Development and persistence of soil impacts following Scotch broom invasion

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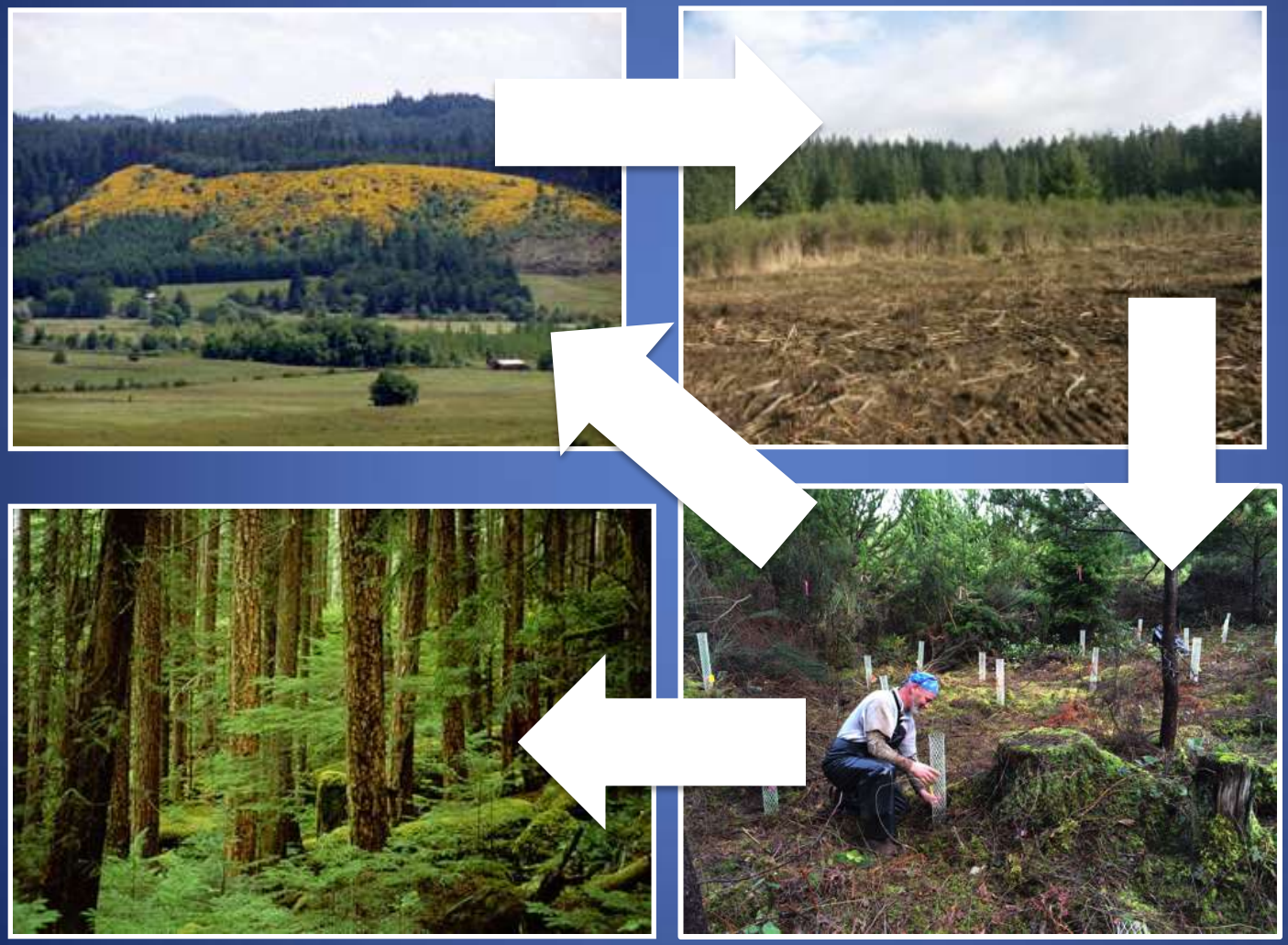
