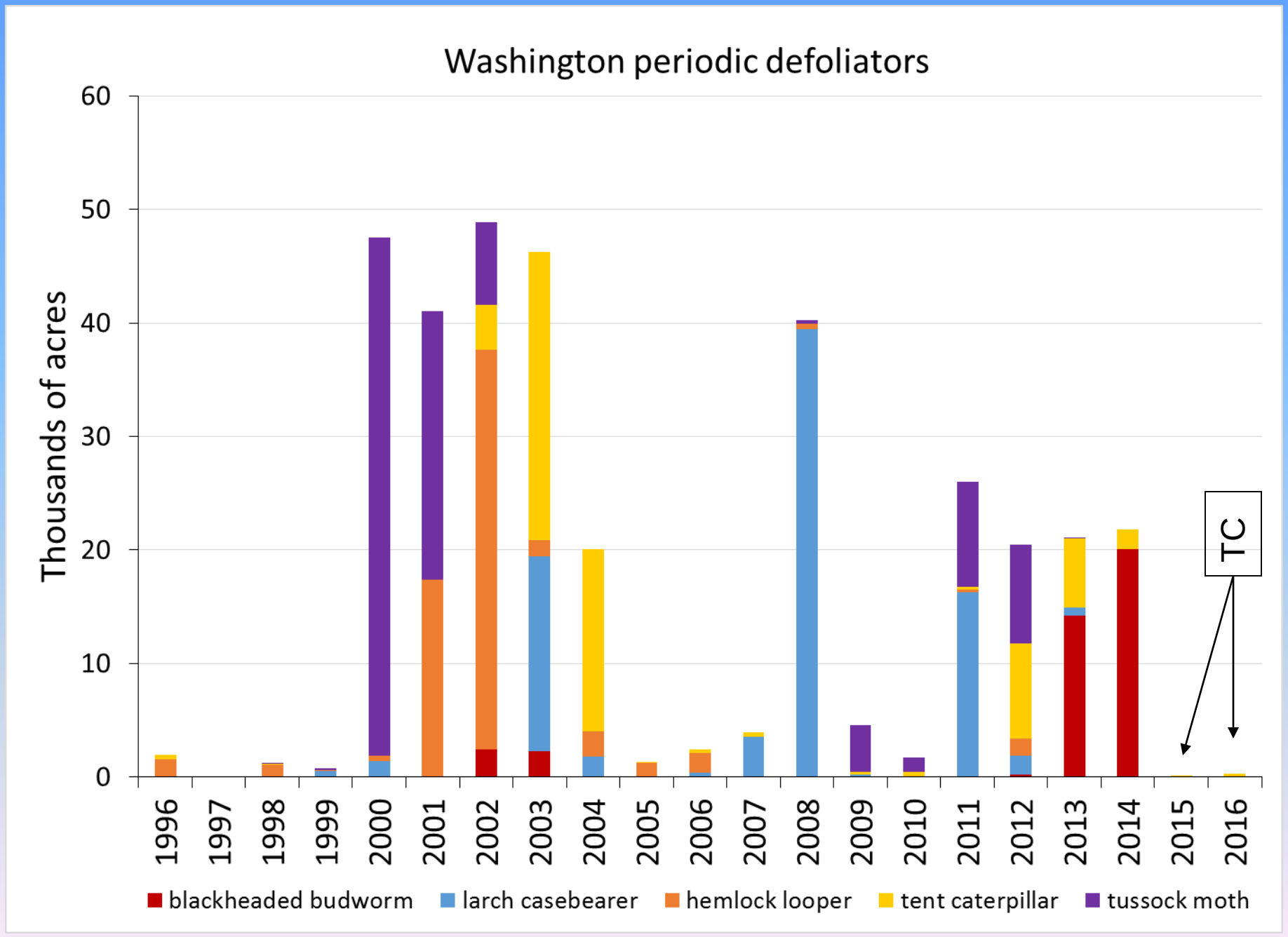
Tom Eckberg,
Idaho Dept lands

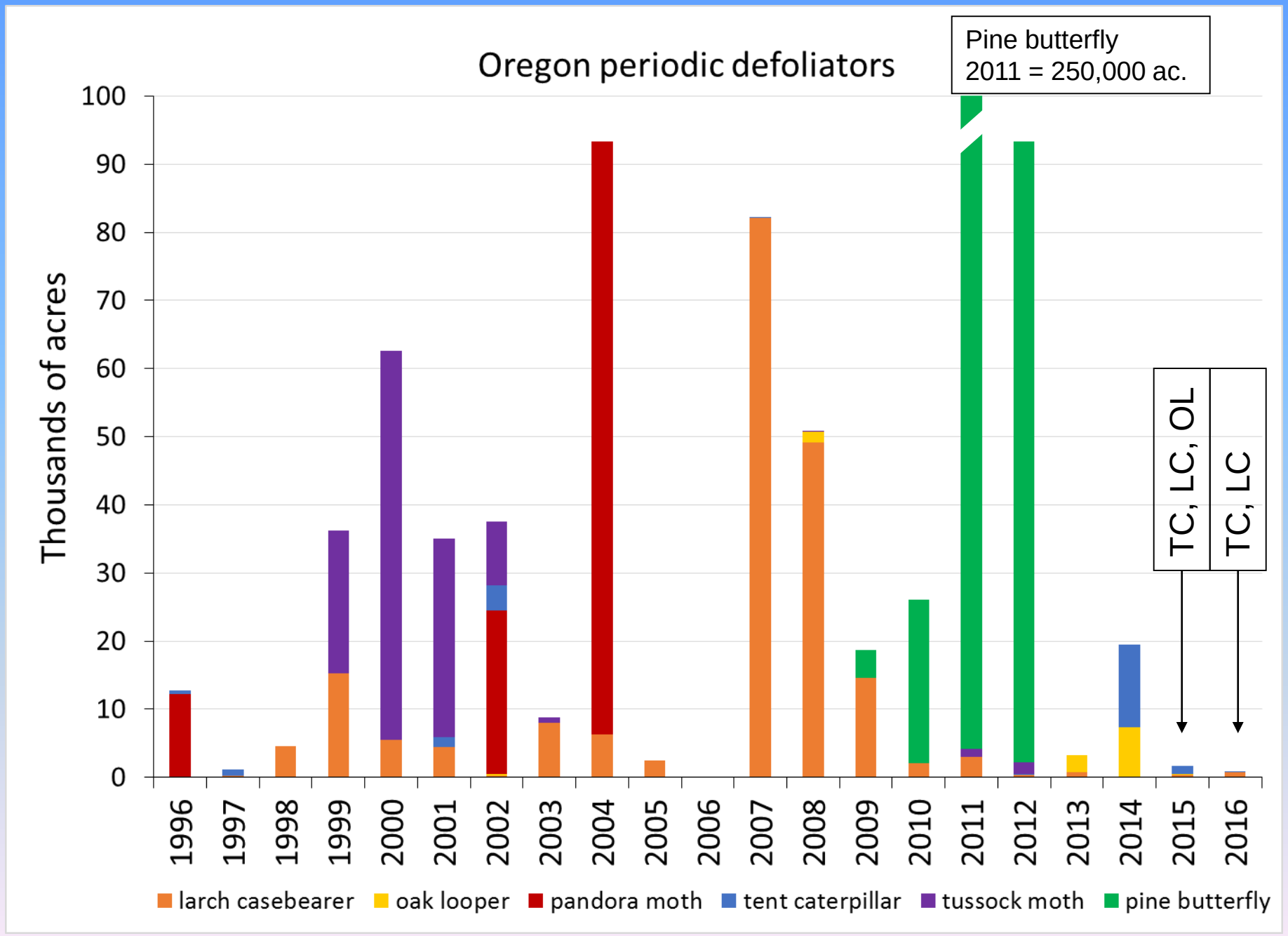
Defoliation mapped in 2016 aerial survey




WA defoliators
Acres with defoliation
1,000,000
800,000
600,000
400,000
200,000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Western spruce budworm
Western blackheaded budworm
Douglas-fir tussock moth
Larch Casebearer
Balsam woolly adelgid
Western tent caterpillar
10-yr average
Source: Region 6 Cooperative Aerial Surveys
State of Washington


OR defoliators
Acres with defoliation
1,000,000
800,000
600,000
400,000
200,000
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016*
Western spruce budworm
Pine butterfly
Larch Casebearer
Balsam woolly adelgid
Western tent caterpillar
Western oak looper
10-yr average
Source: Region 6 Cooperative Aerial Surveys (*Draft data)
State of Oregon


Washington periodic defoliators
Thousands of acres
60
50
40
30
20
10
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
TC
blackheaded budworm
larch casebearer
hemlock looper
tent caterpillar
tussock moth


Oregon periodic defoliators
Pine butterfly
2011 = 250,000 ac.
Thousands of acres
100
90
80
70
60
50
40
30
20
10
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
TC, LC, OL
TC, LC
larch casebearer
oak looper
pandora moth
tent caterpillar
tussock moth
pine butterfly

gypsy moth – NON-NATIVE

Lymantria dispar

- **Hosts** –hardwoods preferred, but feed on numerous hosts including conifers
- **Severity** – Serious damage and mortality in eastern US & Canada. Introduced populations in WA & OR are monitored and eradicated as needed

