

Armillaria Root Disease

Brennan Ferguson
USDA Forest Service
Forest Health Protection

General Biology

- Numerous *Armillaria* species worldwide
 - *A. ostoyae* is the dominant conifer pathogen in western North America.
 - Other species are mainly saprophytes.
- *A. ostoyae* infects and kills vigorous trees
 - The fungus can then live on for decades in roots and stumps. Root disease occupies the site.

Recognition

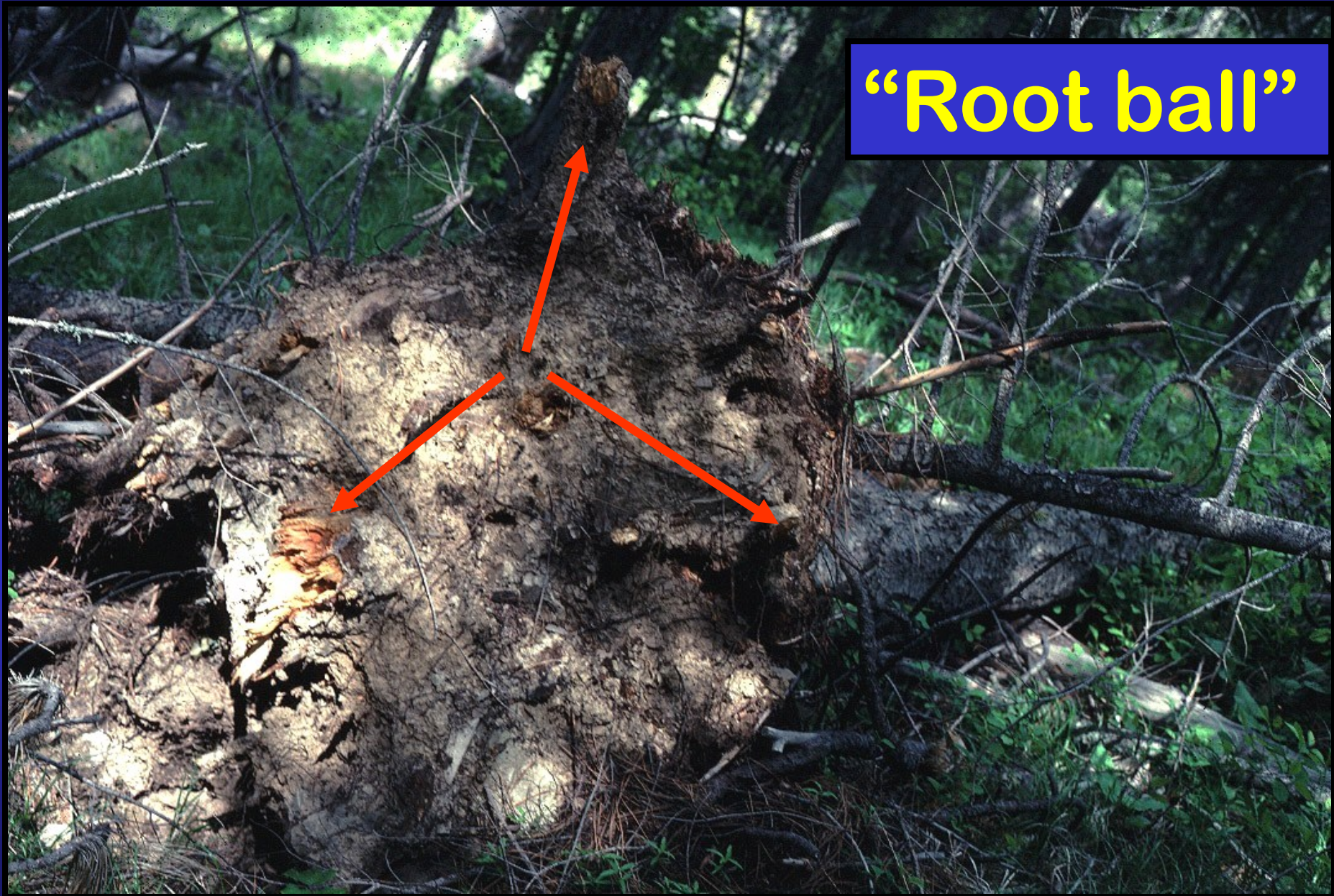
Tree-Level

Symptoms

- Reduced growth
- Thinning crown
- Yellowing foliage
- Stress cones



Things that catch a pathologist's eye ...



“Root ball”