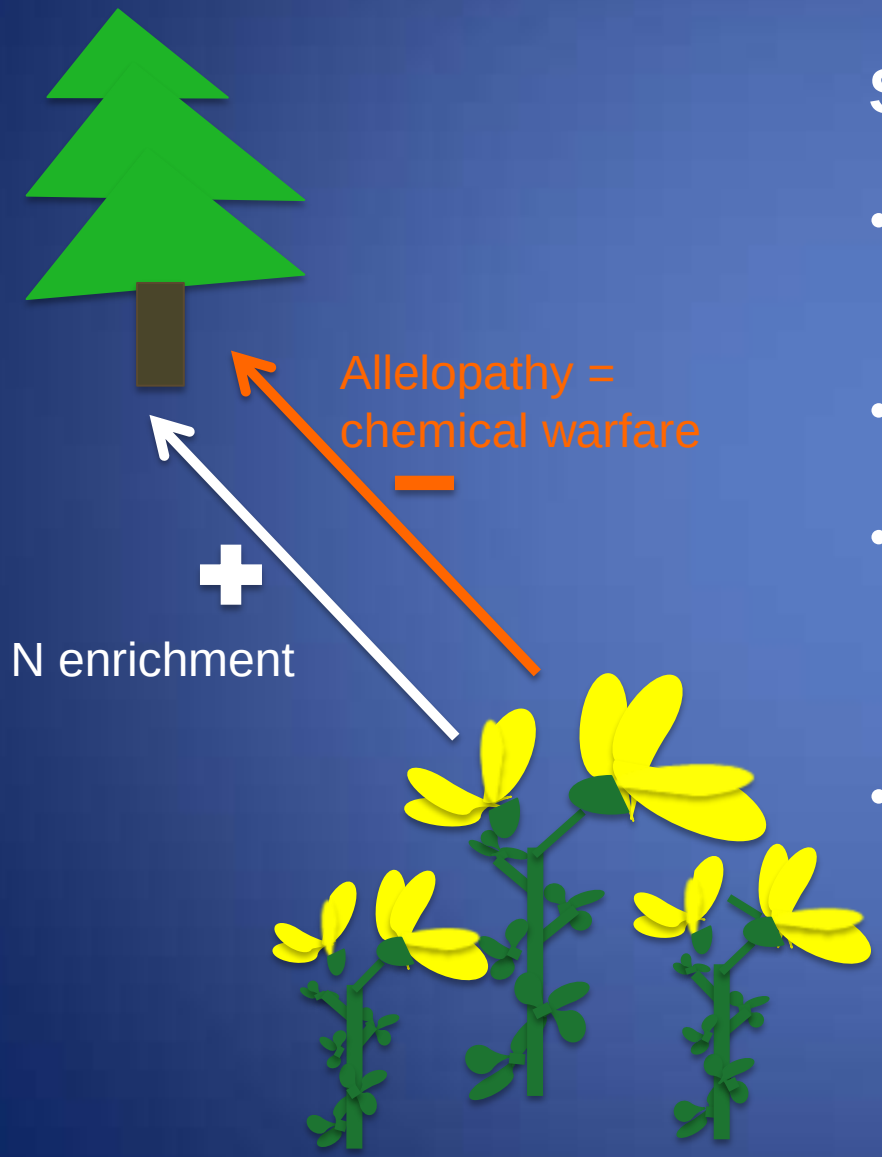
We remove invasive species with the expectation that the impacts with go away with it and ecosystems will eventually recover to the pre-invasion conditions