Gypsy Moth Defoliation – A reality in 20 states

Photos courtesy of New Jersey Department of Agriculture

Monroe Twp, Cumb Co.
The average tree in the woods

Courtesy of Andrew Pulskamp

Digital Executive Producer

WGAL.com

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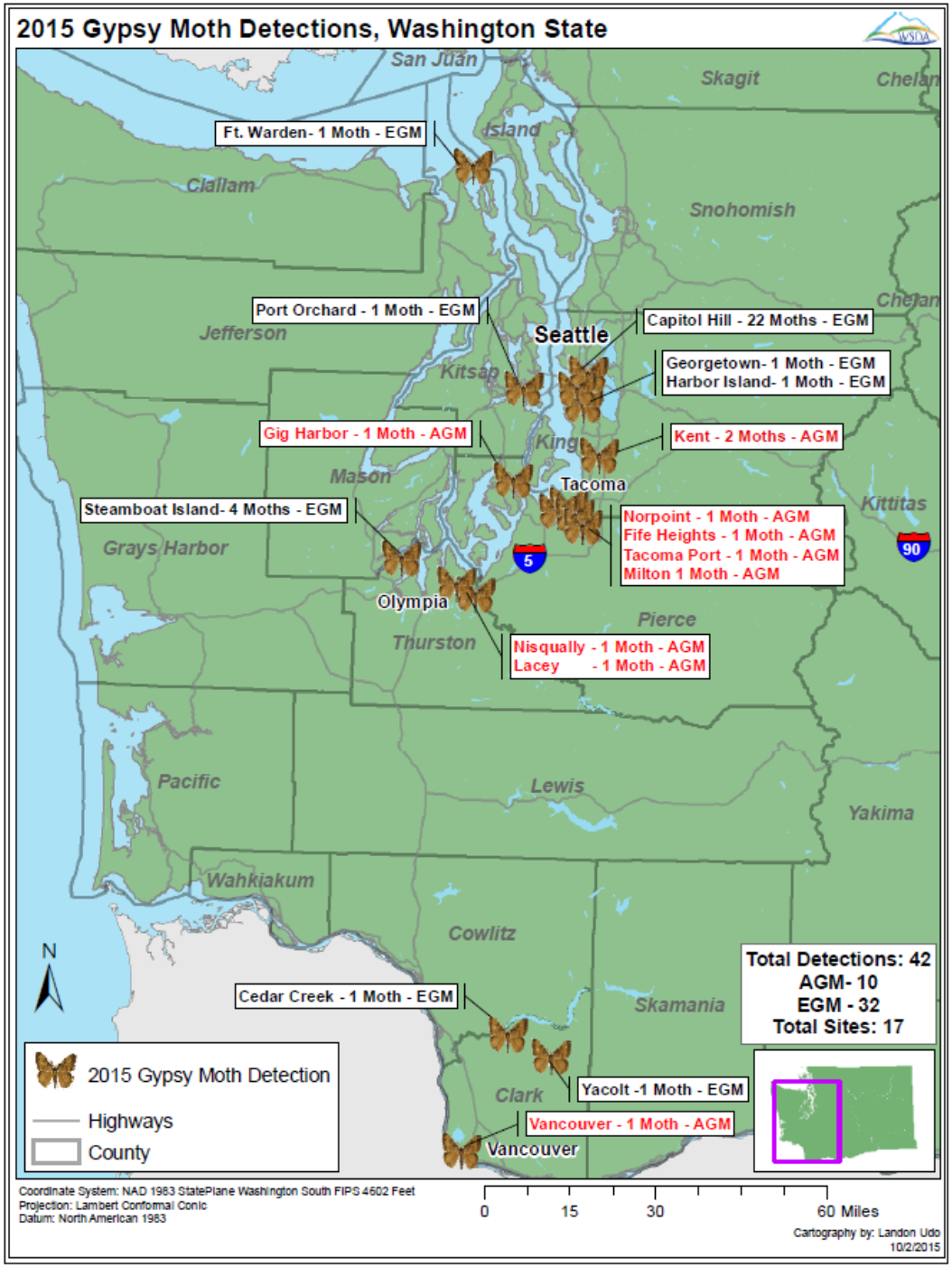
Asian Gypsy Moth a Greater Threat!

- Female has flight capability.
- Defoliates conifers as well as broadleaf trees.
- Feeds on a greater number of hosts.

Asian Gypsy Moth
Port of Vladivostok, Russia



Trap Catch Results for 2015

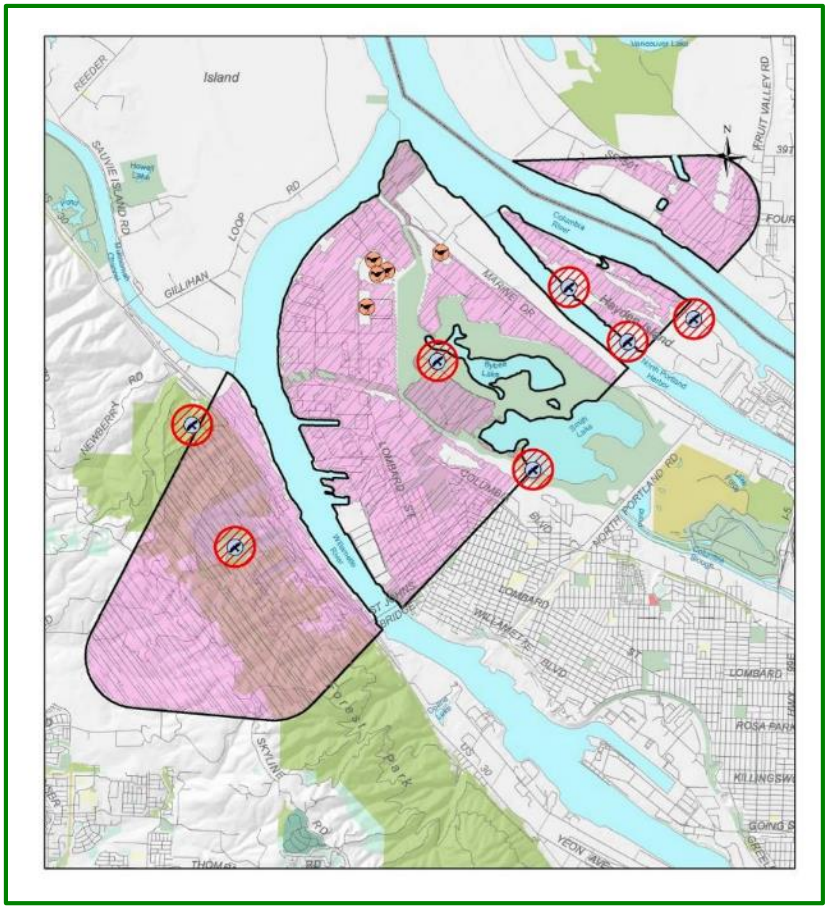
42 moths total

10 Asian gypsy moths
- 4 Port of Tacoma
- 2 Kent
- 1 Nisqually
- 1 Lacey
- 1 Gig Harbor
- 1 Port of Vancouver

32 North American GMs
- 22 Capital Hill, Seattle
- Egg masses also detected

Washington State Department of Agriculture

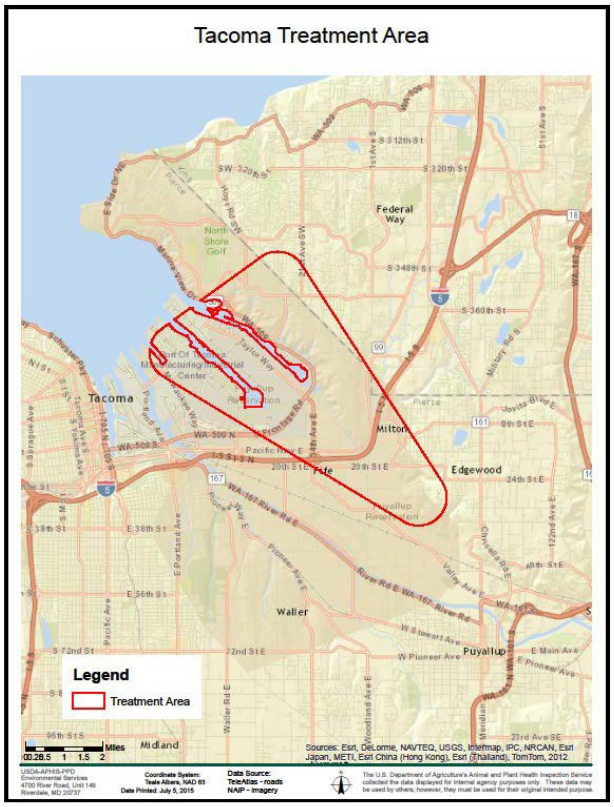
Aerial spraying of Btk (spring 2016)