Decay caused by Armillaria is yellowish and stringy with a “shredded” appearance







Basal resinosis or “pitching” as reaction to infection







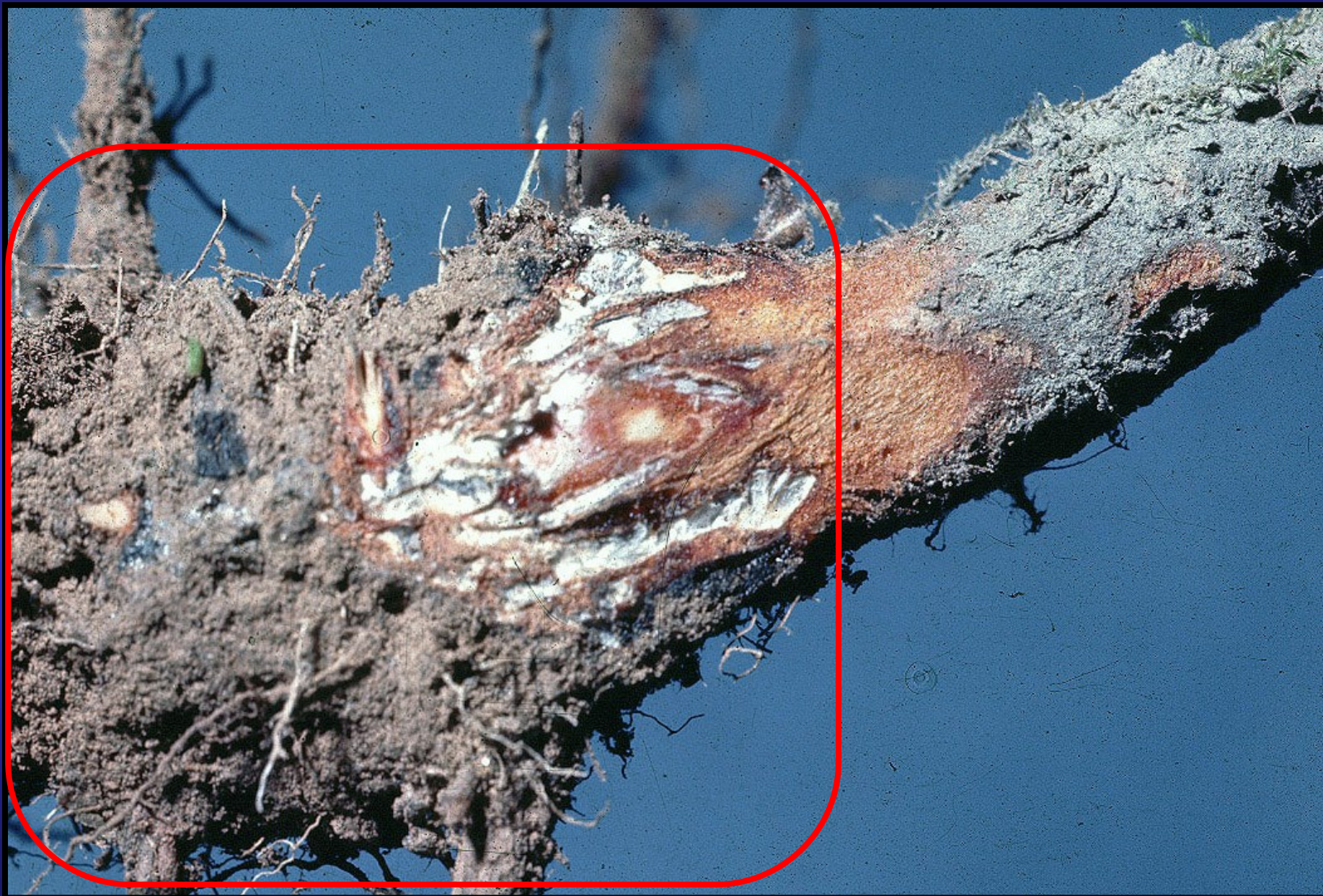
Mycelial fans under bark of Douglas-fir



Mycelial fans under bark of ponderosa pine



Soil and pitch clump together



**Fruiting bodies
(mushrooms) of
Armillaria spp.**

Often appear in fall
after rains.

Inconsistent -- some
years there is heavy
fruiting, other years
almost none.