How does Scotch broom impact reforestation?

- Planted ~10,000 seedlings into areas where broom had been removed
- 90% seedling mortality
- Scotch broom had been removed , so mortality NOT caused by broom competition.
- Did Scotch broom change the soil environment in some way that limits Douglas-fir establishment

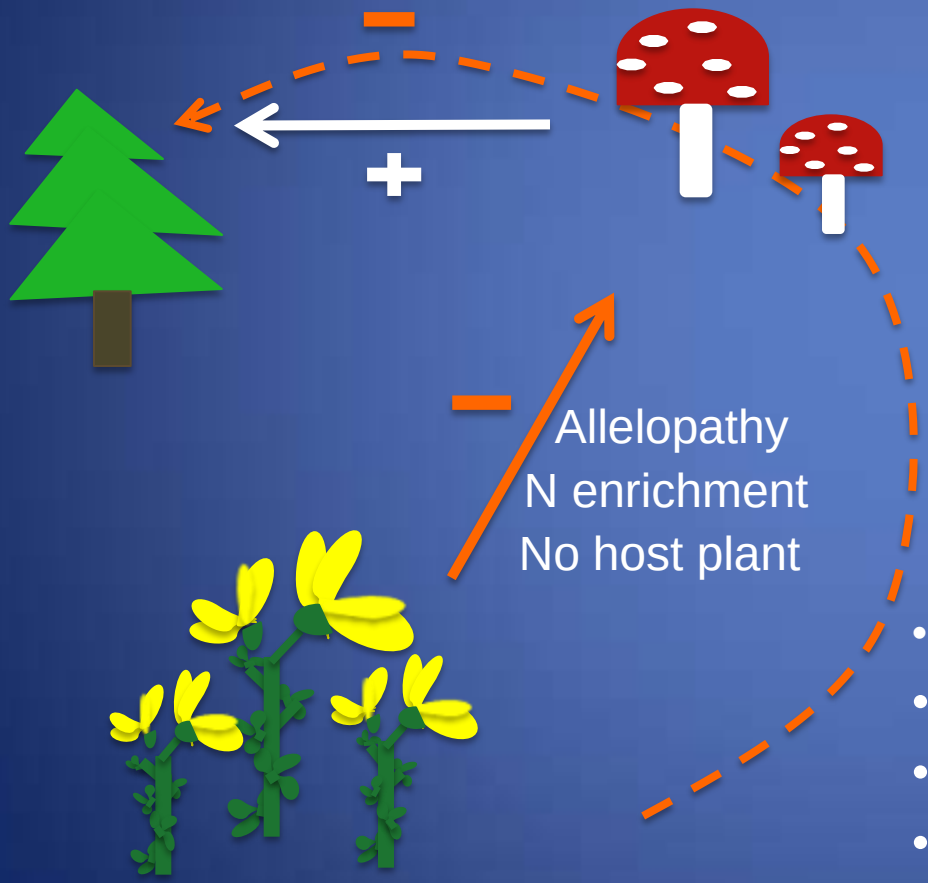
Potential pathways for soil legacy effects



Sparteine:

- Alkaloid secondary defense compound
- In leaf and stem tissues
- Protects against herbivores and pathogens (Küçükboyacı et al. 2012, Wink, 1982)
- Know virtually nothing about how it accumulates or persists in the soil

Impact of broom invasion: Loss of the ectomycorrhizal mutualism?



- Increases soil surface area contact
- Increases access to nutrients and water
- Provides pathogen protection
- Increases drought tolerance
- Plants provide C (sugar/food) to fungi

Evidence of a soil legacy effect

findings from a greenhouse experiment

Soil Legacy Effects:

Trees grown in broom invaded soil were **SMALLER** than trees grown in uninvaded forest soil

Trees grown in broom invaded soil had **LESS** ectomycorrhizal colonization than trees grown in forest soil