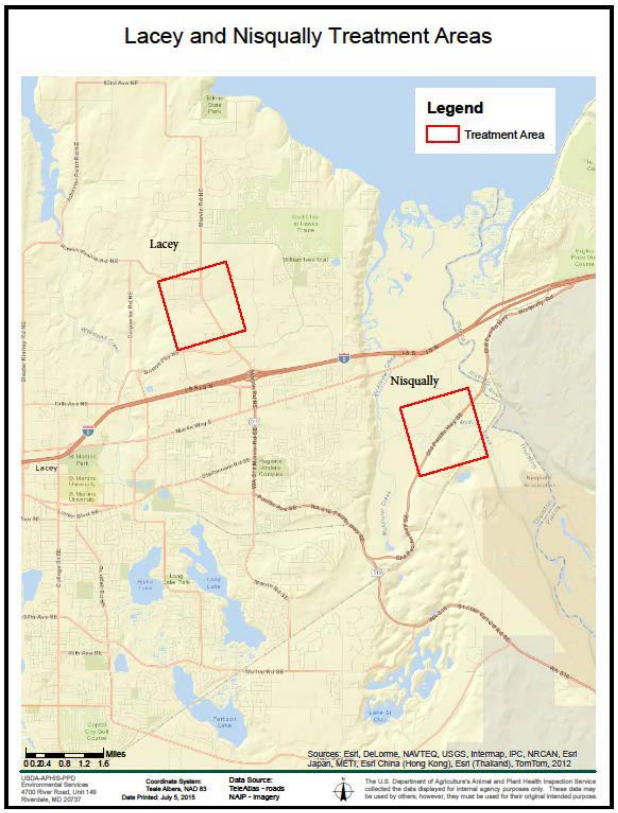


Oregon treatment block:
7,923 acres

Washington Treatment Blocks

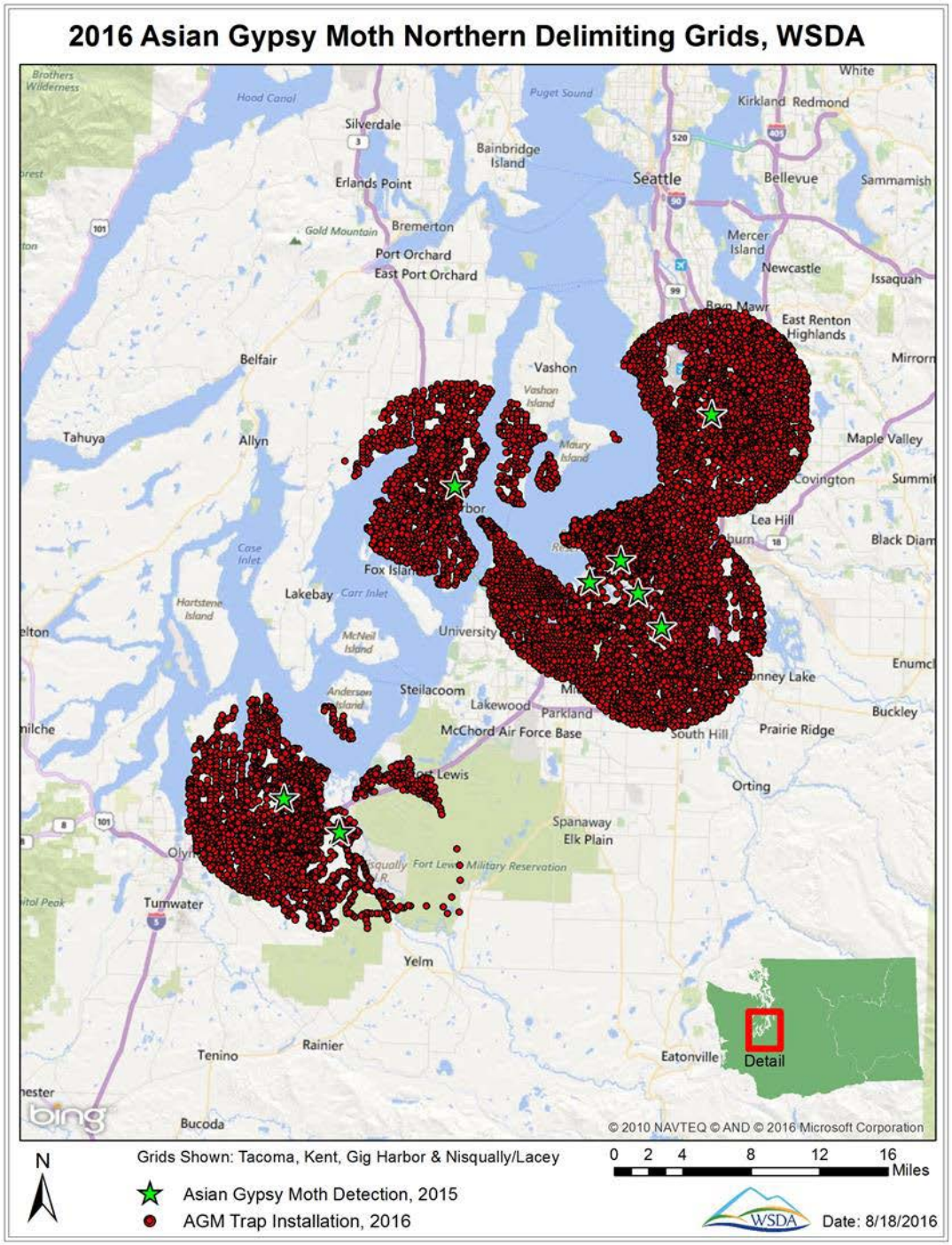
7 blocks 10,500 acres treated





Not shown:

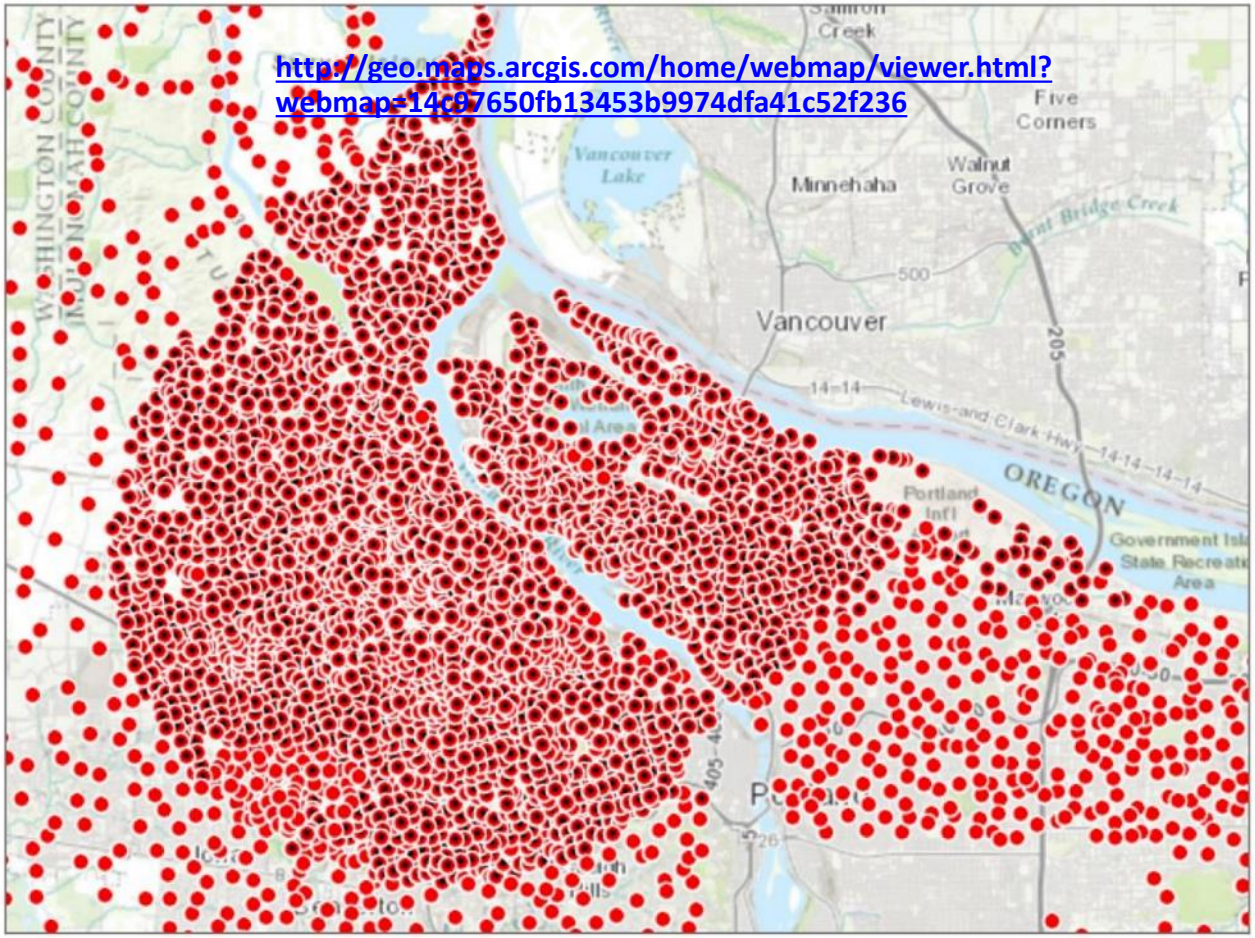
- square mile each in Gig Harbor and Kent.
- Vancouver.
- Capitol Hill in Seattle for EGM.



2016:

10,477 Delimitation traps

Oregon Department of Agriculture: 2016 GM and AGM Traps



County of Clark, MRLC, Bureau of Land Management, State of Oregon, State of Oregon DOT, State of Oregon GEO, Esri, HERE, DeLorme, Intermap, USGS, NGA, EPA, USDA, NPS, U.S. Forest Service | Oregon Department of Agriculture, Insect Pest Prevention and Management

2016:

3,086 Delimitation traps

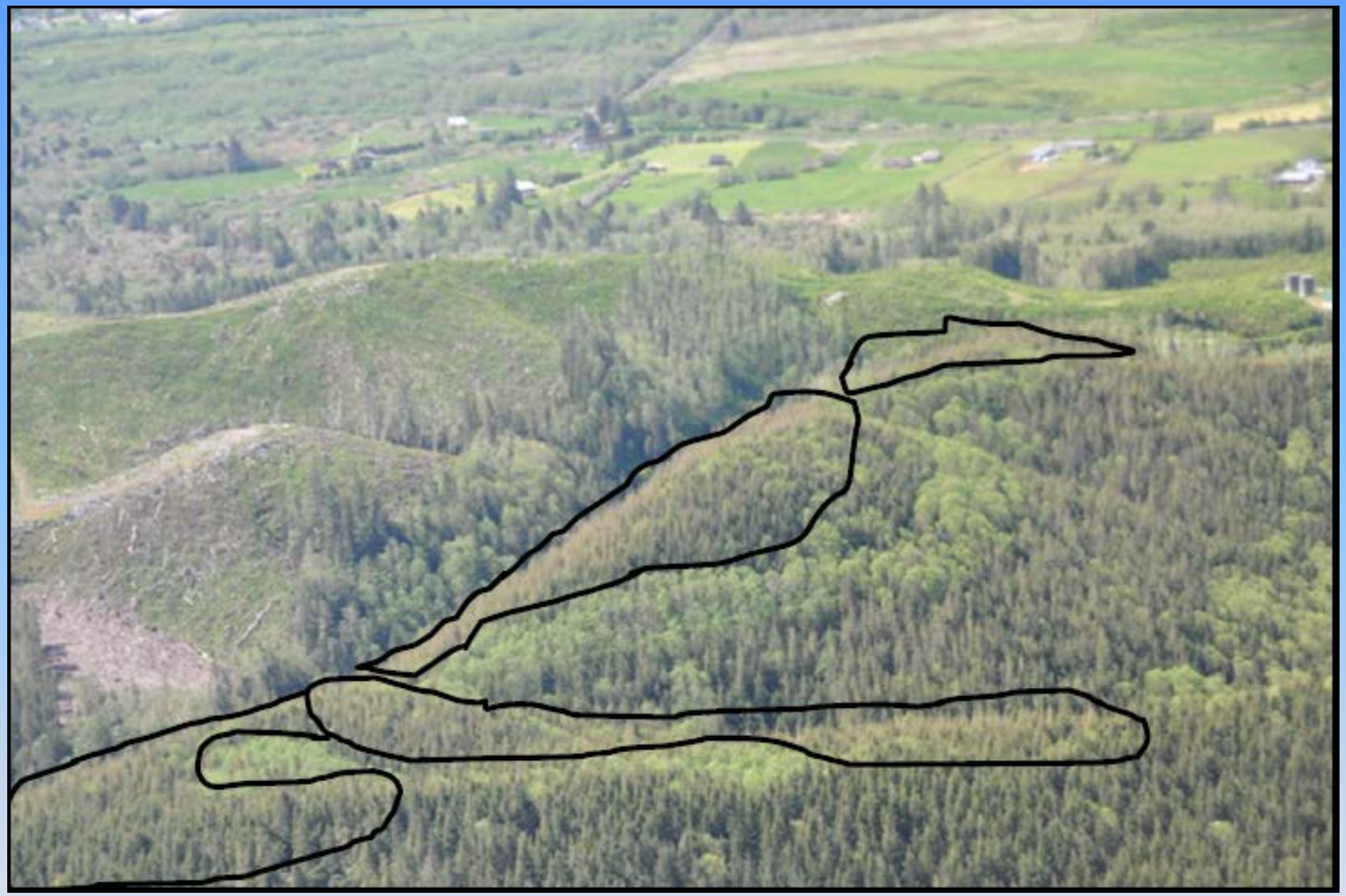
Foliage Diseases

- Typically **not** mature tree killers, but often cause growth losses.
- Some fungi may also damage stems.
- Strongly influenced by local weather.

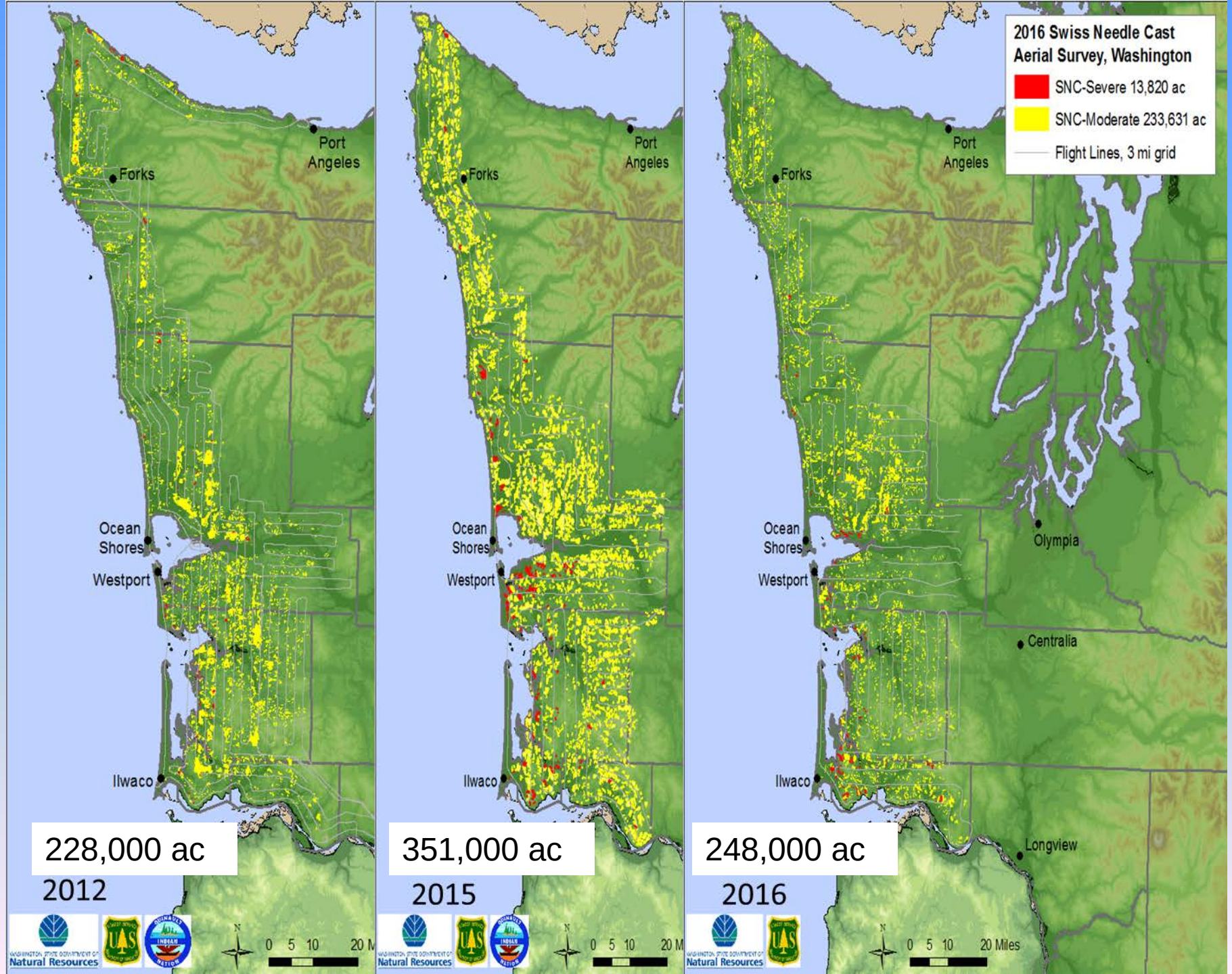
Swiss Needle Cast

- Native foliar disease
- **Host:** Douglas-fir
- Impacts – growth loss

Swiss needle cast causes loss of older-age classes of needles, giving branches a sparse appearance.

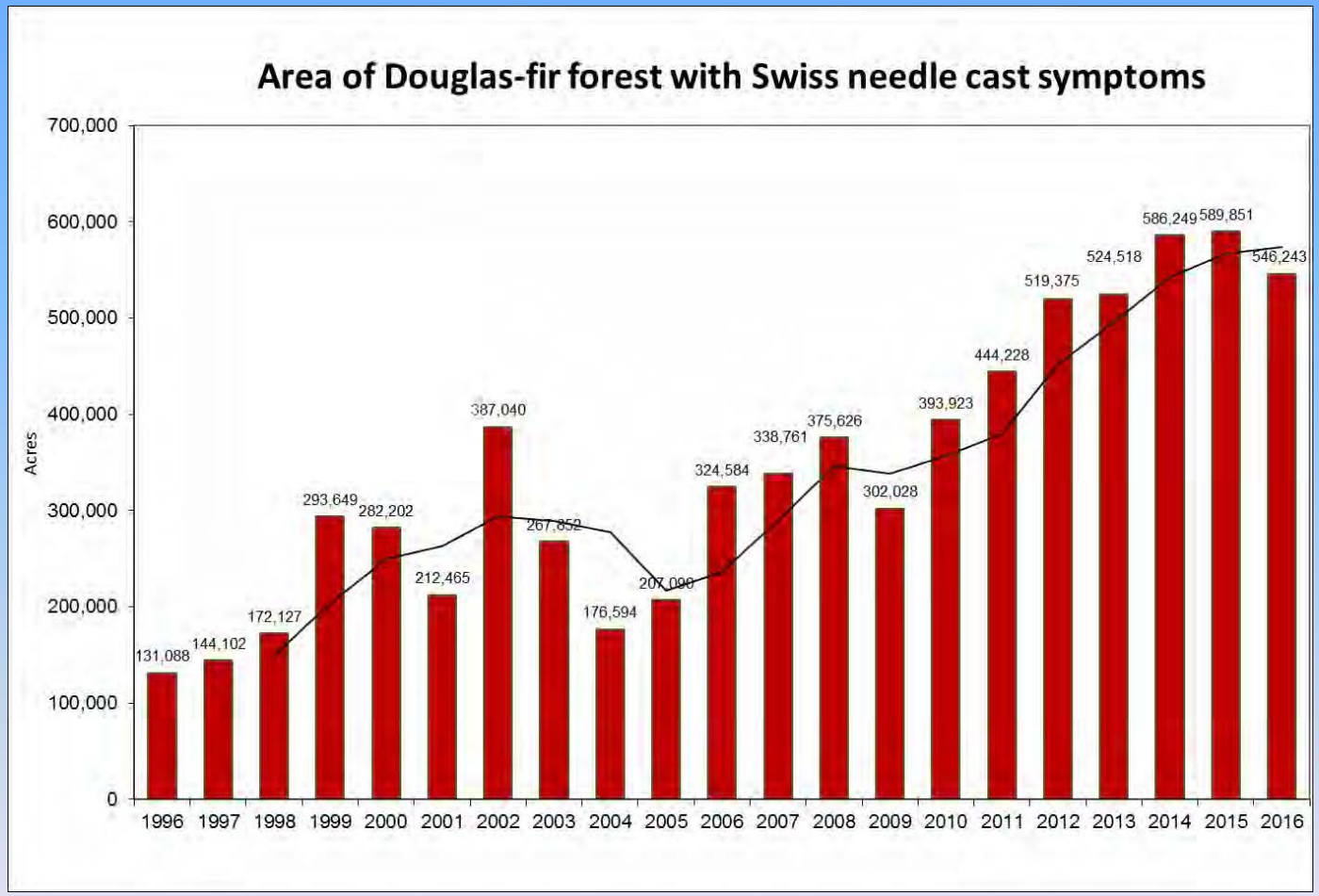


Swiss Needle Cast damage from the air


2016 Swiss Needle Cast
Aerial Survey, Washington
SNC-Severe 13,820 ac
SNC-Moderate 233,631 ac
Flight Lines, 3 mi grid
Port Angeles
Forks
Ocean Shores
Westport
Ilwaco
Olympia
Centralia
Longview
228,000 ac
2012
351,000 ac
2015
248,000 ac
2016
0 5 10 20 Miles