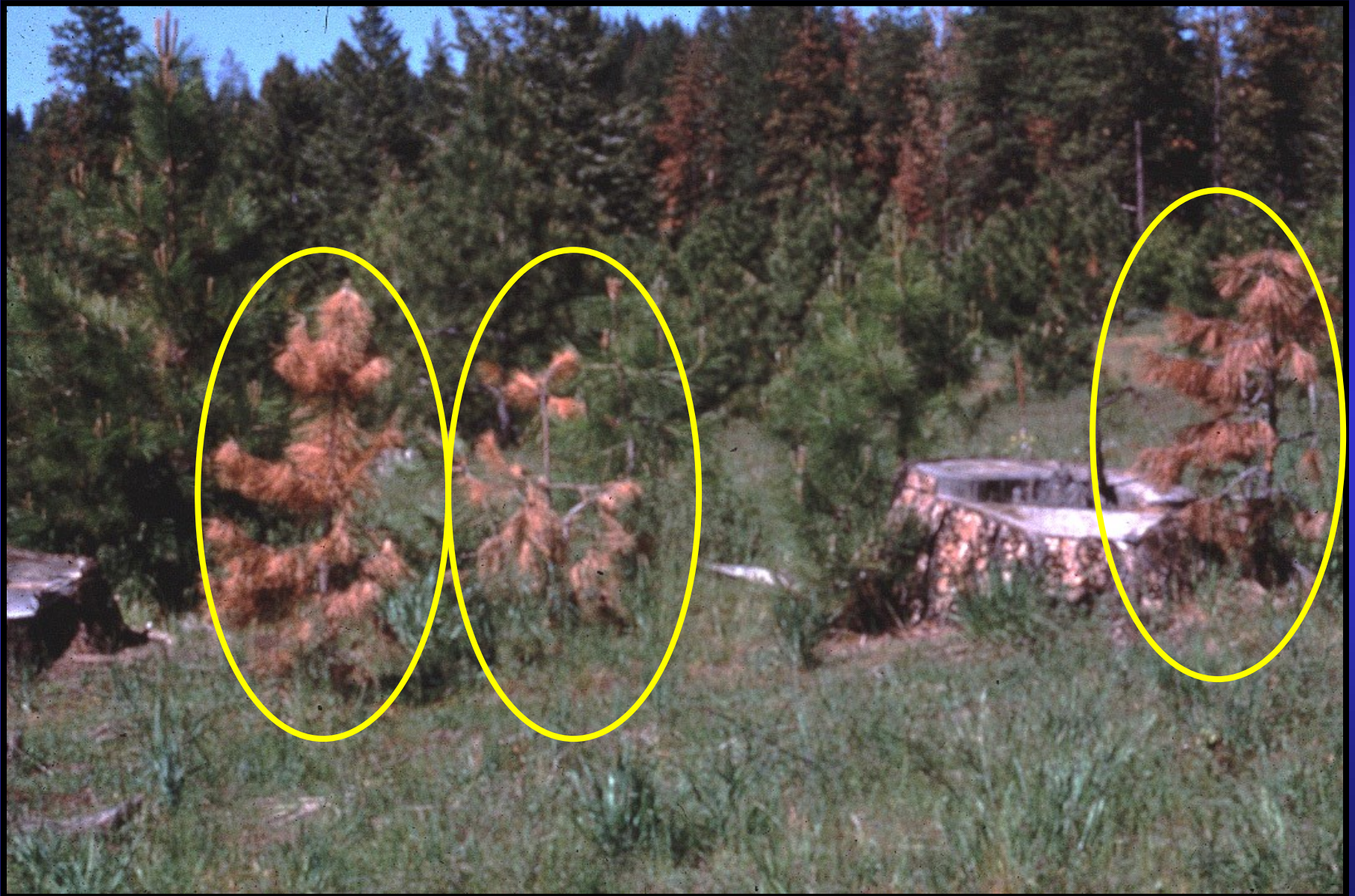


Stumps, Roots, & Spread

**Symptomatic
regeneration
associated
with stumps**



Mortality centered around stumps



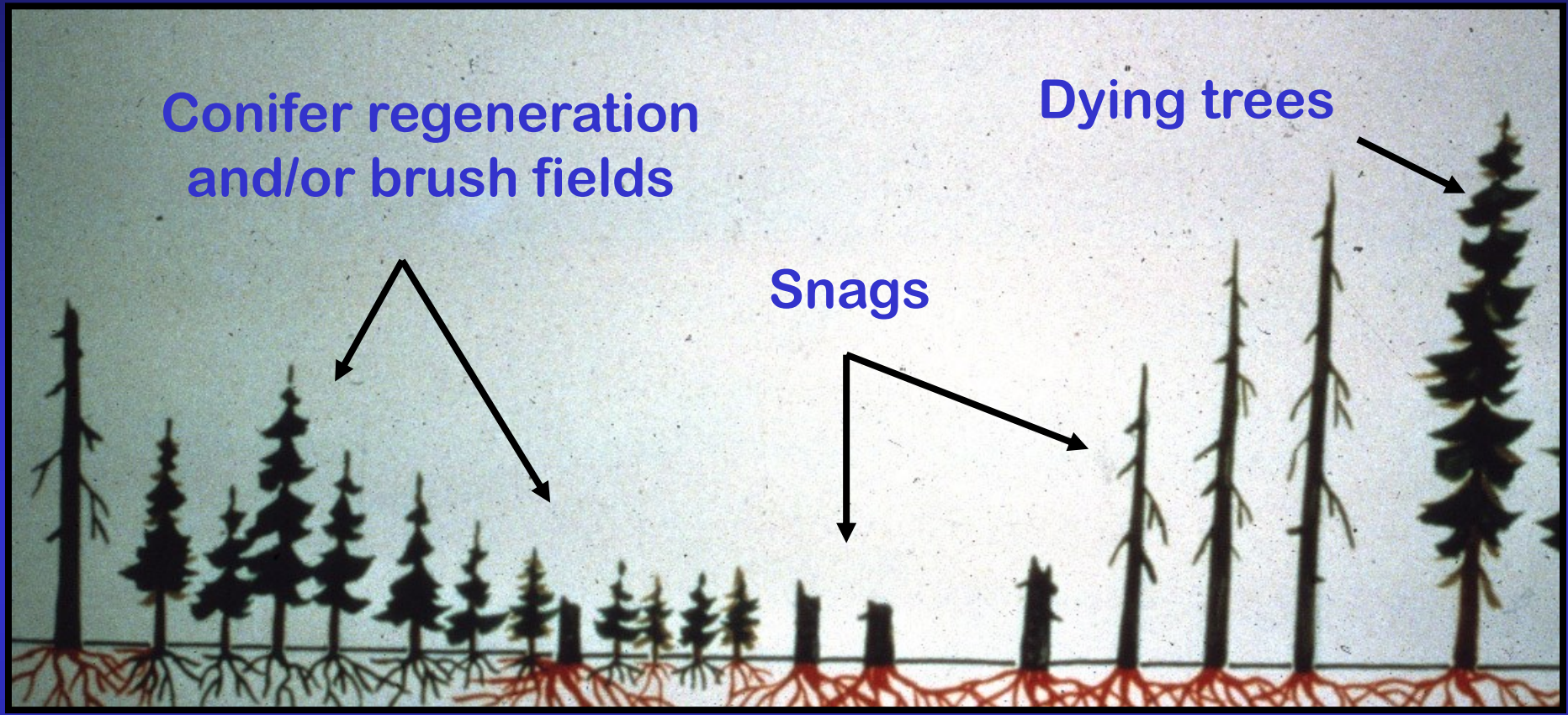
Root contacts are
primary method
of spread



