Flatheaded fir borer in southwestern Oregon Douglas-fir: Is the insect responsible for all die-off?

Forest Health in Oregon: State of the State 2018

Bill Schaupp, USDA Forest Service, Forest Health Protection

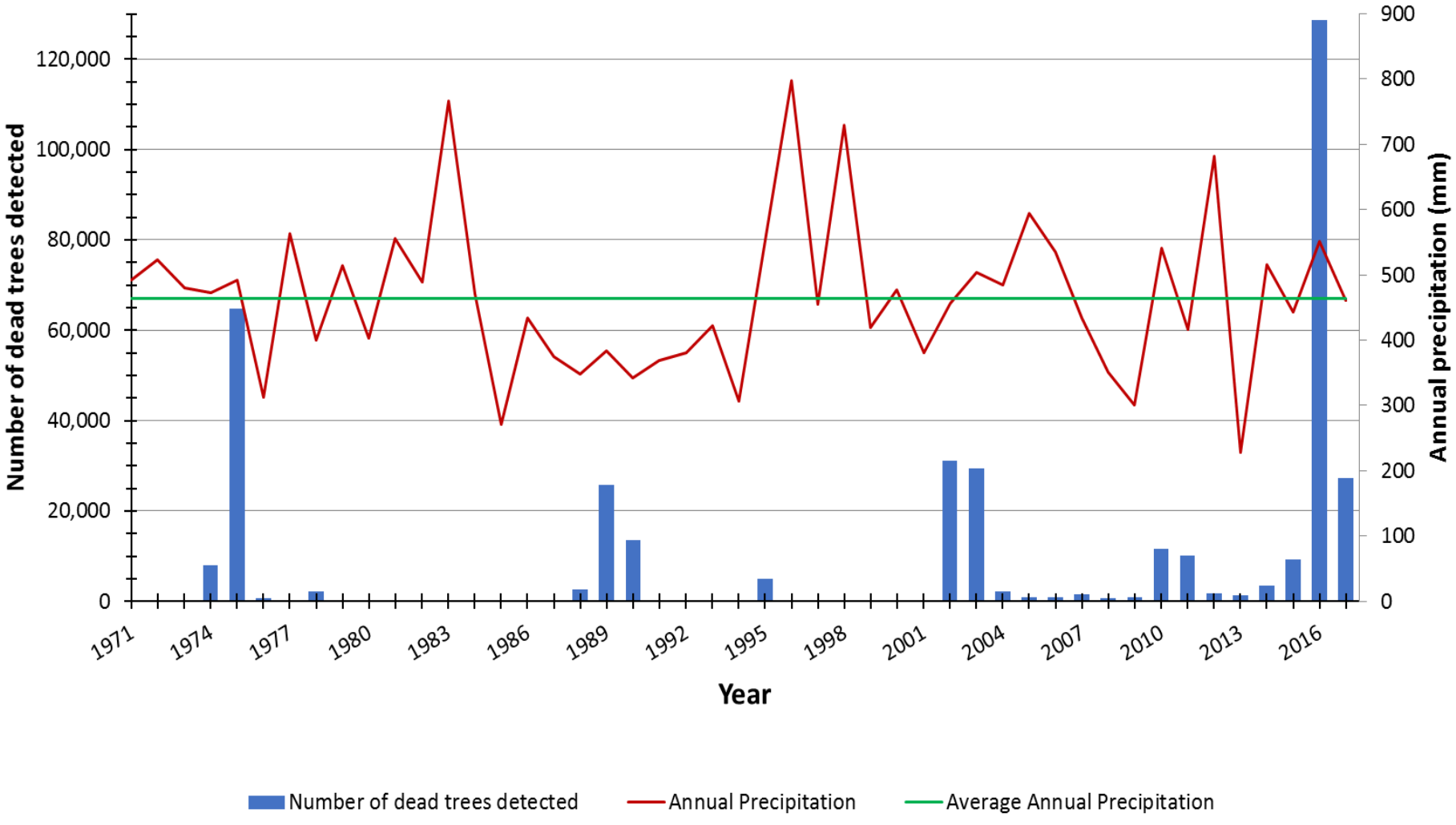
Douglas-fir Mortality Attributed to Flatheaded Fir Borer

Annual Aerial Detection Surveys 1974 - 2017

and

Annual Precipitation 1971-2017

Medford International Airport, Medford, OR



Slide by E. Goheen

Phaenops drummondi (Kirby)
[Coleoptera:Buprestidae]