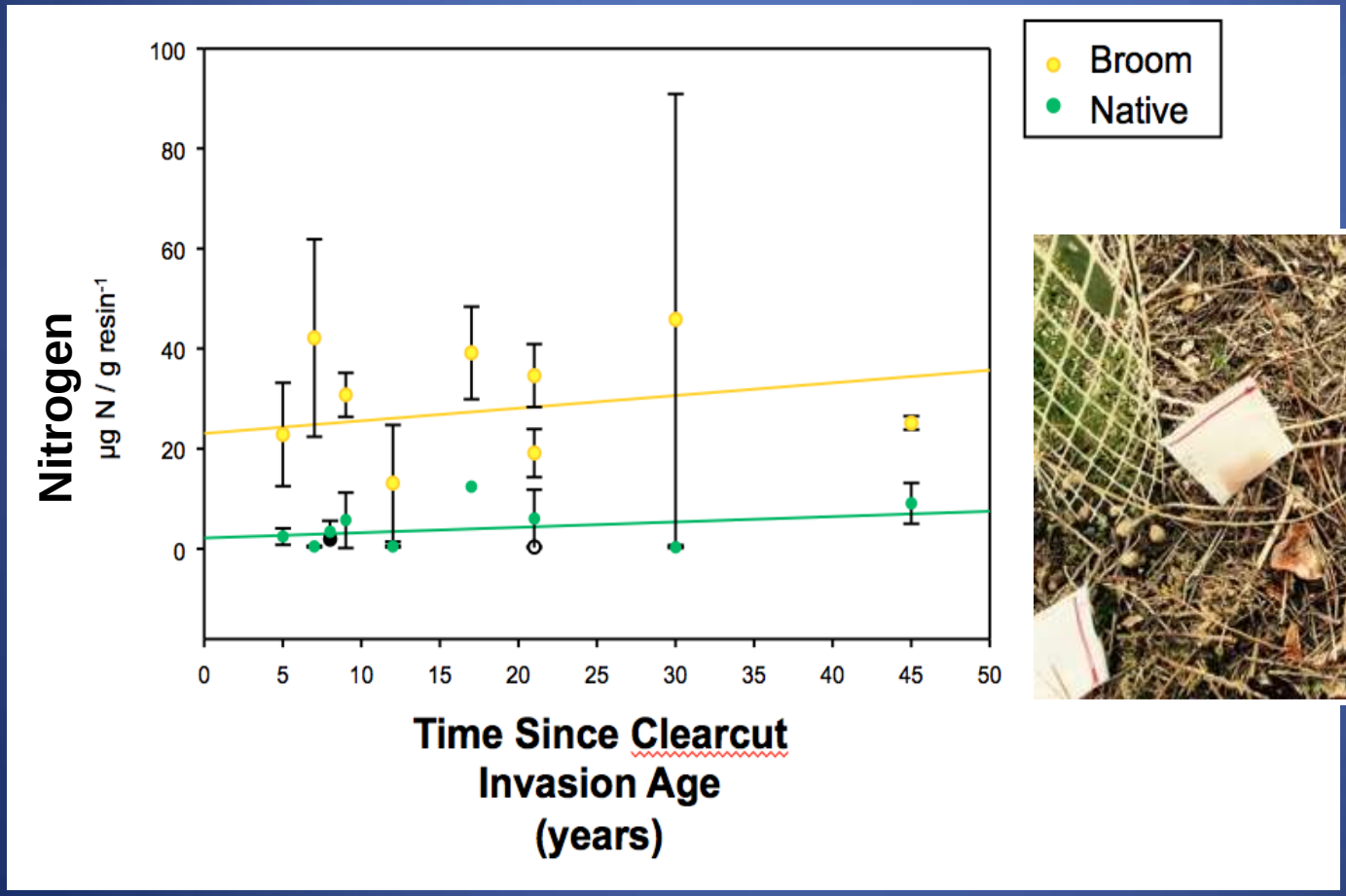
Adding Scotch broom mulch to forest soil **SUPPRESSED** tree growth and EMF

Grove et al. 2012 Plant Ecology

How do impacts of Scotch broom change with time since invasion?

Grove et al. 2017 Journal of Ecology

Available **nitrogen increases** with invasion with **no effect of time** since invasion?



Why worry about nitrogen enrichment ?