Recognition

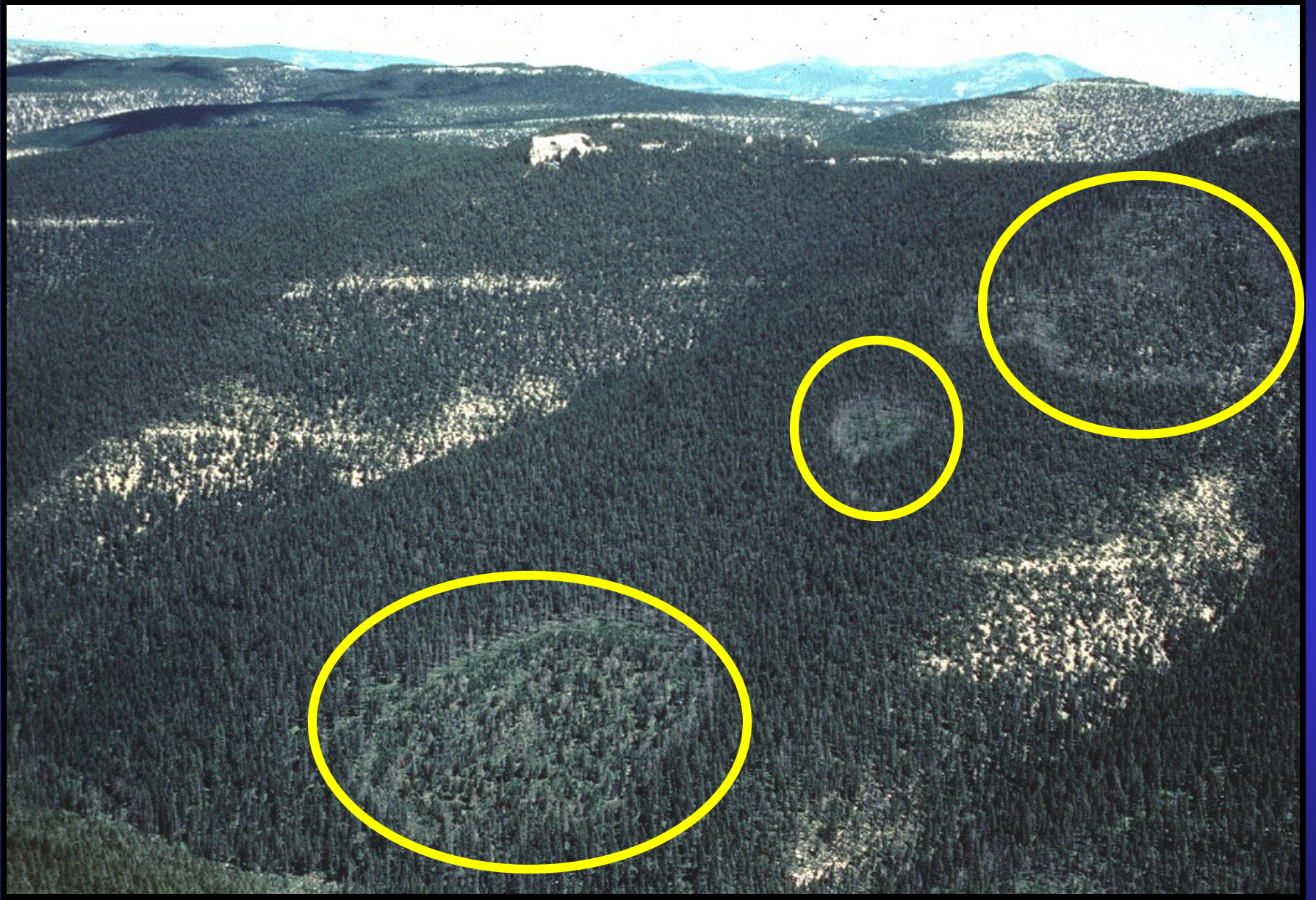
Stand-Level

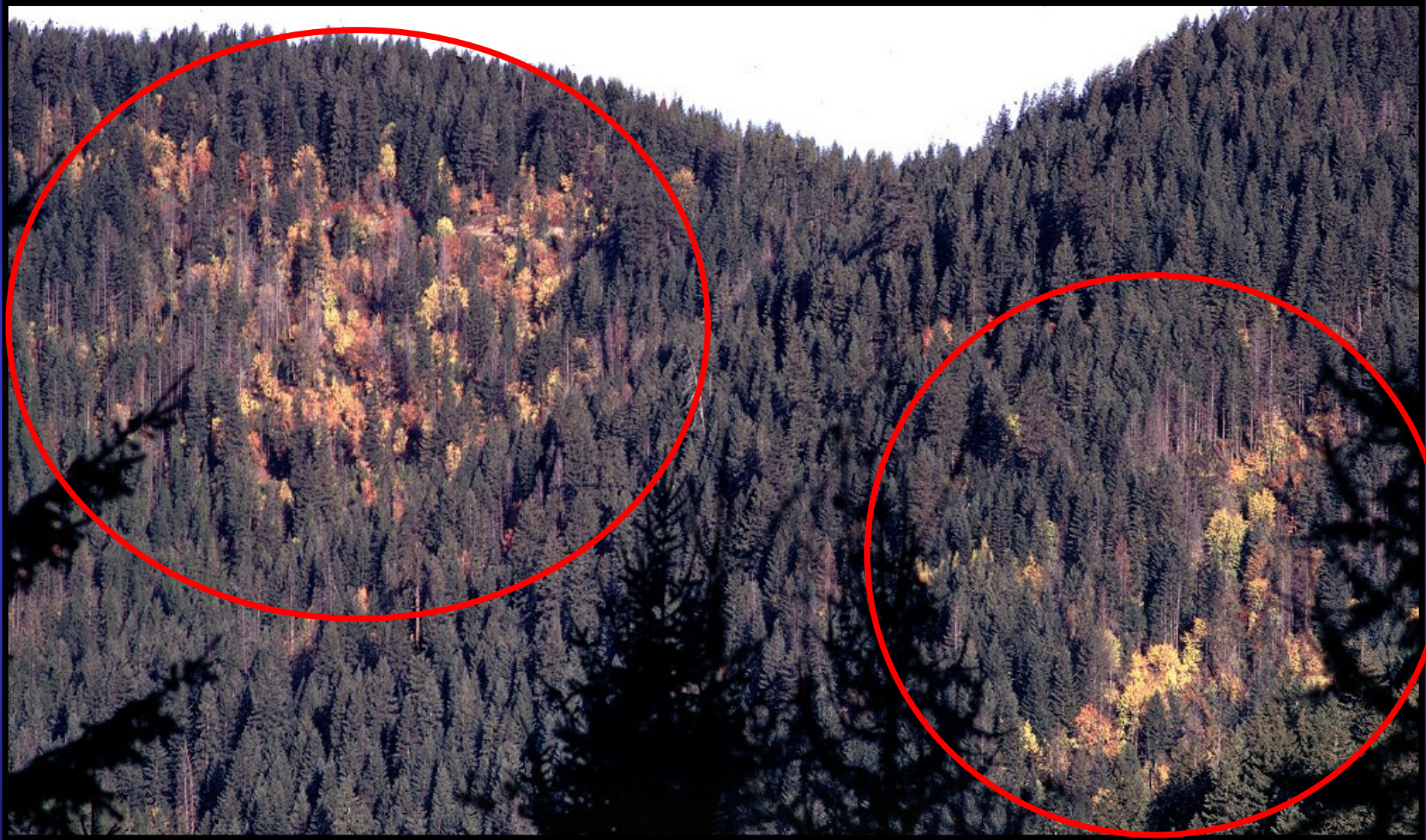
Dynamics of a root disease "center"



