Armillaria Root Disease

Armillaria ostoyae or solidipes

- Affects wide variety of species including deciduous and some shrubs (Douglas-fir is highly susceptible)
- grows on roots and survives on dead roots and stumps (15-25yrs.)
- Can spread from root to root contact or through soil via rhizomorphs (shoe strings)
- Causes death and mortality in trees of all tree species and ages. Can be widespread on roots even in relatively healthy looking stands
- Rapidly colonizes roots of freshly cut or killed trees

Outline

1) Symptoms & Signs
2) Hosts
3) Distribution/Hazard
4) Biology
5) Detection
6) Treatment

Tree Symptoms

- reduced height growth rounded crown
- Resinosus or sap flow
- Thinning
- Yellowing
- Distress cones
- death

Above ground symptoms on Fd relative to root colonization for trees 7-15 yrs. (Morrison 2011)

% root length colonized (roots over 1cm dia.)	% with root collar girdling (resinosis)	Reduced height growth in prev. 2 years
10-30	30	no
30-60	70	slight
60-99	90	moderate

Take home: You only see part of the picture

Mycelial Fans

More Fans

Fan Growth on Dead Roots (*A. ostoyae or A. sinapina?*)

Decay & Bioluminescence

Honey Mushrooms

Host suscept. - Armillaria SEDA

Spp.	Relative Susceptibility