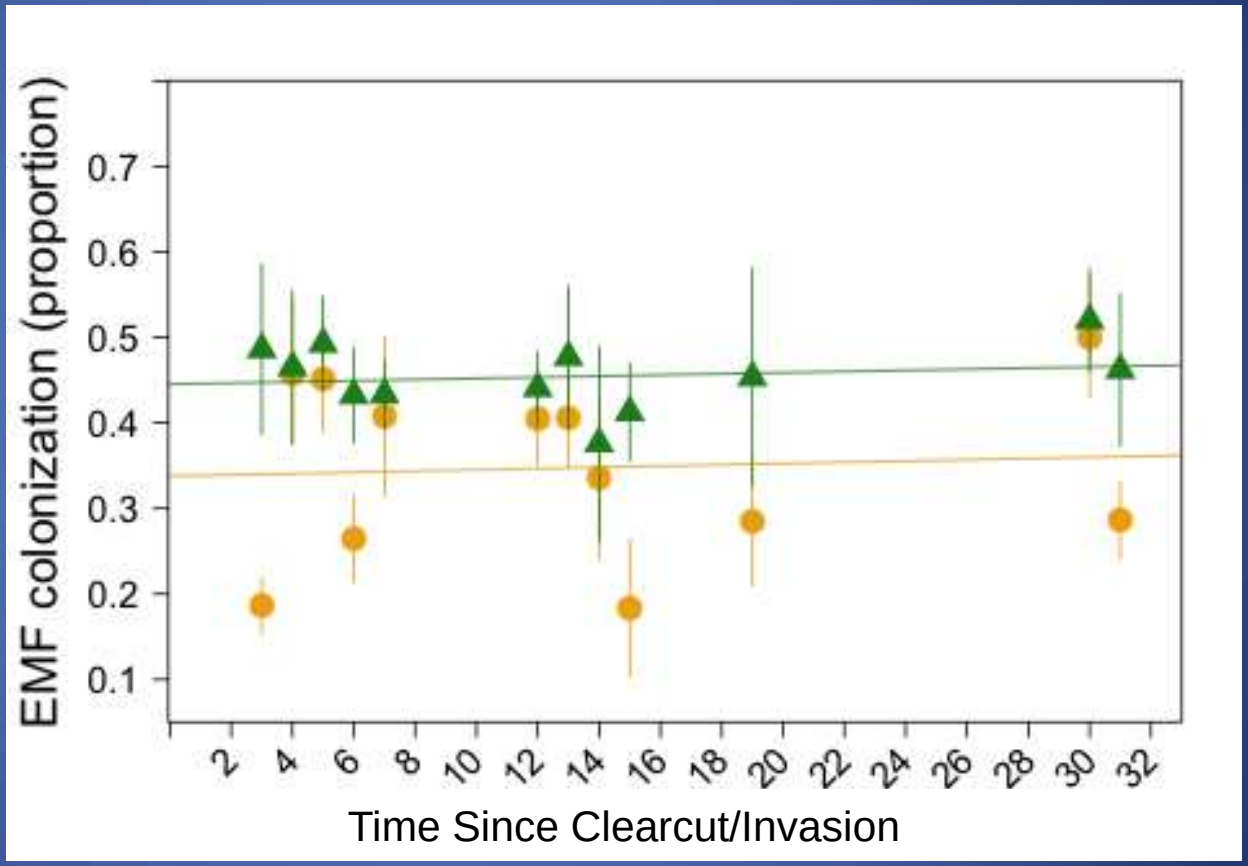
Douglas-fir forests are N limited

- Decrease abundance of ectomycorrhizal fungi

- Facilitate invasion by fast growing exotics that quickly utilize N