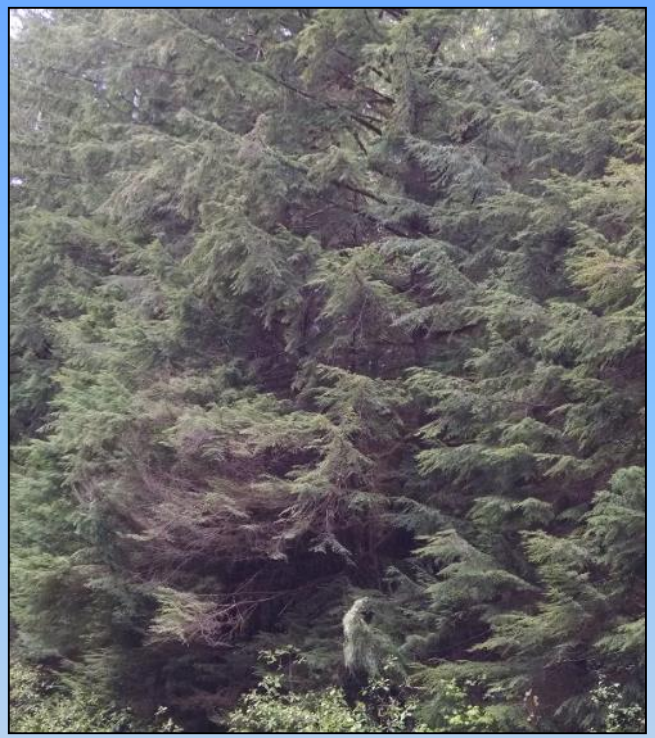
Oregon SNC aerial survey

2016 = 546,000 acres



Map and chart: ODF

Phytophthora pluvialis and *Rhizoctonia spp*.
Hosts: Douglas-fir and western hemlock



Ryzoctonia damage to western hemlock

Phytophthora pluvialis in Oregon

Map: ODF

Alan Kanaskie, ODF

Phytophthora pluvialis damage to Douglas-fir

Bigleaf maple damage:
WA: 4,100 acres (2,800 in 2015)

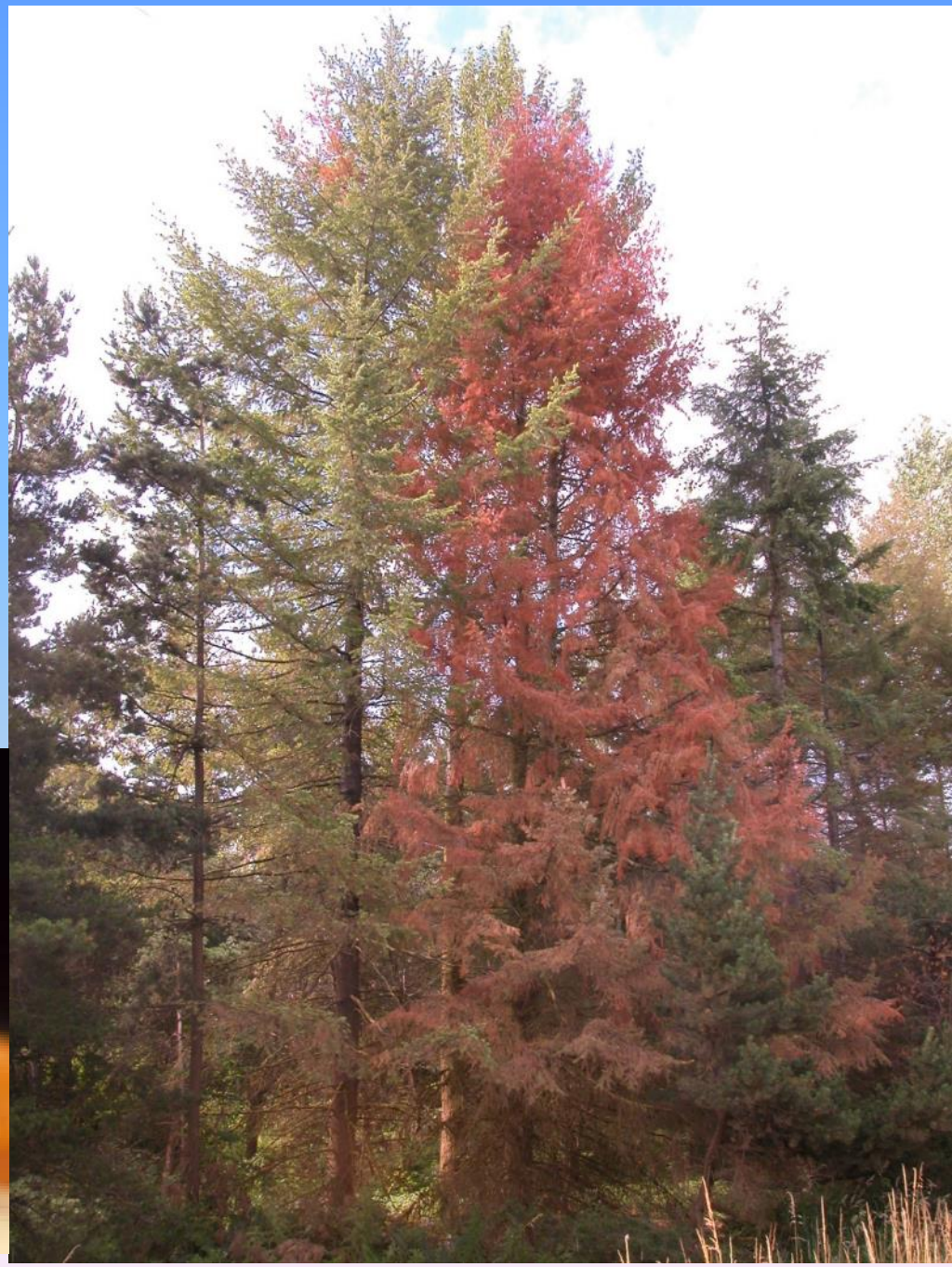
Sudden oak death
Phytophthora ramorum NON-NATIVE
-Southwest OR tanoak quarantine area expanded to 515 sq. mi. in 2015.
-64 new infestations beyond generally infested area but within quarantine area
.
-WA DNR sampled 10 waterways in 6 counties in 2016 (no positives).
-To date, positives in 8 waterways in 7 western WA counties.

Sarah Navarro, ODF

Storm Damage and Douglas-fir Beetle Outbreaks

Glenn Kohler, Forest Entomologist
WA Dept. of Natural Resources

Bark Beetles



Death by a Thousand Bites

For centuries the relationship was mutually beneficial: Pine beetles culled older, weaker trees, producing new beetles but also a healthier forest. Climate change, with its warmer, drier conditions, has upset that balance, leaving even healthy trees vulnerable to attack.

PINE BEETLE, ACTUAL SIZE SHOWN

FIRST WEEK
Selection and Invasion
The cycle begins in summer, when a lone female beetle bores into a tree's bark and releases a pheromone that attracts hundreds of other beetles.

The tree tries to suffocate the insects by secreting resin into the beetles' boreholes.

SECOND WEEK
Burrowing and Egg Laying
Beetles dig galleries under the bark, depositing eggs and blue fungi to feed the next generation. The galleries block nutrient flow in the tree's phloem layer.

Sixty to eighty eggs are laid in each gallery.

Phloem layer

THIRD WEEK TO 4 MONTHS
Hatching and Feeding
Larvae hatch and chew side galleries, feeding on the phloem and the fungi.

The larvae develop cold resistance in time for winter.

The tree remains green for months after beetles have fatally mauled it.

5 TO 12 MONTHS
Overwintering and Dispersal
The beetle larvae lie dormant until spring, when they'll turn into pupae, then adults. The new brood feeds on fungal spores before dispersing to another tree.

Pupal stage

Fungi-carrying new adult

Needles turn yellow in the dry heat of summer.

13 TO 24 MONTHS
Red Means Dead
The beetles are long gone, and the drying tree turns red. Finally it loses most of its needles and becomes gray.

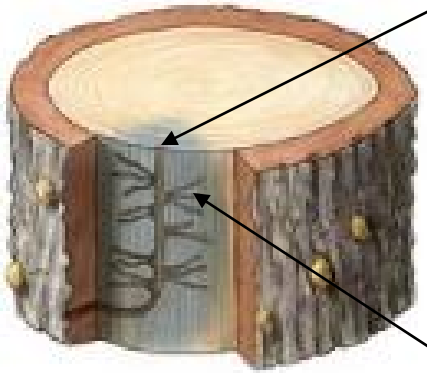
JOHN TOUMISKO, NEW STAFF; SHELLEY SPERRY
ART: SAMANTHA WILKINS
SOURCE: DANA S.R., UNIVERSITY OF MONTANA

THIRD WEEK TO 4 MONTHS

Hatching and Feeding

Larvae hatch and chew side galleries, feeding on the phloem and the fungi.

egg gallery



The larvae develop cold resistance in time for winter.

The tree remains green for months after beetles have fatally mauled it.

larval galleries

"bluestain" fungi brought in by adults grows quickly in wood. Provides nutrition for larvae and hastens tree death.

Bark Beetles

- Are generally tree host and size specific
- Attack trees weakened by competition, defoliation, drought, root disease, and fire
- Some build populations in storm/fire damage
- Some species can switch to coordinated mass-attack of vigorous trees
- Death occurs rapidly
- Damage may not show up until tree dries out one year later

Wood Borers

Bark Beetles

Bark beetles and wood borers attracted to stressed and damaged trees

- Ethanol
- Terpenes (alpha-pinene)
- Pheromones

Bark Beetles love juicy dead trees

- Easy to get into, phloem is undefended, offspring won't die from toxic defense chemicals.
- Aggressive species will "breed up" following storms, fires, landslides, floods that generate large amounts of dead trees.
- Then outbreak populations may kill nearby trees.