- Woodborer known as *Melanophila drummondi* until 1996
- Nearctic, hosts in all native genera of Pinaceae
- Prefers dying, burned, and recently downed hosts
- Associated with mortality of western hemlock and Douglas-fir by A.D. Hopkins in 1889 in Oregon
- Noted as capable of killing “apparently healthy” trees in reference texts and textbooks
- Little research, few publications, episodic attention
- May not be acting alone (e.g. *Phaenops vandykei*)
- Douglas-fir beetle not involved at lower elevations, for now

Lifecycle

- Normally requires one year
- Can have extended life cycle depending on host quality
- Hosts in Oregon
  - *** Douglas-fir, true fir, western larch
  - ** spruce, western hemlock
  - * pines
- Dimorphic, varied adult forms

Lifecycle in green Douglas-fir

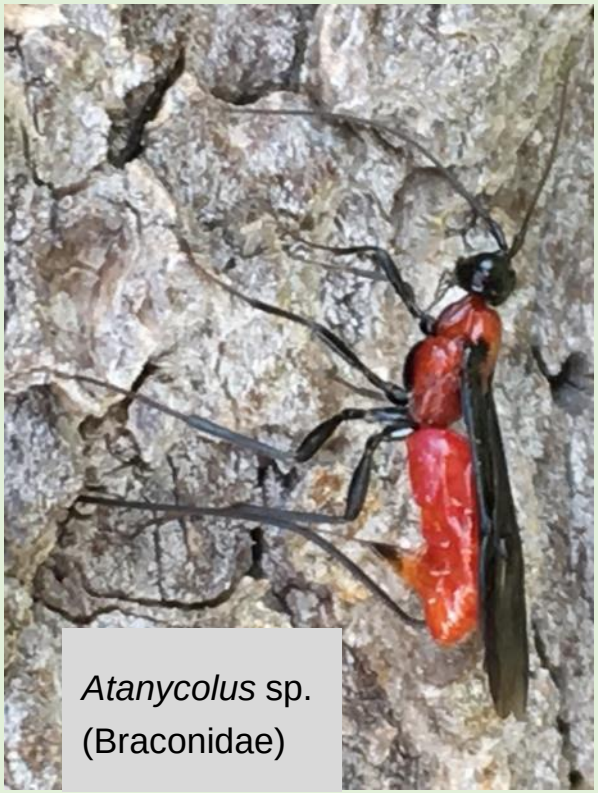
- Adult emergence begins Spring (March - April), feed on conifer needles, bask in sunlight, mate
- Eggs laid in bark crevices
- Larvae bore into cambium
- Tiny larvae with slow development
- Actively feeding larvae first consume cambium, then a bit of inner phloem
- Mature larvae move to outer bark (August - September), overwinter
- Spring pupation

Initially larvae feed strictly on the cambium.

Outer bark

Partly consumed phloem

Not FFB exit hole



Atanycolus sp. (Braconidae)

Some flatheaded fir borer characteristics

Sunlight is preferred.

Host finding may be chemically mediated.

High heat and/or sunlight and moisture deficit may change volatile chemicals coming off Douglas-fir that are attractive.

Larval success is greater at the bottom & host resistance greater at the top…attack profile oft referred to as “top down”.

“Apparently only when the radial tree growth stops are they able to grow rapidly and mature” – R.F. Anderson, Forest and Shade Tree Entomology (1960)

Detection in green Douglas-fir

- Difficult --- no positively diagnostic symptoms or signs
- No pitch tubes, frass or boring dust prior to emergence
- Other woodborer species quickly colonize declining host
- Larvae tough to locate and identify, “key” to genus
- Jewel-like pitch droplets inside bark crevices (entrances sites?)
- ❖ Bark removal by woodpeckers feeding on overwintering larvae
- Thin crown, low crown ratio, stress crop of cones, stagnant stand
- One or more faded branches for one or more years
- Foliage fading observed all year, mostly in late Spring/early Summer