- Increase susceptibility to drought stress

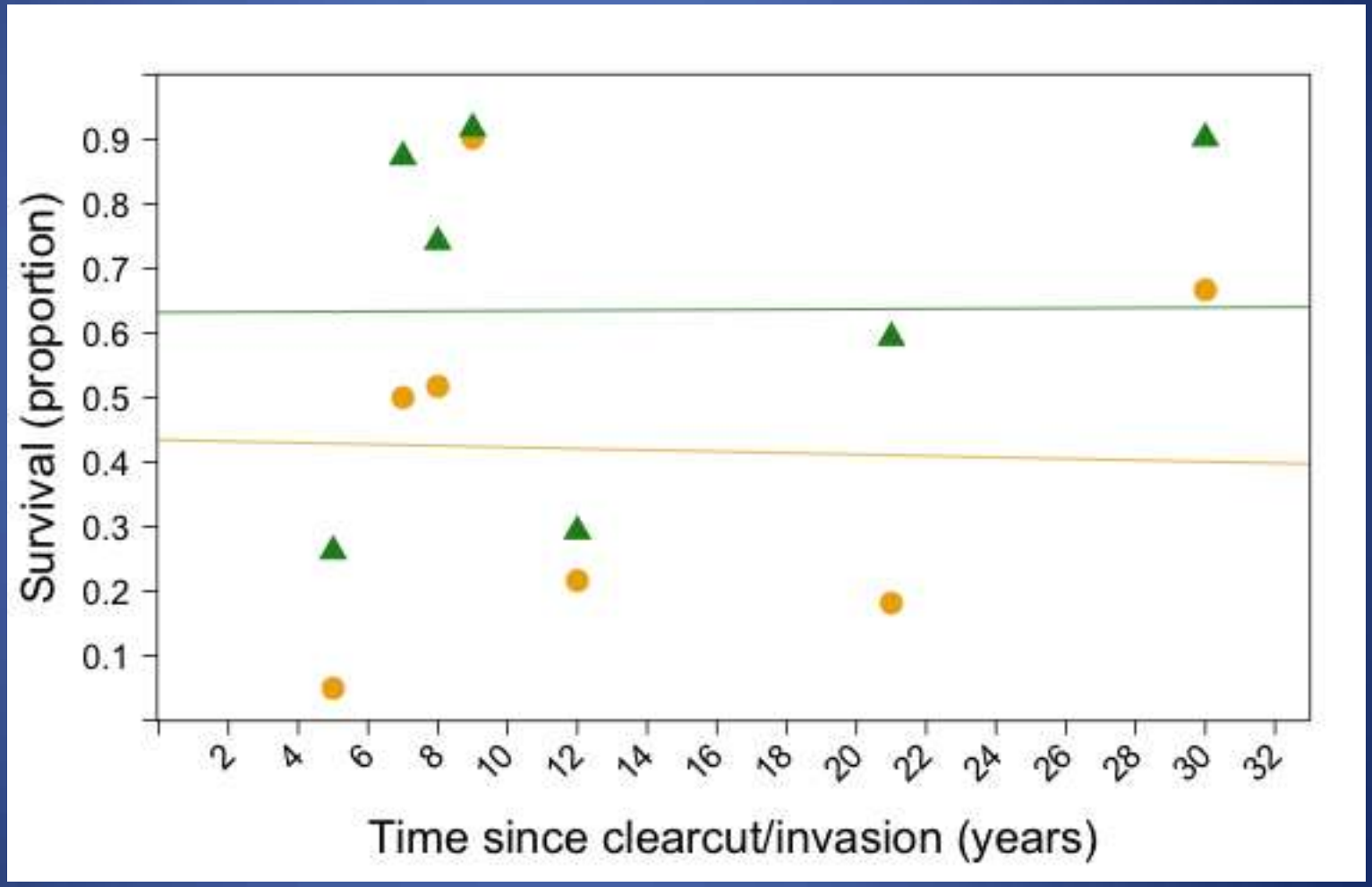
Ectomycorrhizal colonization **decreases with invasion** with **no effect of invasion age**?