…but they hate dried up dead trees

- Trees that die in late summer & fall may dry out (especially if down) before spring and summer beetle flights.
- Thin barked or smaller diameter trees will dry faster.

Bark beetles are coming!!!

Wait... are they?

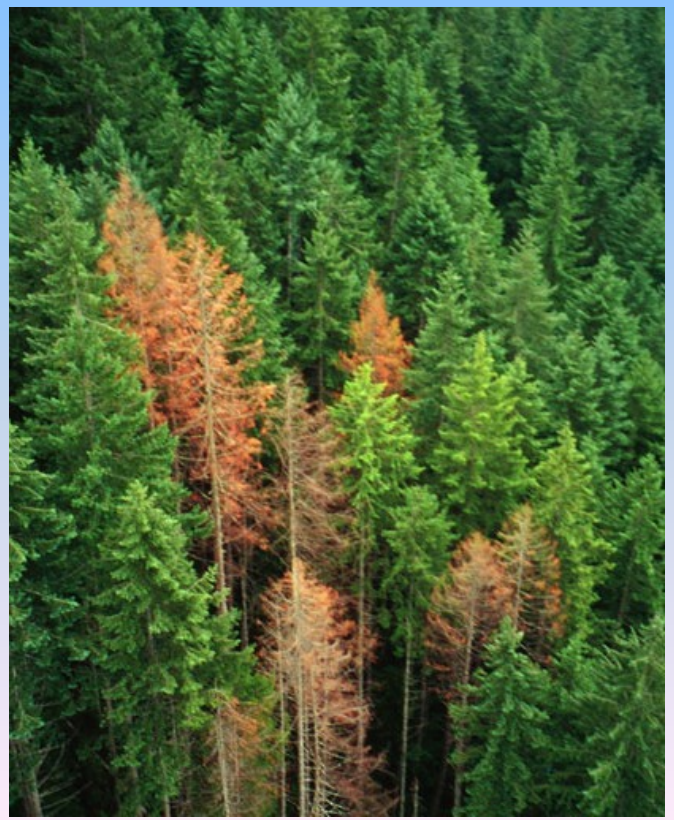
To evaluate risk of bark beetle outbreaks from storm damage, consider:

- Species of down material
  - Doug-fir, pine, and spruce are riskier if fresh
  - True fir (grand fir, Pacific silver fir) are less likely
  - Hemlock, cedar, larch, hardwoods are low risk
- Timing of storm
  - Material from winter/spring storms will stay fresh
  - Late summer & fall storms are lower risk (may dry or get wood borers)
- Diameter of material
  - Except pine, pieces under 8 inches diameter will not generate enough beetles for outbreak
- Amount of material
  - Rule of thumb: equivalent of 5 large trees per acre is enough to produce outbreaks
- Drought conditions
  - Drought stressed live trees will be at higher risk near storm damage

Douglas-fir Beetle

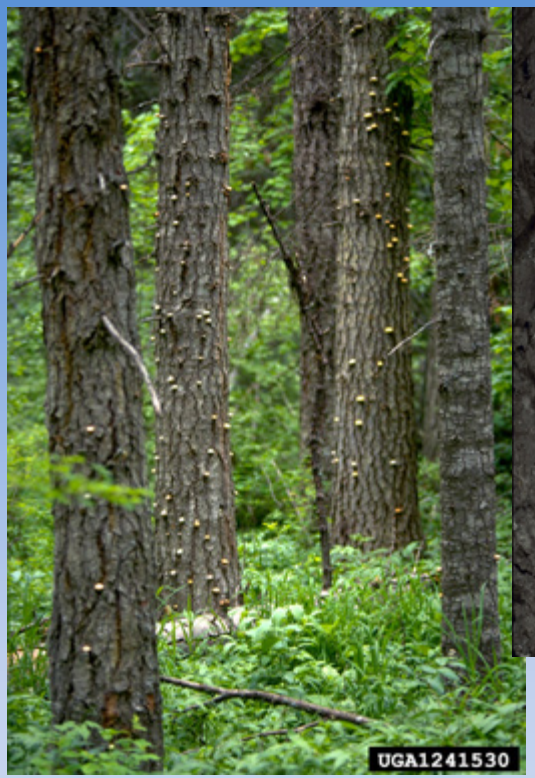
Dendroctonus pseudotsugae

- **Host:** Douglas-fir
- Breeds in felled, injured or diseased trees, resulting in widely scattered mortality
- Prefers >10 inch DBH trees
- Epidemic populations kill apparently healthy trees over extensive areas
- Commonly group kill



Douglas-fir beetle

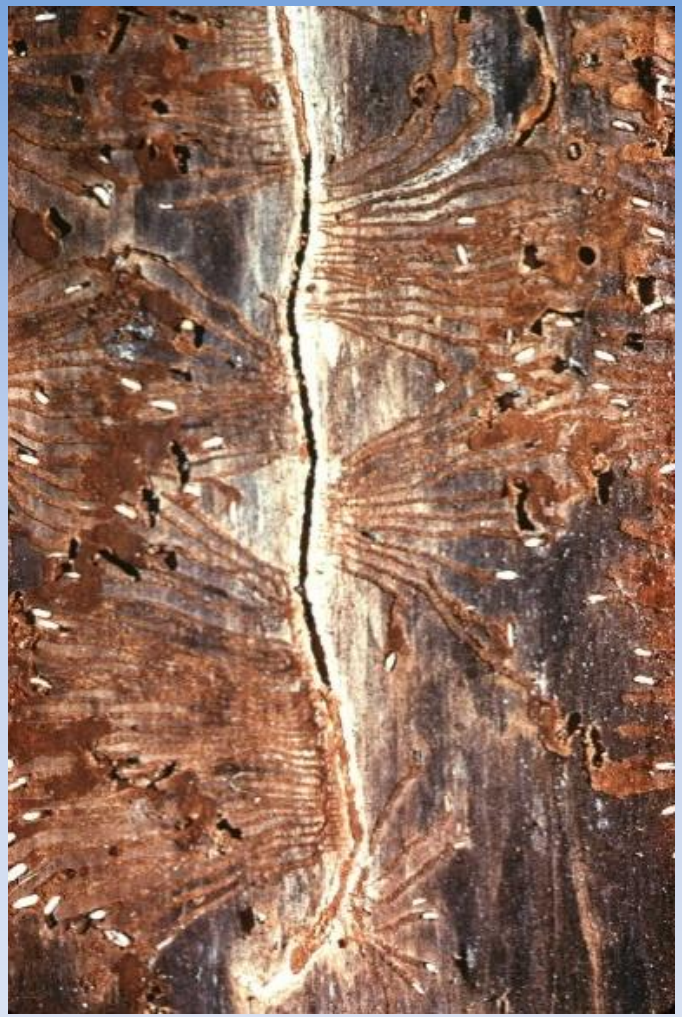
- Signs of attack
  - Boring dust
  - Pitch streams



"Pouch fungus" – *Cryptoporus volvatus*

Green attacked tree – pitch streaming (attacks often heaviest 30 ft. up bole)

Douglas-fir beetle



Eggs laid on alternating sides of vertical egg gallery

Typical western WA gallery pattern

DOUGLAS-FIR BEETLE

Infestation/Outbreak Cycle

Low Populations
Attack Scattered
Blowdown &
Root Disease
Pockets

Population
Build-Up
Following Large
Storm Events
(1-2 Yr Duration)

Outbreak Levels
Standing Trees
Attacked (>9”)
(2-5 Yr Duration)

Healthy trees can be a sink (beetles die trying to get in).

General bark beetle management

- Beetles have already flown from trees with red crowns.
- There are exceptions (of course!)
  - Very hot summers: trees may fade early or fade on sunny winter days

General bark beetle management

- **Maintain tree vigor** (reduce stress, manage spacing for site)
- **Avoid stem or root injury**
- **Manage large inputs of fresh dead trees**
- **Removal of green attacked trees**

General bark beetle management

- Pesticides can be used only to prevent attack – practical only for high value trees
- Bole application up to smallest diameter beetles might attack
- Systemics may work, but are more effective when applied leaving enough time for translocation to phloem (fall vs. spring) before beetle attack

Douglas-fir beetle management

- Less than 5 large (>8” DBH) dead DF per acre is low risk.
- Include standing dead DF (crown blown out).
- Salvage blowdown before two springs pass.
- Salvage infested trees before next spring.

MCH (antiaggregation pheromone)

- Best for small high value stands – campgrounds, timber sale, old growth
- Can be applied by hand (bubble caps) or from the air (flakes)
- Must be applied before April flight

Winter 2015 windthrow events

DFB infest windthrow spring 2016

MCH

salvage

1st brood flies spring 2017, attack live trees

Killed trees turn red summer 2018

MCH

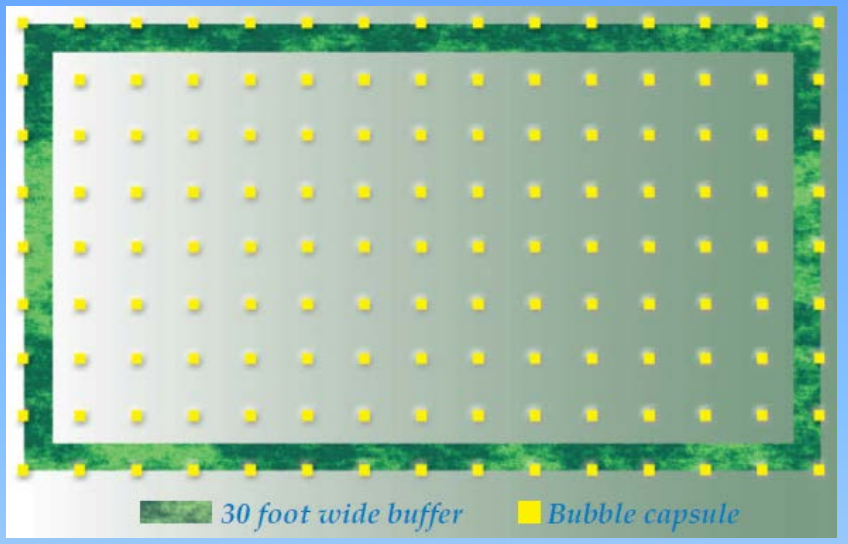
?