Signatures of root disease centers

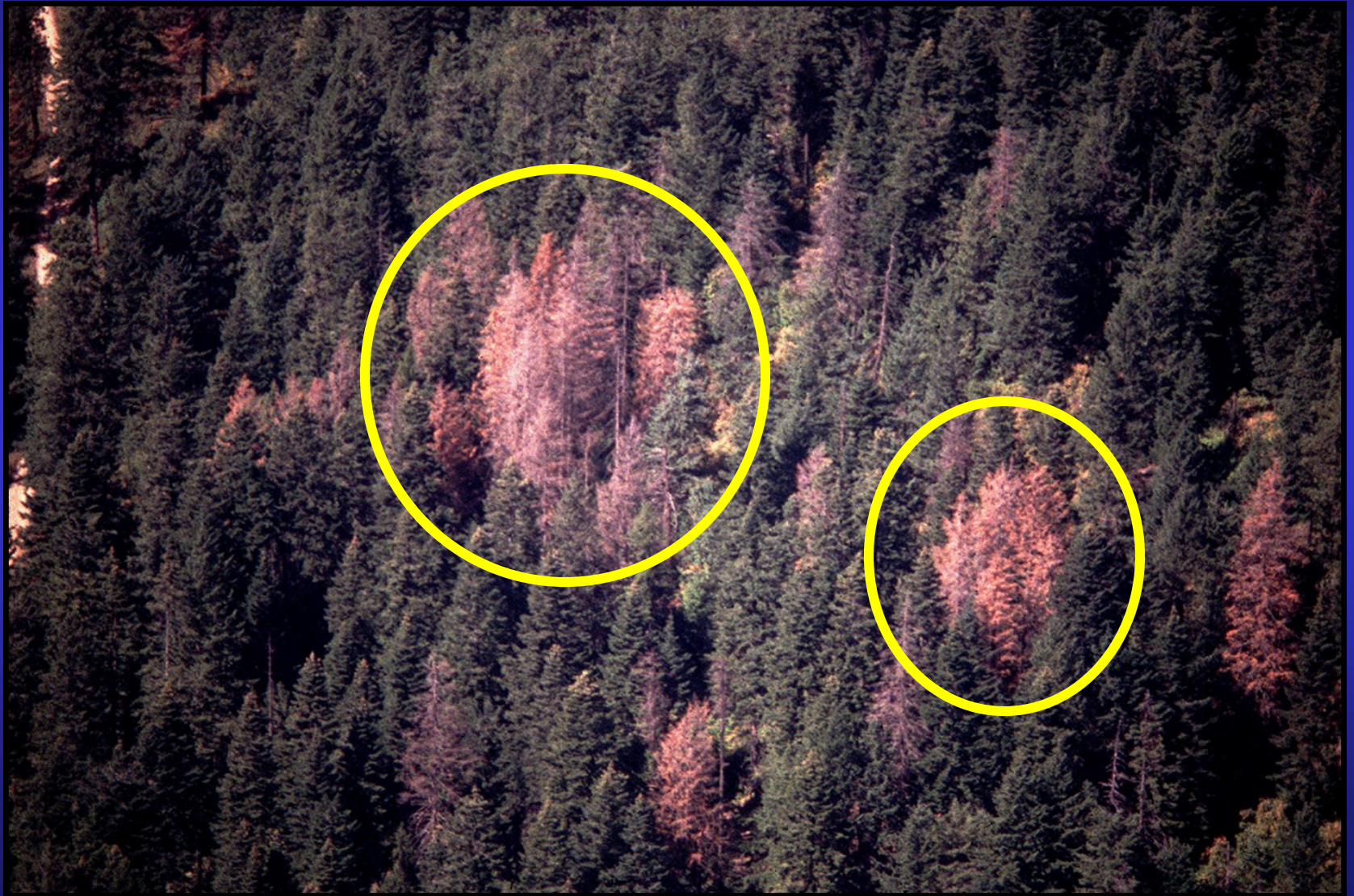








Bark beetles can kill infected trees rapidly and mask scattered root disease



Armillaria genets

- A fungal genet is an individual, it means the genet began with a single spore and spread from there.
- *Armillaria* genet are know to range in size from small to massive.
- Genetic relationships among isolates collected from infected trees can be determined.