Douglas-fir	High
Western Hemlock	High
Subalpine fir	High
Spruce	Moderate - High
Pine	Moderate
Western Larch (>25 yrs.)	Low
Western red cedar	Low
Deciduous	Low

Distribution/Hazard

- ICH highest hazard
- Lower incidence in other subzones
- Mesic sites higher hazard than other site series
- Not present on the Chilcotin Plateau & begins to drop out as you move north into Quesnel (Robson Valley northern limit)
- Elevation and aspect limits as you move north

Distribution in the old Horsefly District

- ICH and adjacent SBSdw
- Below 3,000 ft
- Southwest facing slopes
- Fd or Sx leading with a deciduous component

Biology

Morrison, D.J. 2011 Epidemiology of Armillaria root disease in Douglas-fir plantations in the cedar-hemlock zone of the southern interior of British Columbia. For. Path. 41 (2011) 31-40

Infection Sources

- Initially most infections arise from rhizomorphs that extend out from infected roots and stumps
- As the trees grow and mature root to root contacts become an important means of spread
- the distance between the source of infection and the new infection can be up to 2m

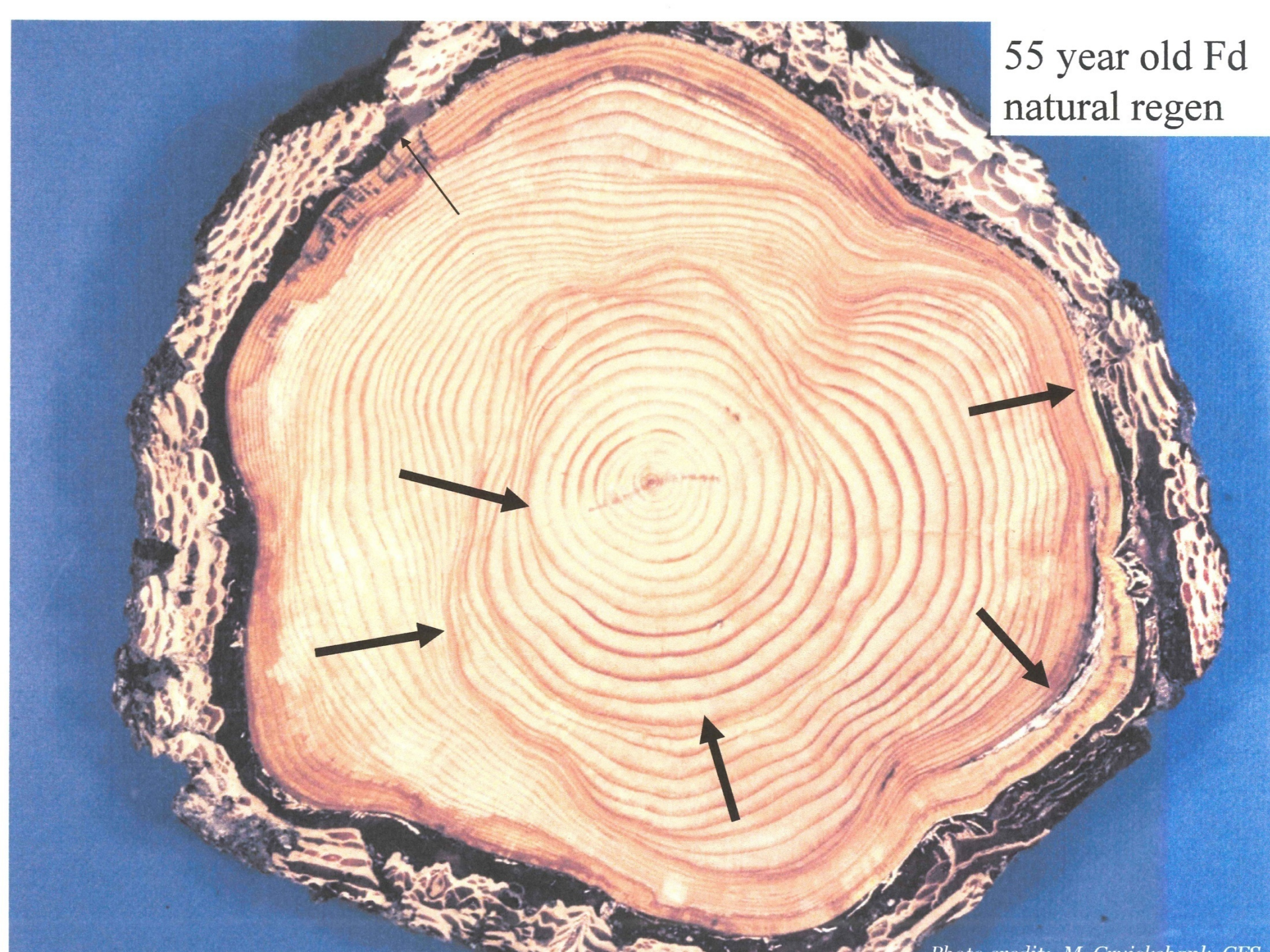
Distance between infection and infection source based on 5 Fdi plantations (3-10 trees per site)