2nd brood flies spring 2018, attack live trees

Killed trees turn red summer 2019

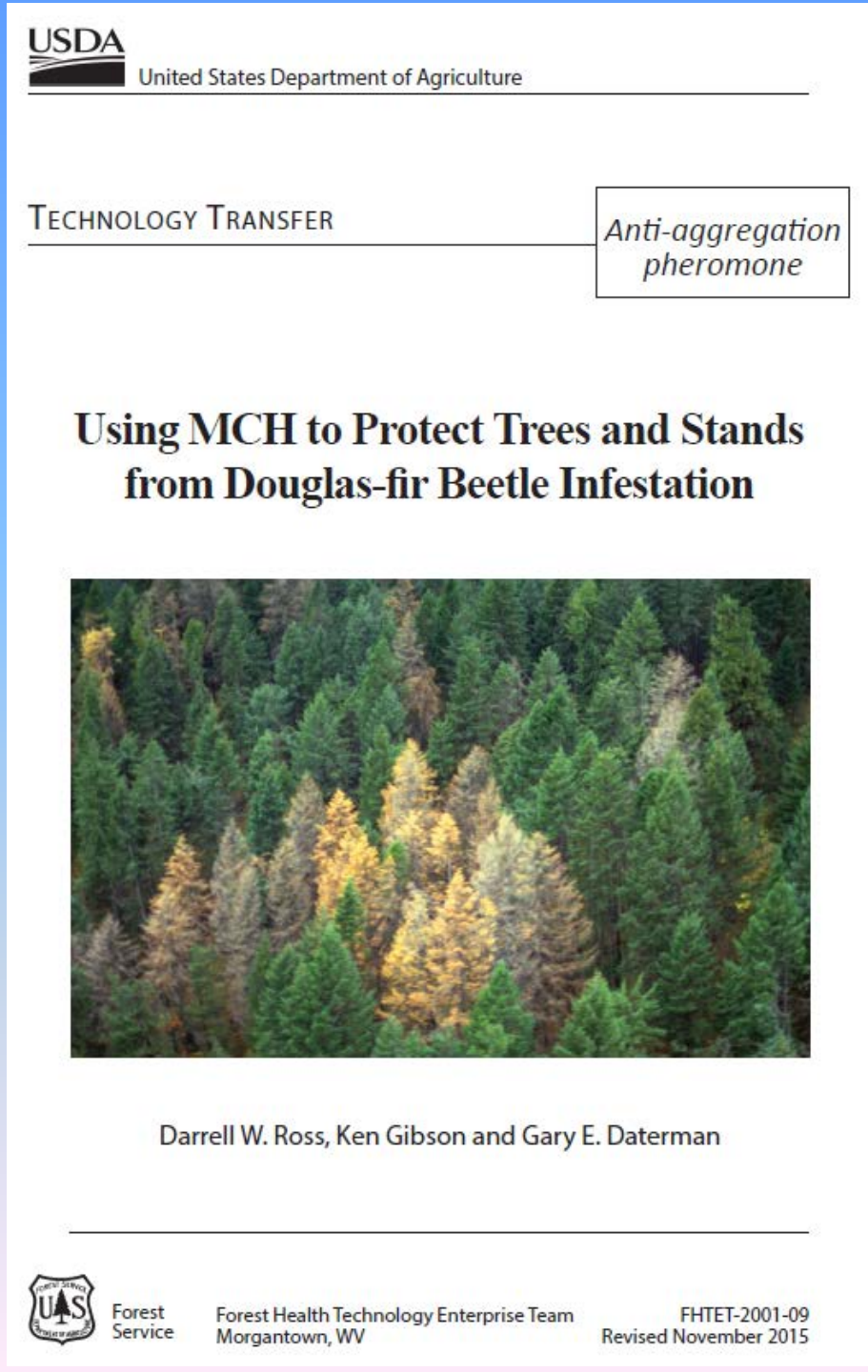
“High release” MCH application

- MCH dose is 30 bubble caps per acre ($50-60/acre).
- One bubble cap per release point is 40 ft. spacing.
- Can double the dose (2 per point at 55 ft spacing).
- Can triple the dose (3 per point at 65 ft spacing).
- Cost per acre is same.
- 3 people treated 25 acres state land in 4 hours (250 release points vs. 750)



New MCH application guidelines available

https://www.fs.fed.us/foresthealth/technology/pdfs/MCH_handbook_11_15_508.pdf



USDA
United States Department of Agriculture

TECHNOLOGY TRANSFER

Anti-aggregation pheromone

Using MCH to Protect Trees and Stands from Douglas-fir Beetle Infestation

Darrell W. Ross, Ken Gibson and Gary E. Daterman

Forest Service
Forest Health Technology Enterprise Team
Morgantown, WV

FHTET-2001-09
Revised November 2015

Tree Defoliating Insects

Glenn Kohler, Forest Entomologist
Forest Health Program

Western hemlock looper

Lambdina fiscellaria lugubrosa

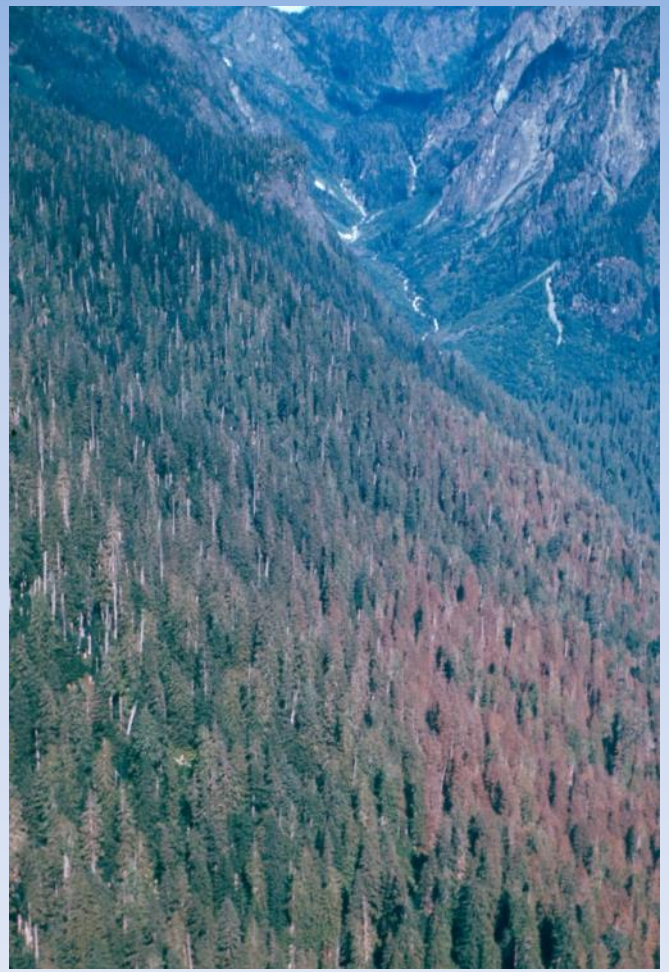
- 'Inchworms'
- Messy feeders, feed on all age class needles
- 2-3 year infestations

Recent outbreaks:

- 2011-2012, Baker Lake
- 2000-2002, NW Region
- 1994-1996, NW and Olympic Regions

Hemlock looper defoliation

- ‘scorched’ appearance, typically in old growth
- Drought conditions increase mortality



Hemlock looper impacts

- Outbreaks may follow dry periods.
- Capable of causing mortality in a single year.
- Western hemlock dominated stands with higher percentage of hemlock more susceptible.
- Hemlocks with >50% crown defoliation may die.

western blackheaded budworm

Acleris gloverana

- **Hosts** – western hemlock, spruce, true firs, Douglas-fir
- **Severity** – primarily feeds on current foliage, but repeated defoliation can cause top-kill and mortality. Outbreaks typically last 2-4 years.

western blackheaded budworm

- **2014:** 20,000 ac.
- **2013:** 14,200 ac.
- **Recent outbreaks:**

  2013-14 (Olympic NF and east Lewis Co., WA)

  2002-2003 (central Cascades, WA)

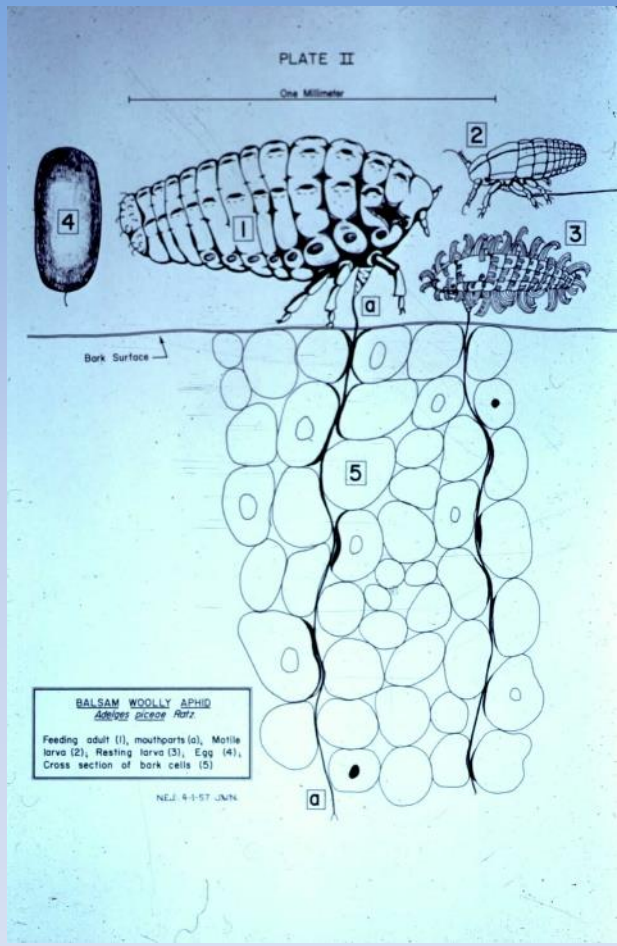
Parasitic wasp enemy of WBB

Western blackheaded budworm impacts

- Larvae feed on current foliage, but in high populations, mature larvae may feed on old foliage.
- Primary impact is growth loss, top-kill and some mortality.
- Western hemlock most vulnerable to damage.