E. Goheen, photo

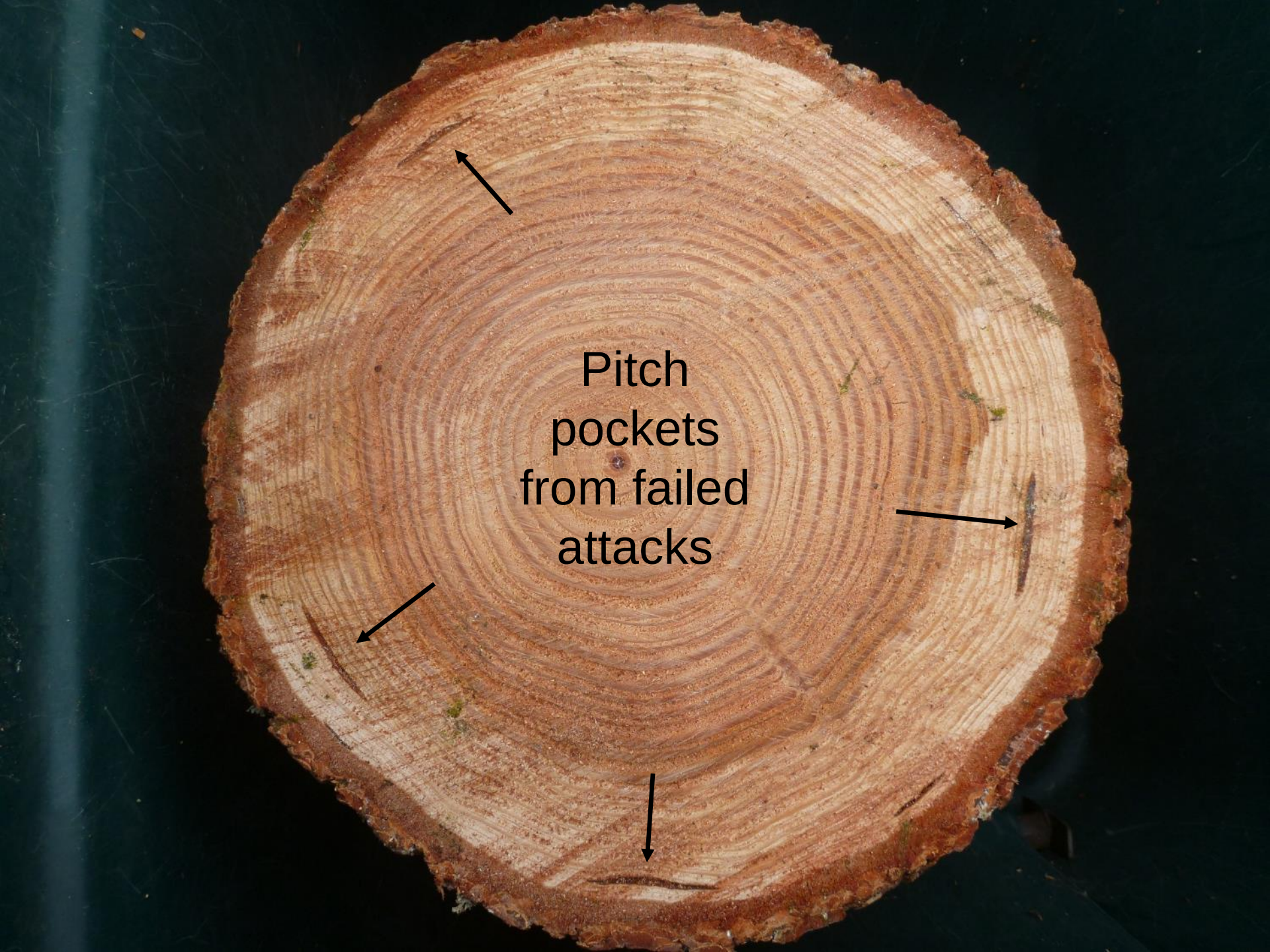
Some infested Douglas-fir fade in one year (left)…and others take longer (right)

May 2013

June 2014

Years of impact from flatheaded fir borer:

- snapped snags (foreground)
- old grey faders (left)
- new red fader (center)
- green, infested Douglas-fir with bird-excavation of the lower stem (right).


Pitch
pockets
from failed
attacks

Predicted Suitable Habitat Flatheaded Fir Borer (*Phaenops drummondi*)

Rogue River - Siskiyou National Forest

Map Created: 6/29/2015

Map Projection: Albers NAD 83 Oregon and Washington

Map Scale = 1:552,000

0 10 20 40 Miles

0 10 20 40 Kilometers

Presence Data and Environmental Varialbes

The study area for this project fell within the EPA Ecoregion III - Klamath Mountains/California High North Coast Range. Each EPA Ecoregion has relatively similar ecological makeup insuring that the model was applied over a similar landscape. A total of 460 sites were used to model suitable habitat for Flatheaded Fir Borer in the study area. 345 sites were used to train the model, and the remaining 115 were used to test the accuracy of that model. Seven environmental variables were used to generate the suitable habitat. The red areas on the map indicate areas that are likely to be suitable for Flatheaded Fir Borer habitat, and pose the greatest chance of current and future infestation,