Age	Range (cm)	Median (cm)
9	7-104	12
15	4-41	15
19	10-220	117
21	25-100	40

Take Home: Most infections occur close to infection source

Callus Formation

- Healthy trees form calluses at the site of lesions that can stop the spread of Armillaria
- If trees become stressed for some reason (eg. drought, harvesting) Armillaria may once again become active
- The location and timing of lesions can be determined by looking at a stump cross section


55 year old Fd
natural regen

Freq. of Armillaria lesions in 7 Fdi plantations 14-21 yrs. in ICH

	ICH dw & mw (moist)	ICH wk & vk (wet)
% with lesions	47	28
Av. # of lesions/tree	3.2	3.6
% Fd with <5 lesions	80	80
% Fd with >15 lesions	1	1
% callused lesions	60-80	60-80

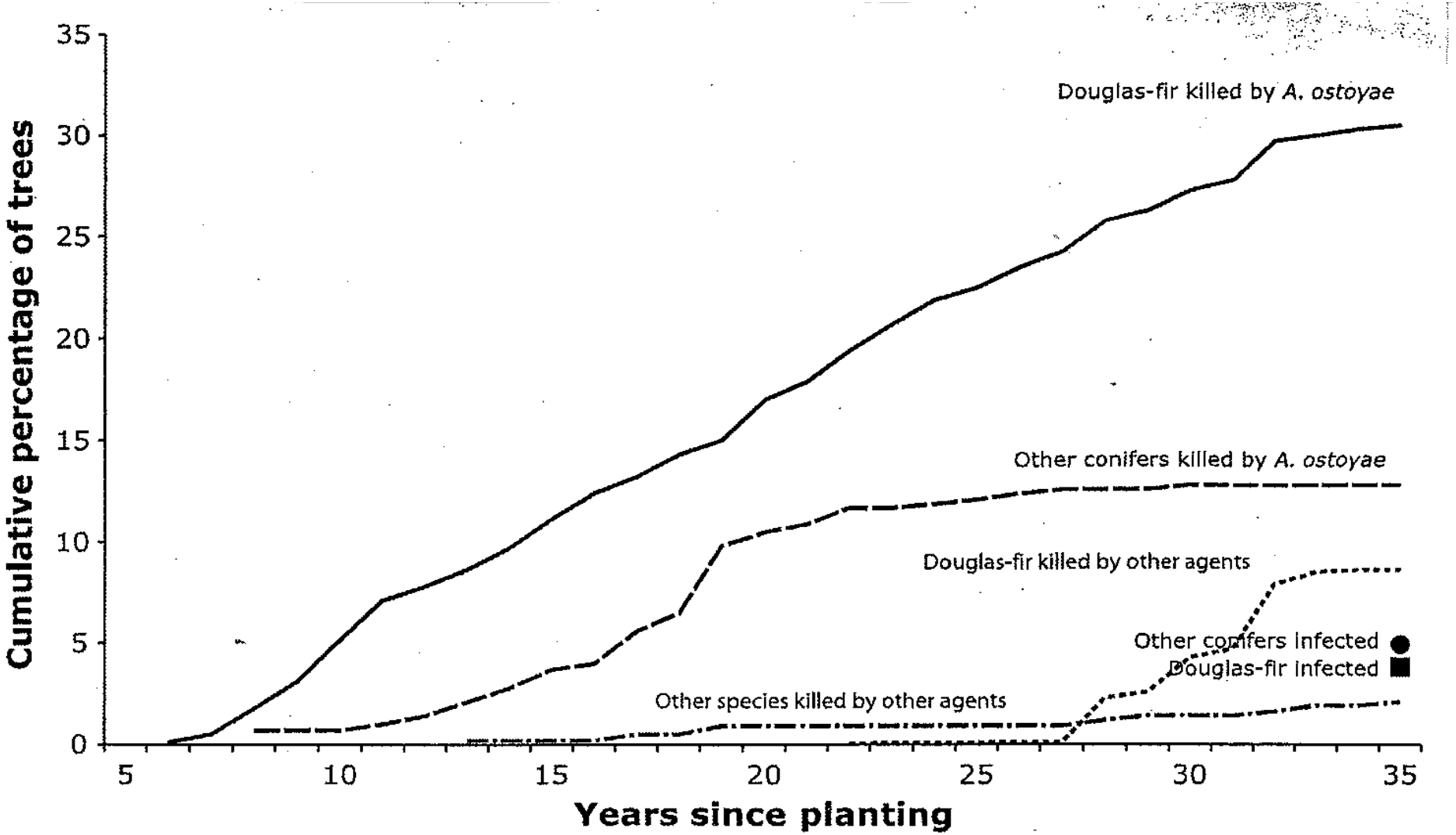
Take home: 25-50% of trees have 1-4 lesions & 70% are callused over

Time from infection to death (based on traumatic resin duct formation in 493 trees from 32 7-33 yr. old Fdi plantations in ICHmw

Age	Time from Infection to Death
7	2
25	11
32	20

Take home: older trees take longer to die

Cumulative Mortality over Time at Sugar Lake



Detection/Surveys

- heli surveys
- walkthrough surveys
- transect surveys
- Sketch mapping can be difficult because root centers are often not well defined and healthy trees may be interspersed with diseased trees
- Areas with high root disease often have a high deciduous component
- Goal of survey is to come up with a stratification/treatment map or polygon