Plate-pairings for determining both *Armillaria* spp. and genets

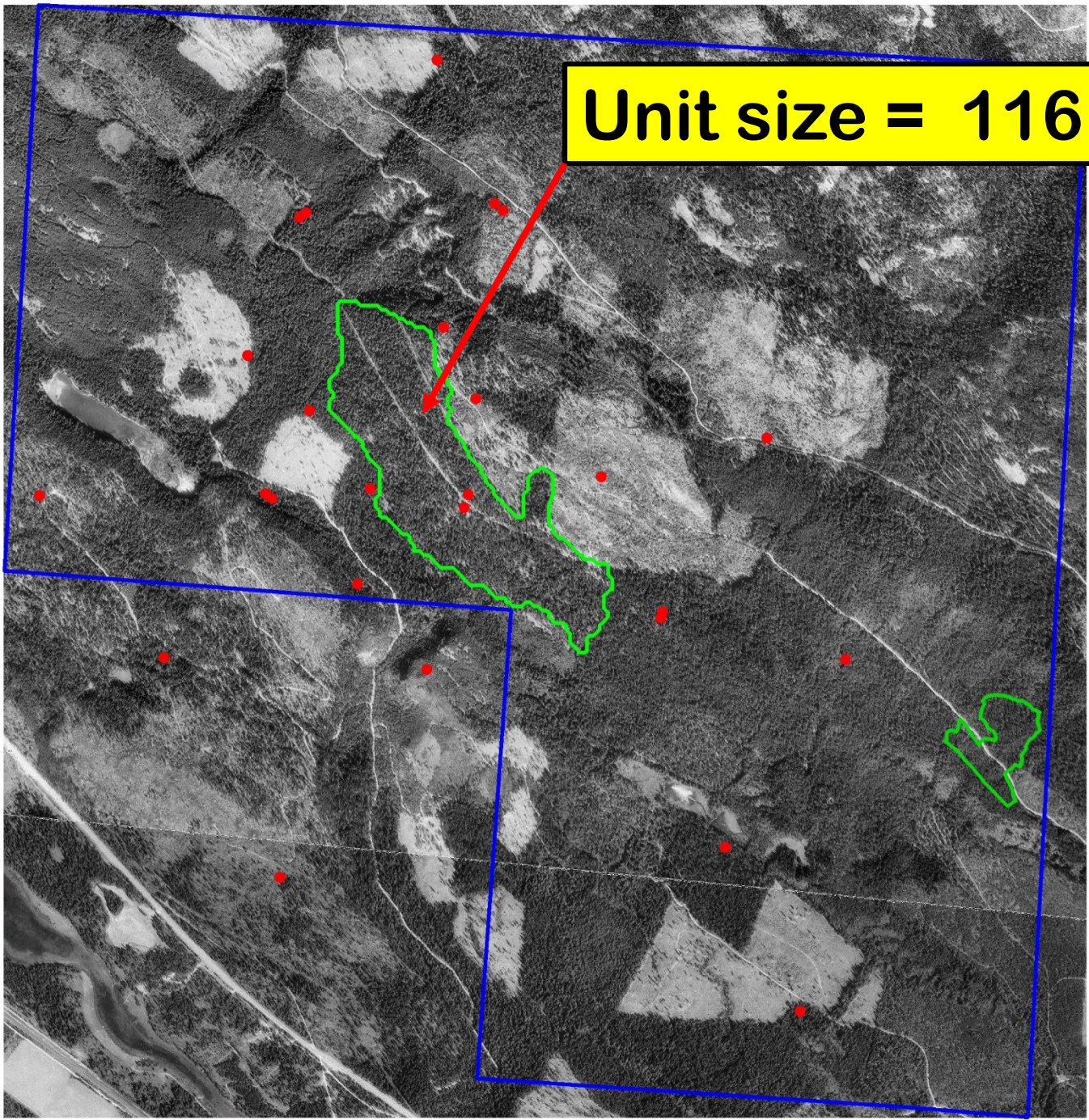
Same species & genet



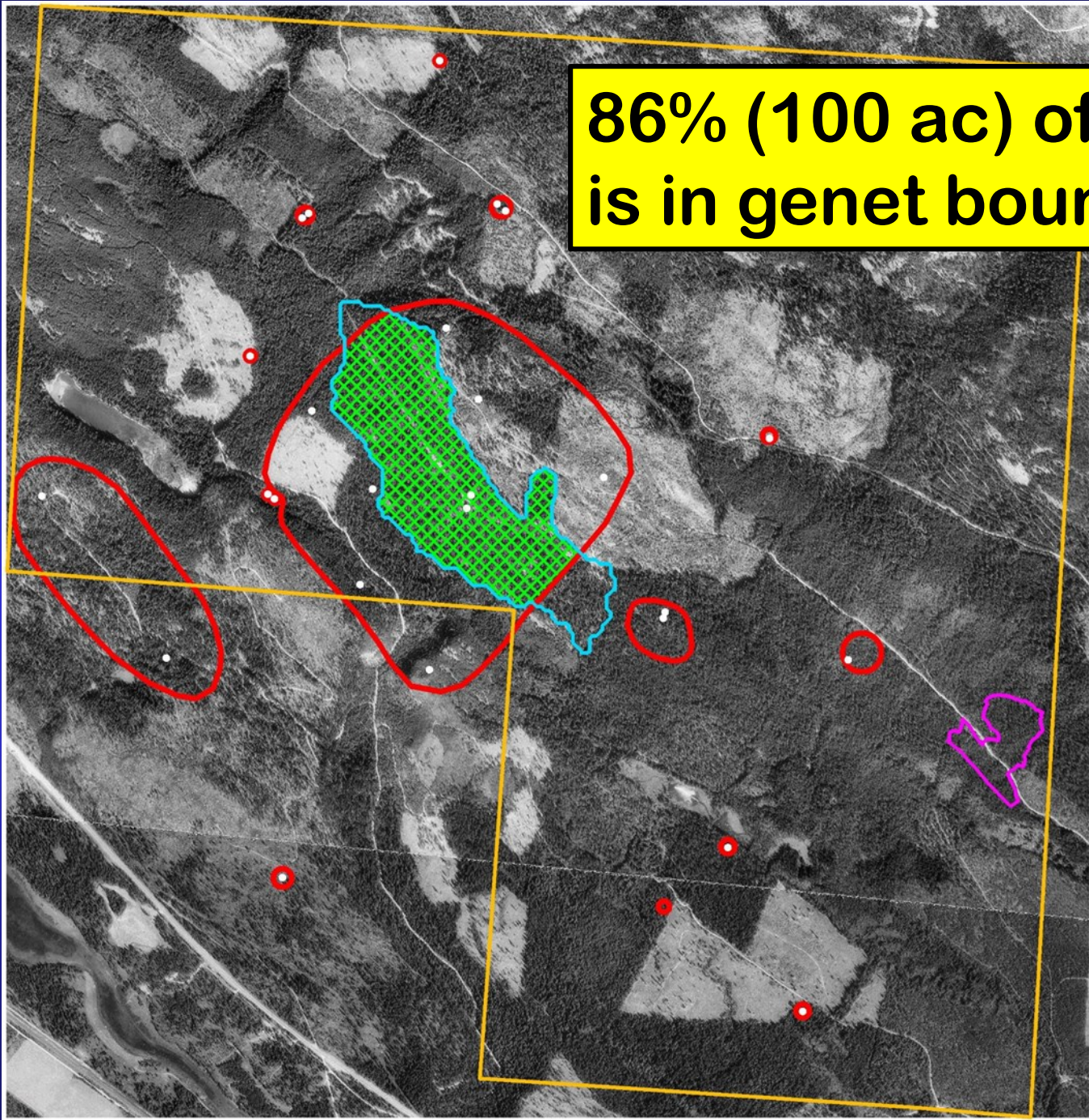
**Same species,
different genets**

Different species

Unit size = 116 acres



**86% (100 ac) of unit
is in genet boundary.**

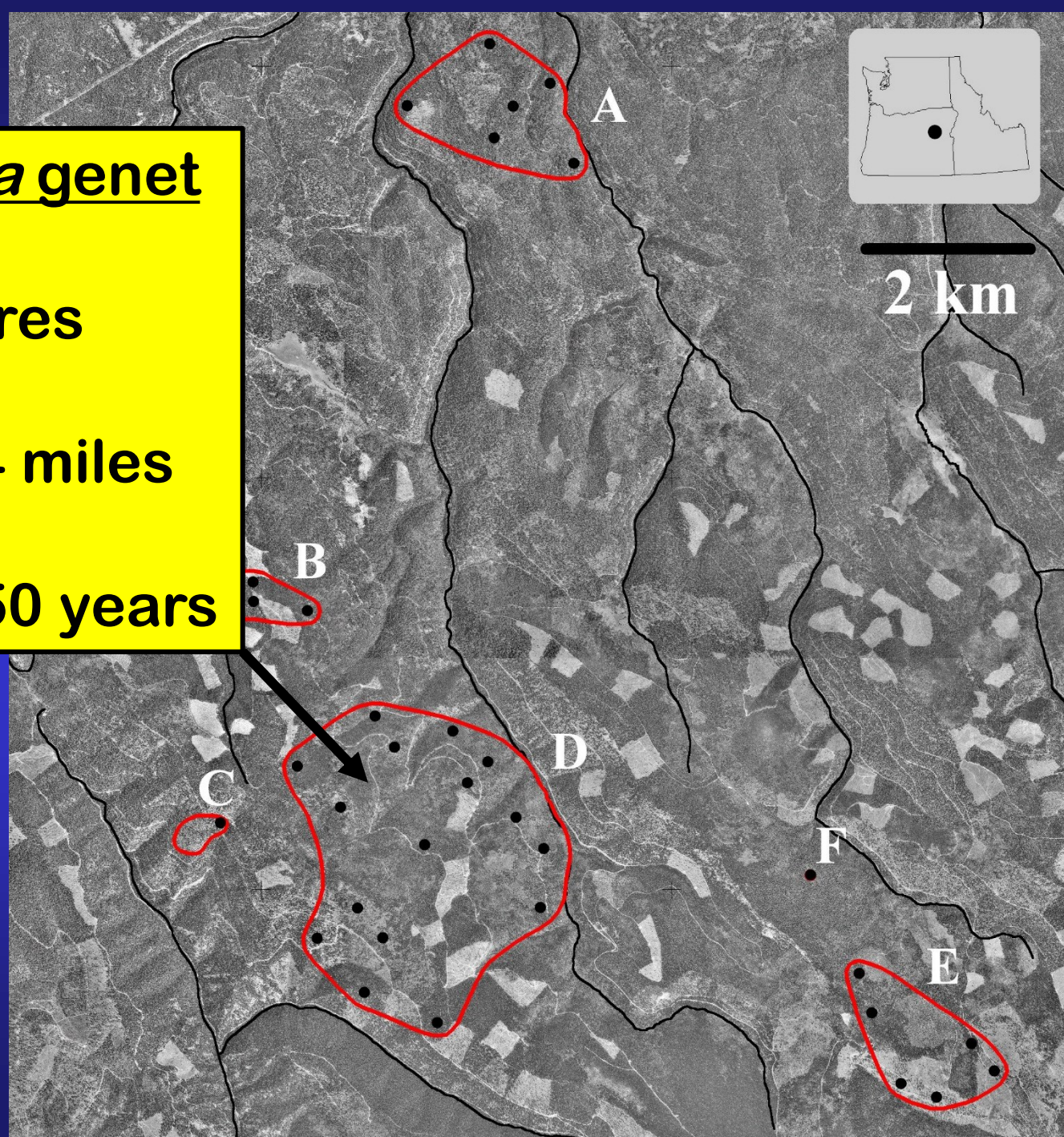


One *Armillaria* genet

Area ~2385 acres

Max width ~2.4 miles

Age ~1900-8650 years



Key Characteristics of Root Disease

- Chronic growth loss & mortality.
- Fungi can infect and kill living, vigorous trees then remain alive for decades in dead stumps & roots.
- Disease centers in managed stands are associated with stumps.
- Trees in regenerated stand are infected as root contacts occur; often years later.
- Root disease spreads outward at average rate of 1-3 feet/year; can double in size over 10 years.