QUGA4 Cover

Occurence Points Flatheaded Fir Borer (2008-2012, >350 acres)

Aspect

Slope

PSME Cover

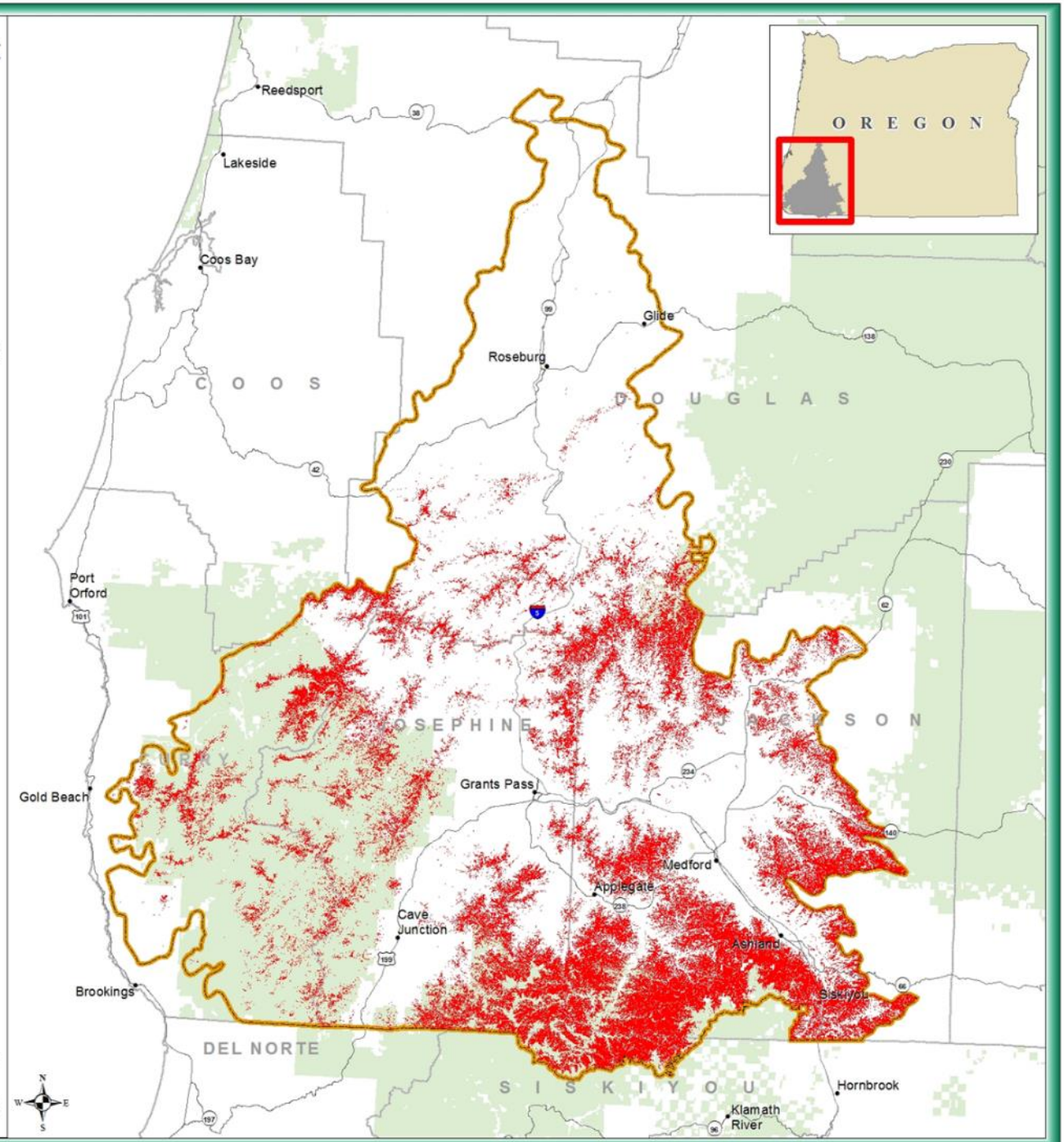
Elevation

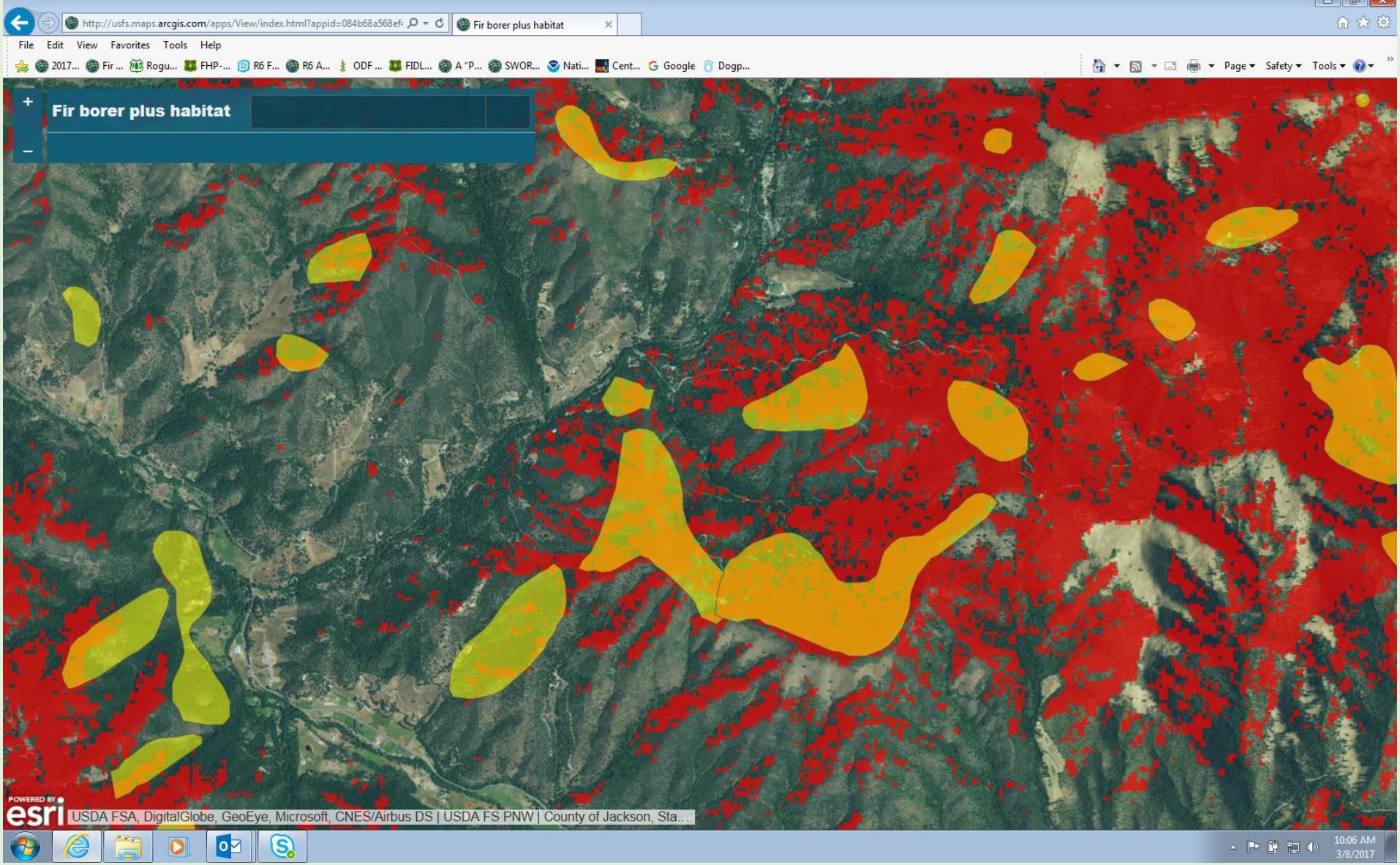
Canopy Cover

Age Dominance

Available Water Storage

DISCLAIMER





Modelled habitat in red; actual 2016 aerial detection survey observations in yellow.

(Model work by Katy Strawn, USDA Forest Service, Data Resource Management).