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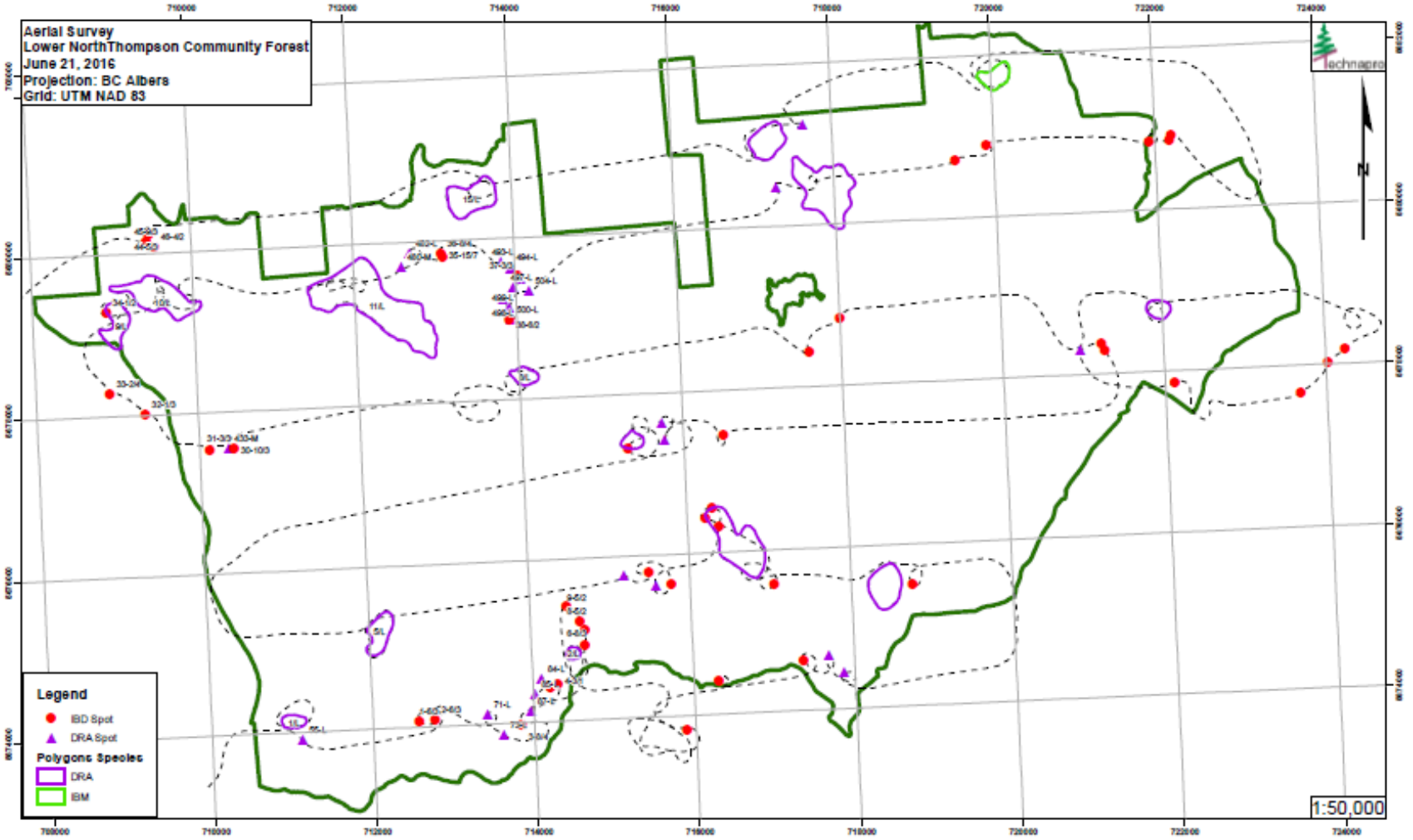
Aerial Detection LNTCF-2016



Management

- Very difficult to manage in the interior
- No alternate species
- Cutting can lead to an intensification in disease severity

What to Do?

- Avoid partial cutting
- Stumping
- regenerate a variety of species that will grow well on the site and hope for the best (natural regen vs. planted, avoid planting adjacent to stumps)

Planting Recommendations

- When planting highly susceptible species (Fd, Hw) use 50% mixture of low susceptible species (Lw, Cw, Decid.) that are ecologically suitable
- more than 30% moderately susceptible species (Sx, Pl) use 30% mixture of low susceptible species that are ecologically suitable

Take Home: Plant a mixture of low susceptible species and avoid planting Douglas-fir as much as possible

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Future Approaches?

- Hypholoma – needs federal approval and someone willing to produce it
- Ring Barking – still experimental

Ringbarking - Experimental

Summary

- Armillaria grows on roots and survives in dead roots and stumps
- Causes typical root disease symptoms and resinosis
- Can be recognized by fans, shoestrings, and mushrooms
- Poses difficult challenges for timber management

Relative % Distribution DRA & DRL

(from distribution and impact of Phellinus Root Diseaes in the southern interior region of BC)

	Kamloops		Okanagan		Arrow Boundry.		Merrit	100 Mile	
	IDF n=22	ICH n=2	IDF n=16	ICH n=11	IDF n=7	ICH n=14	IDF n=25	IDF n=12	ICH n=1
DRL	23	0	31	73	0	29	44	0	0
DRA	64	100	75	100	100	79	32	25	100

Take Home: Armillaria is very widespread in the ICH

Mean % Incidence L1 Fd DRA & DRL

(from distribution and impact of Phellinus Root Diseaes in the southern interior region of BC)

	Kamloops		Okanagan		Arrow Boundry.		Merr it	100 Mile	
	IDF n=22	ICH n=2	IDF n=16	ICH n=11	IDF n=7	ICH n=14	IDF n=25	IDF n=12	ICH n=1
DRL	5	0	7	23	5	43	0	0	0
DRA	7	8	11	33	14	29	1	4	9

Take Home: highest root disease incidence in Okanagan and Arrow Boundary ICH