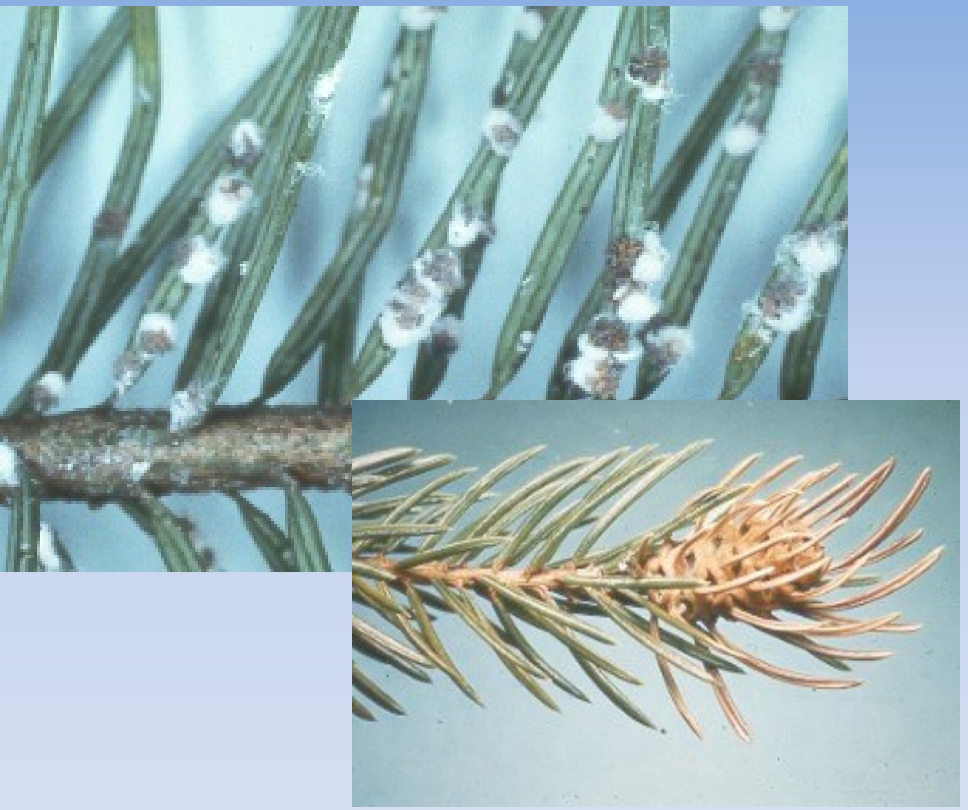
Balsam Woolly Adelgid – NON-NATIVE

Adelges piceae



- **Hosts:** True firs (Abies)

Balsam Woolly Adelgid can be confused with:



Cooley spruce gall adelgid

Hemlock woolly adelgid

balsam woolly adelgid symptoms

Twig ‘gouting’

Red stained sapwood, ‘rotholtz’

Crown defoliation and stunting in Pacific silver fir

balsam woolly adelgid management

- Subalpine fir and Pacific silver fir very susceptible, grand fir varies by area.
- Damage can be worse on moist sites.
- Natural enemies not effective.
- Harvest infested trees, plant non-hosts.
- Noble fir rarely infested unless off-site.
- Some individual trees show resistance.

conifer sawflies - *Neodiprion* species

- **Hosts** – western hemlock, true firs, Douglas-fir, pines, larch
- **Severity** – most feed on old foliage, may slow growth, but most trees recover after short outbreaks collapse (1-2 years)

conifer sawfly defoliation

Silver spotted tiger moth

- *Lophocampa argentata*

Eastside conifer defoliators: western spruce budworm

Choristoneura freemani

Hosts: Douglas-fir, true firs, spruce, larch

- Eats only new foliage each year
- Becomes serious after many years of activity

Eastside conifer defoliators: Douglas-fir tussock moth

Orgyia pseudotsugata

Hosts:

Douglas-fir, true firs

Eastside conifer defoliators: larch casebearer – NON-NATIVE

Coleophora laricella

- **Hosts** – western larch
- **Severity** – larch tolerates defoliation, but repeated heavy defoliation can cause dieback, growth loss, and stress. Outbreaks short-lived.

Defoliators of Deciduous Trees

Forest tent caterpillar defoliation of red alder, July 2009

Same stand, October 2009

Photos: Mike Johnson, WADNR

tent caterpillars

Malacosoma species

- **Hosts** – alders, poplars, oak, willows, birch, other hardwoods
- **Severity** – outbreaks short-lived, trees recover but repeated heavy defoliation may cause dieback

western tent caterpillar (*Malacosoma californicum*)

forest tent caterpillar (*Malacosoma disstria*)

Pacific tent caterpillar (*Malacosoma constrictum*), prefers oaks)

tent caterpillars

- **2013:** 6,100 acres
- **2012:** 8,000 acres

- **Recent outbreaks:**

  2013 (Pacific tent caterpillar in oak, Klickitat Co., WA)

  2012-2013 (western tent caterpillar in western WA)

  2009 (forest tent caterpillar in northeast WA)

western oak looper

Lambdina fiscellaria somniaria

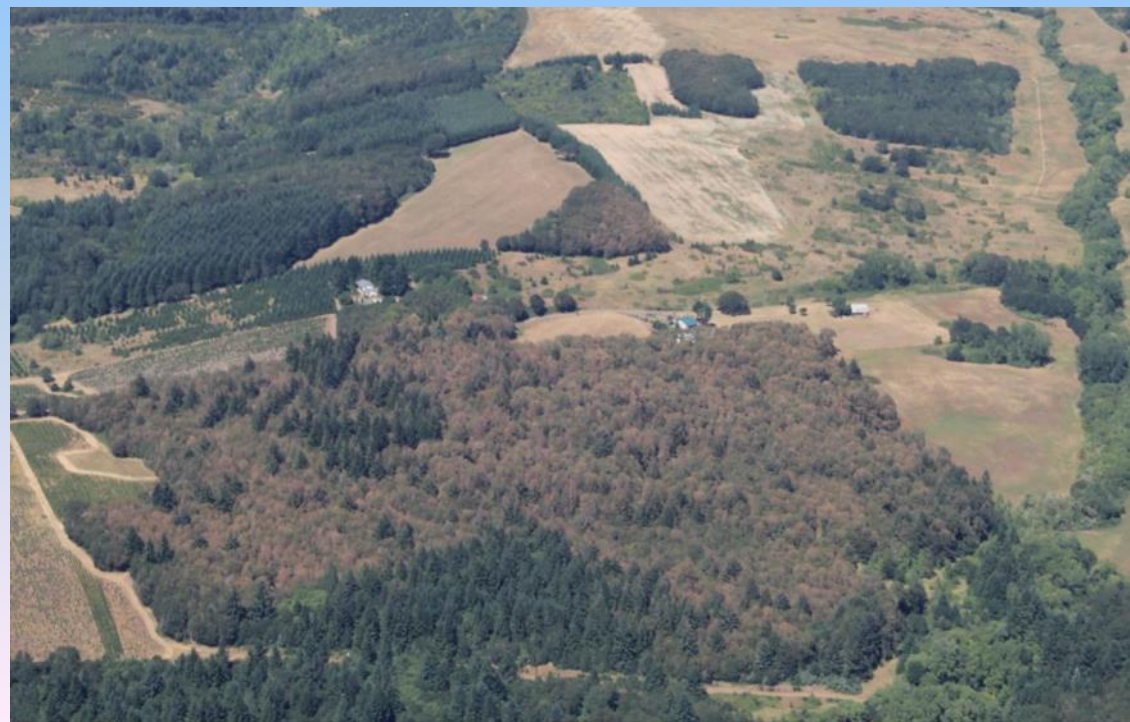
- **Hosts** – Oregon white oak (Douglas-fir and others when in oak stand)
- **Severity** – defoliation is often complete, but outbreaks are short-lived, healthy trees usually recover

western oak looper

- **2015:** 160 ac. (OR)
- **2014:** 7,300 ac. (OR)
- **2013:** 2,400 ac. (OR)

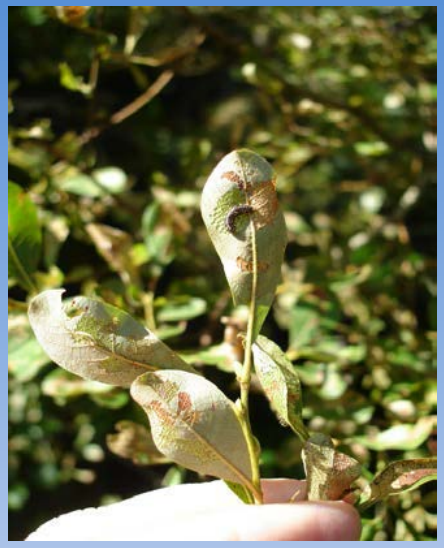
Recent outbreaks:

2013-2014 (Willamette Valley, OR)



leaf beetles - Chrysomelidae

- **Hosts** – alders, willows, poplars
- **Severity** – leaves are skeletonized. Outbreaks are short-lived and trees recover. Swarming adults can attract attention



leaf beetles

- **2013:** approx. 5,000 ac. on Kitsap Peninsula, south Puget Sound, and northeast WA