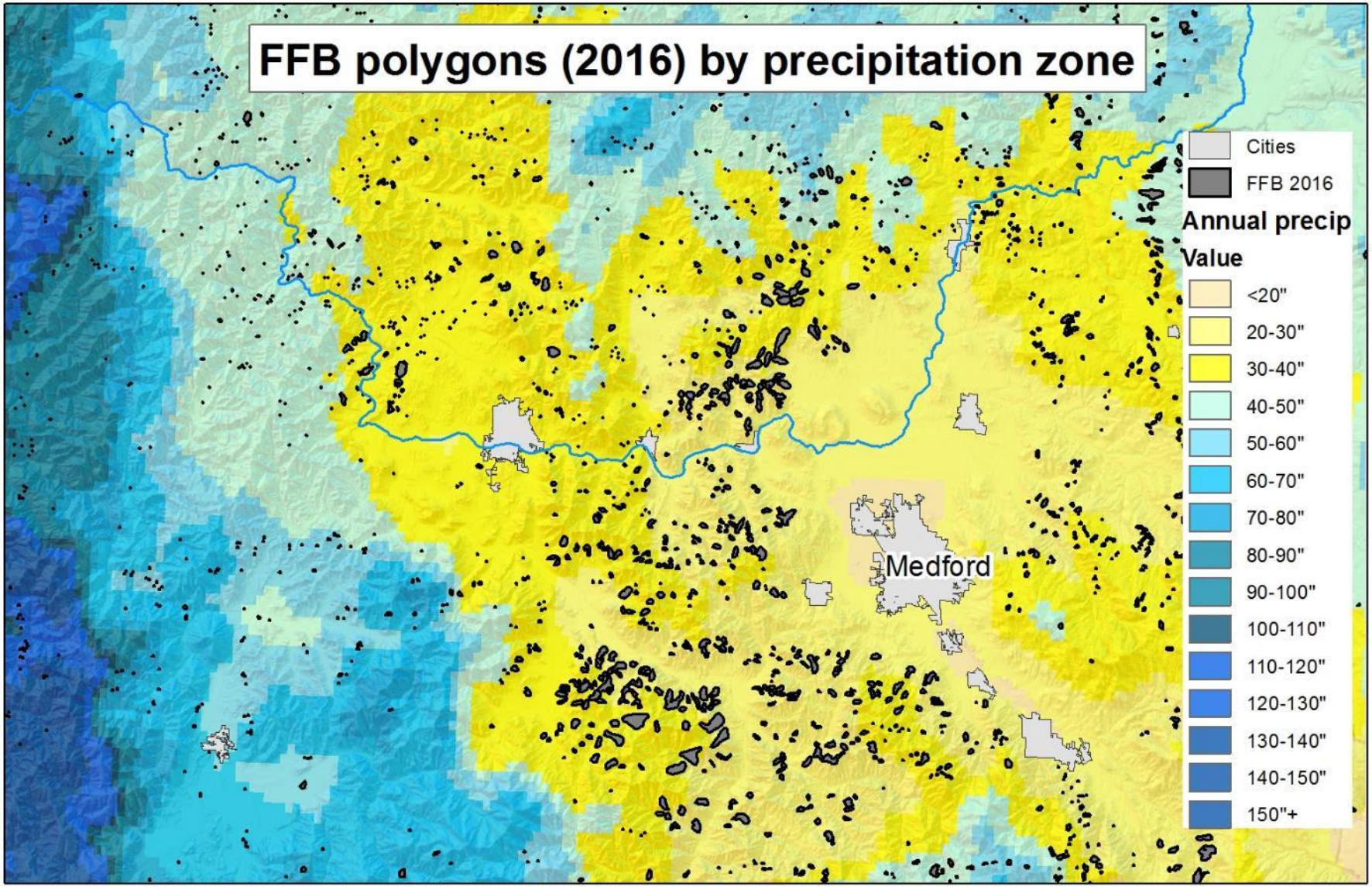
Characterizing habitat with risk: environmental variables of interest

Max Bennett, OSU Extension Forester
Ed Reilly, Bureau of Land Management (retired)

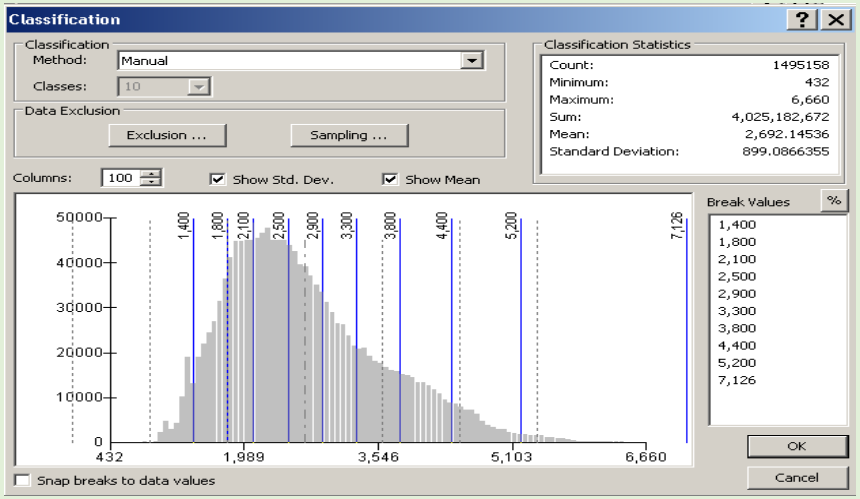
- Precipitation
- Elevation
- Aspect
- Heat load index
- Slope position
- Stand density
- Canopy cover
- Soil water storage
- Oak cover
- Douglas-fir cover
- Slope
- Stand Age
- “Edginess”