Management

Variation in Host Tolerance is Key!!

Susceptibility of conifers > age 15-25

	Armillaria root disease
Highly susceptible	Douglas-fir True firs
Low susceptibility	Western larch Pines (in most instances) Western redcedar

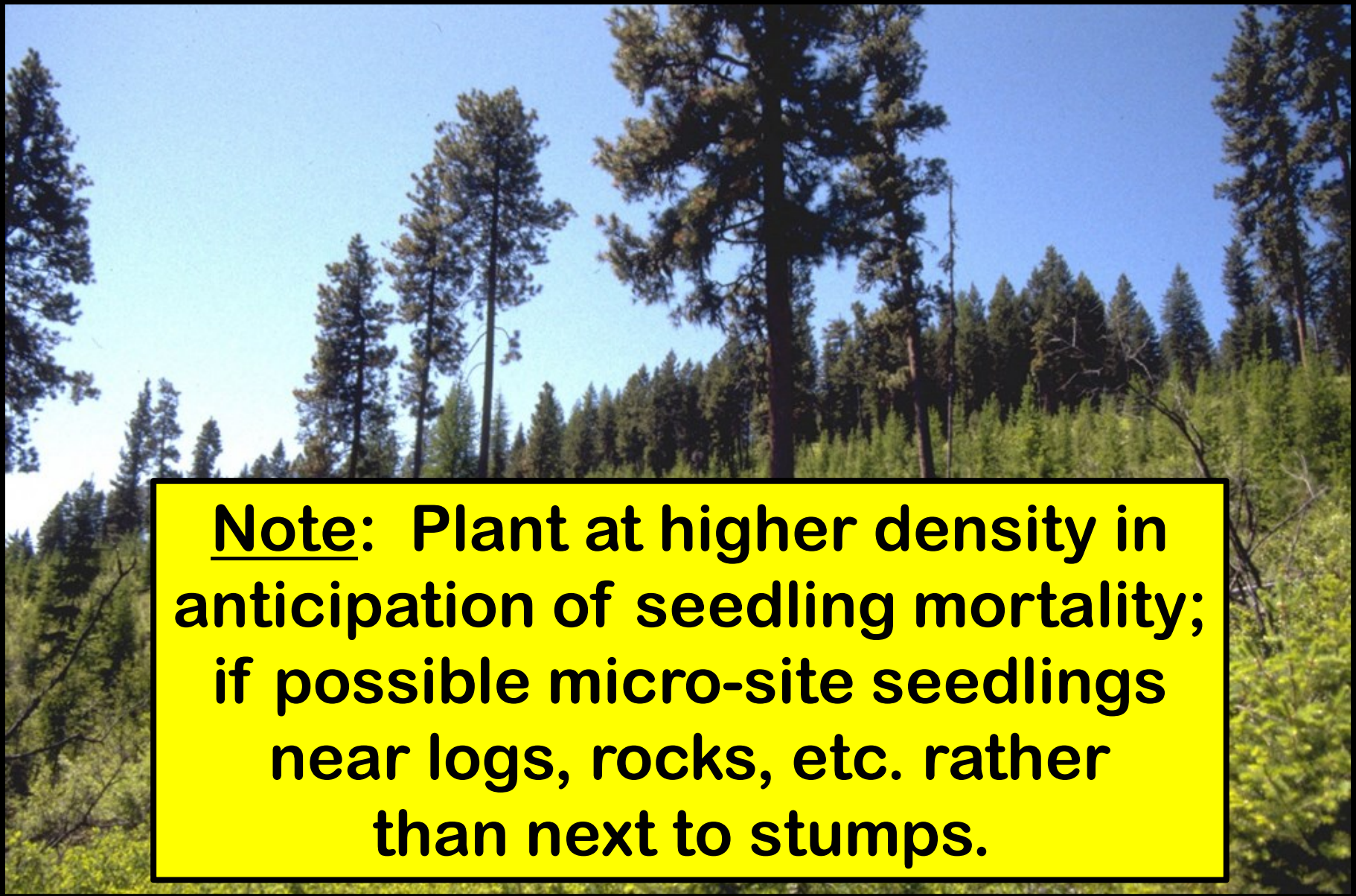
Spread during the life of a stand

- *Tolerant species* can be infected at an early age via contact with stumps and roots; some will die but root-to-root contact between infected, living trees does not continue through the rotation.
- *Susceptible species* will be similarly infected, but root-to-root spread will continue between trees throughout the life of the stand.

Consider the tree-to-tree spread throughout the life of a Douglas-fir or true fir stand ...



... compared to regeneration via ponderosa pine seed trees and planted western larch.



Note: Plant at higher density in anticipation of seedling mortality; if possible micro-site seedlings near logs, rocks, etc. rather than next to stumps.

Removal of infected stumps & roots



Push-falling

Stumping



Stumping by pulling or pushing:

- Temporarily reduces infection; does not “sanitize” the site.
- Disease will slowly start again in the regeneration as seedlings contact inoculum.
- Risk of soil compaction and severe disturbance; limit to drier sites.
- Cost-benefit must work for you.

Summary

- Root disease is very likely impacting your lands far more than you realize.
- Root disease cannot be ignored if you want to maintain, much less maximize, forest productivity.
- Address through careful planning, good record-keeping, and a silvicultural approach that emphasizes species composition.
- There is no “easy fix” to root disease.