FFB Habitat in green Douglas-fir

- Environmental variables associated with FFB in GIS analysis: precipitation, elevation, soil water
- Not strongly associated: Aspect, slope, heat load index, density/canopy cover
- Coarse scale analysis; fine-scale phenomenon
- Factors that seem important:
  - DF growing in or on margins of stands with Oregon white oak
  - Local topography, e.g. concave vs. convex slopes
  - Patch edges vs. interiors
  - Low vigor DF in the 80 -120 year age class growing on marginal sites for DF


FFB polygons (2016) by precipitation zone
Cities
FFB 2016
Annual precip
Value
<20"
20-30"
30-40"
40-50"
50-60"
60-70"
70-80"
80-90"
90-100"
100-110"
110-120"
120-130"
130-140"
140-150"
150"+
Medford
N
Sources: OSU PRISM (precip)
USFS/ODF (aerial detection survey)
0
5
10
20 Miles

Elevation & aspect
(2003 - 2012 mapped polygons)



Recalculation of Aspect (Subset) with Both Norths			
Values	Count	Aspect	Percent
1	3711	Flat	0.05
2+10	788531	North	11.61
3	876527	Northeast	12.91
4	1002349	East	14.76
5	853311	Southeast	12.56
6	740430	South	10.9
7	803401	Southwest	11.83
8	891514	West	13.13
9	831697	Northwest	12.25

Mean = 2,692ft., Std. Dev = 899ft.

1 Std. Dev: Range =1,793ft to 3,591ft.,
2 Std. Dev: Range = 894ft to 4,490ft

Analysis by Leo Chan, USFS

Oregon white oak – indicator of poor DF habitat

Bill Schaupp photo

Predictors of white oak presence in TNC analysis:

- Shallow depth to bedrock
- Drainage index (basically, low soil water storage)
- pH

Higher mortality on stand edges, in small isolated patches, lower mortality in patch interiors

E. Goheen, photo

Where has flatheaded fir borer killed green Douglas-fir?

Oregon:

- Locations with ingrowth of Douglas-fir on harsh sites better suited for other species (oaks, pines)
- Columbia Gorge; the eastern edges of the Willamette Valley; and rain shadows of Mt. Hood; SW Oregon.
- Eastern Oregon on western larch

California:

- NE (post-drought; drier D-f sites, oak & pine; also scattered)
- NW (continuous, slow-paced, different associates; alluvial floodplains during drought)
- Southern Sierra Nevada (Douglas-fir beetle also rare)

Idaho:

- Following large Douglas-fir beetle epidemic

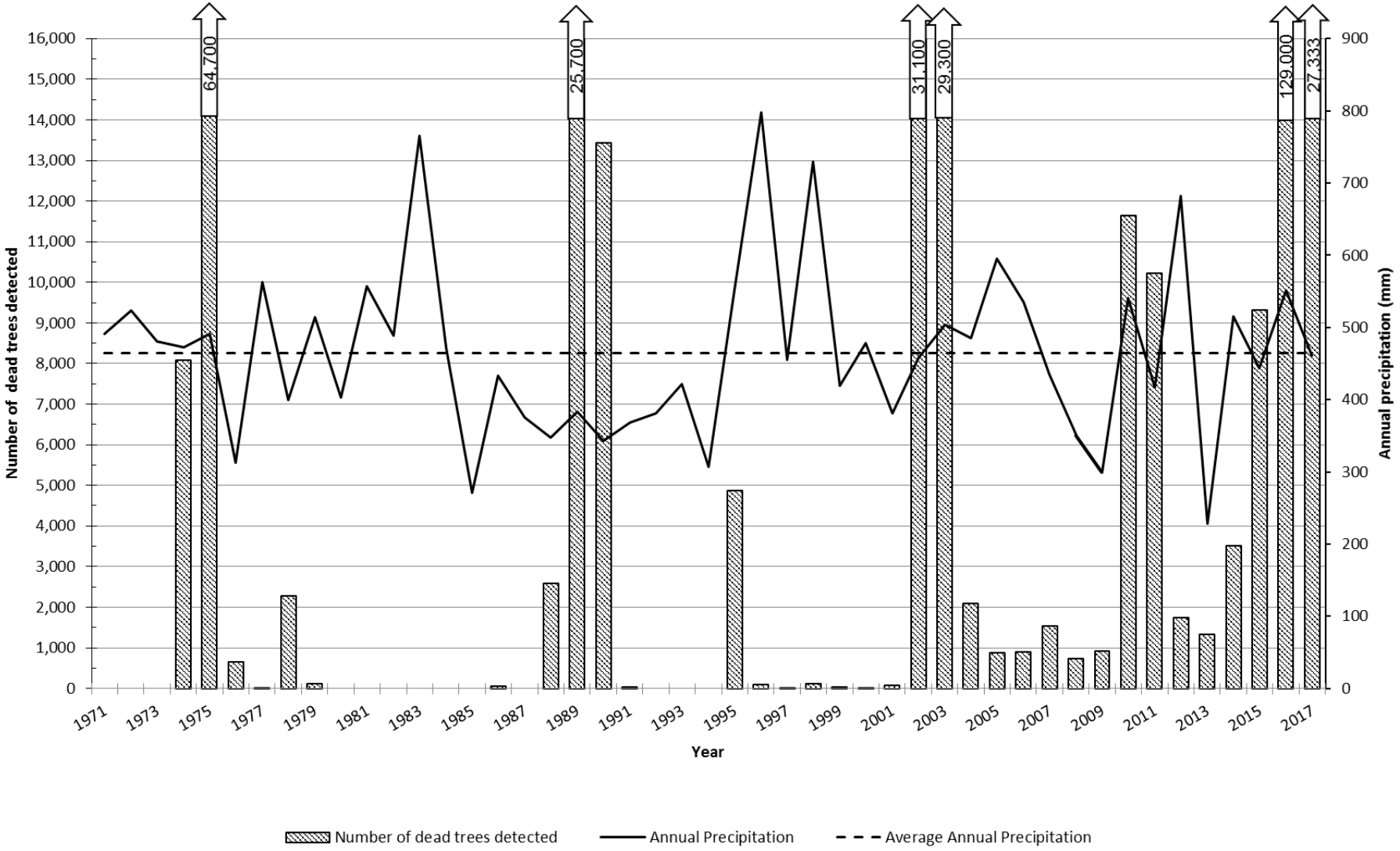
Periodic Severe Water Stress

When there's not enough water……

- Water-conducting cells blocked by air bubbles
- Water conducting cells collapse
- Close stomata (openings in leaves) for too long, reduce amount of food produced (carbon starvation)
- Less food available for growth, defense, and repair
- Fewer defensive mechanisms or compounds makes tree more vulnerable to insects and pathogens
- Overheats, proteins denature, volatiles emitted
- Wilting
- Cells and features formed are small = stunting

Stunted growth, Dieback, Disease, Insect attack, Death

Douglas-fir Mortality Attributed to Flatheaded Fir Borer
Annual Aerial Detection Surveys 1974 - 2017 in southwestern Oregon and
Annual Precipitation 1971-2017
Medford International Airport, Medford, OR



Douglas-fir Stem and Branch Mortality

Environmental Stress

Secondary Organisms

- Canker fungi

Douglas-fir Stem and Branch Mortality

Environmental Stress

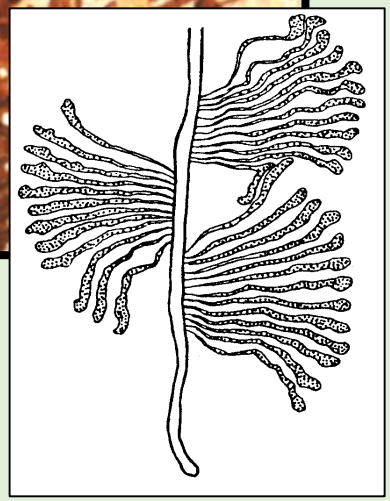
Secondary Organisms

- Branch bark beetles
- Branch-feeding weevils

D-f twig weevil

D-f engraver

D-f pole beetle



Douglas-fir Beetle

Root Diseases

Black Stain Root Disease

Photo by J. LeBoldus

Phaenops vandykei (Obenberger)

What is the role of *Phaenops vandykei* in dead and dying Douglas-fir? Any others?

Phaenops drummondi, the flatheaded fir borer

Is flatheaded fir borer responsible for all die-off?

-no-

Opportunistic “secondary” insects and plant pathogens

- response to host stress

Mortality of Douglas-fir in southwestern Oregon

- primarily from flatheaded fir borer in Klamath ecoregion
- increases during and after drought
- especially severe with “high temperature” drought
- other agents, esp. on smaller D-f, may change
- may persist after drought conditions improve