Grove et al. 2017 Journal of Plant Ecology

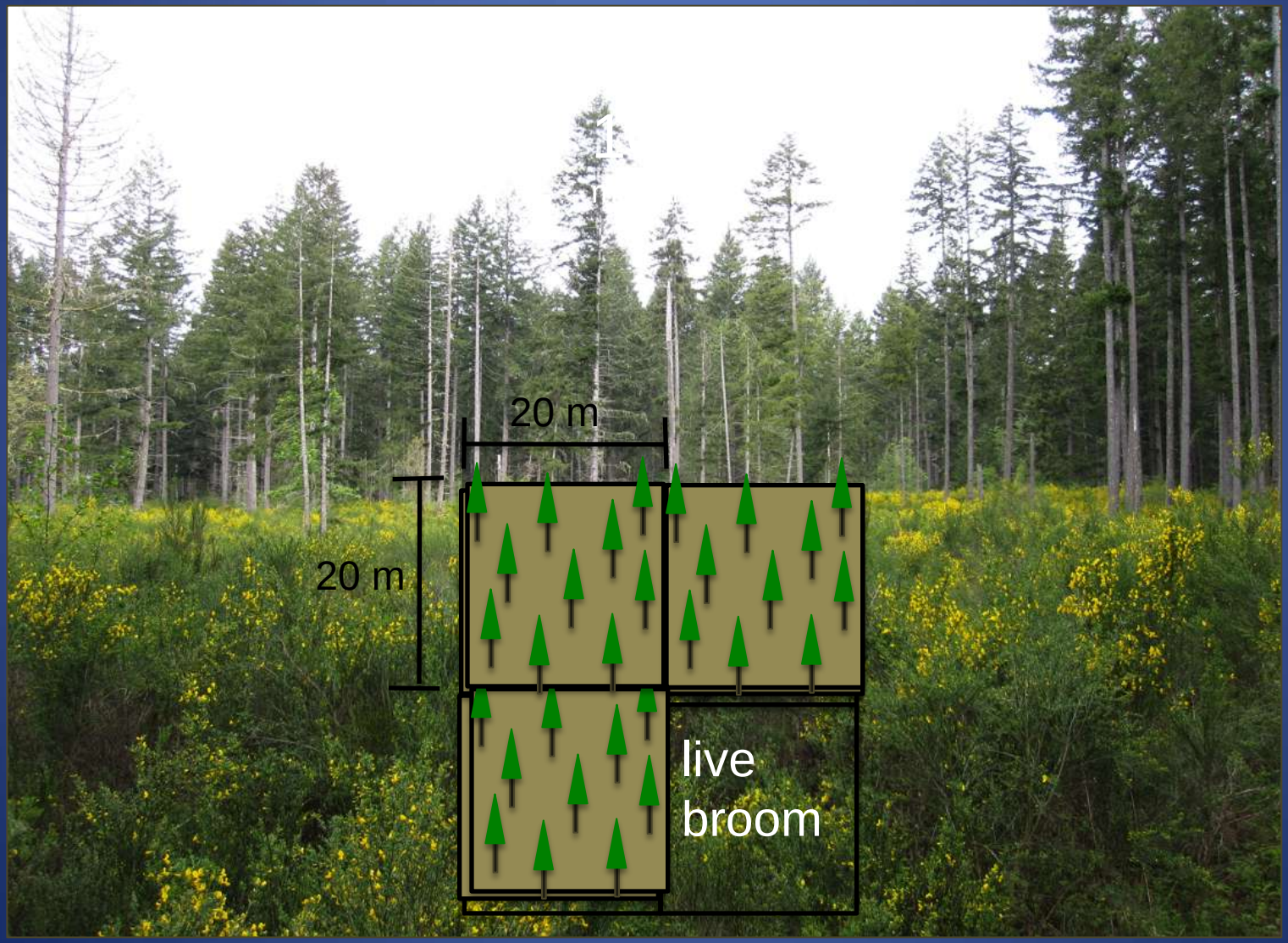
Douglas-fir survival

Big impact of invasion, but no effect of time

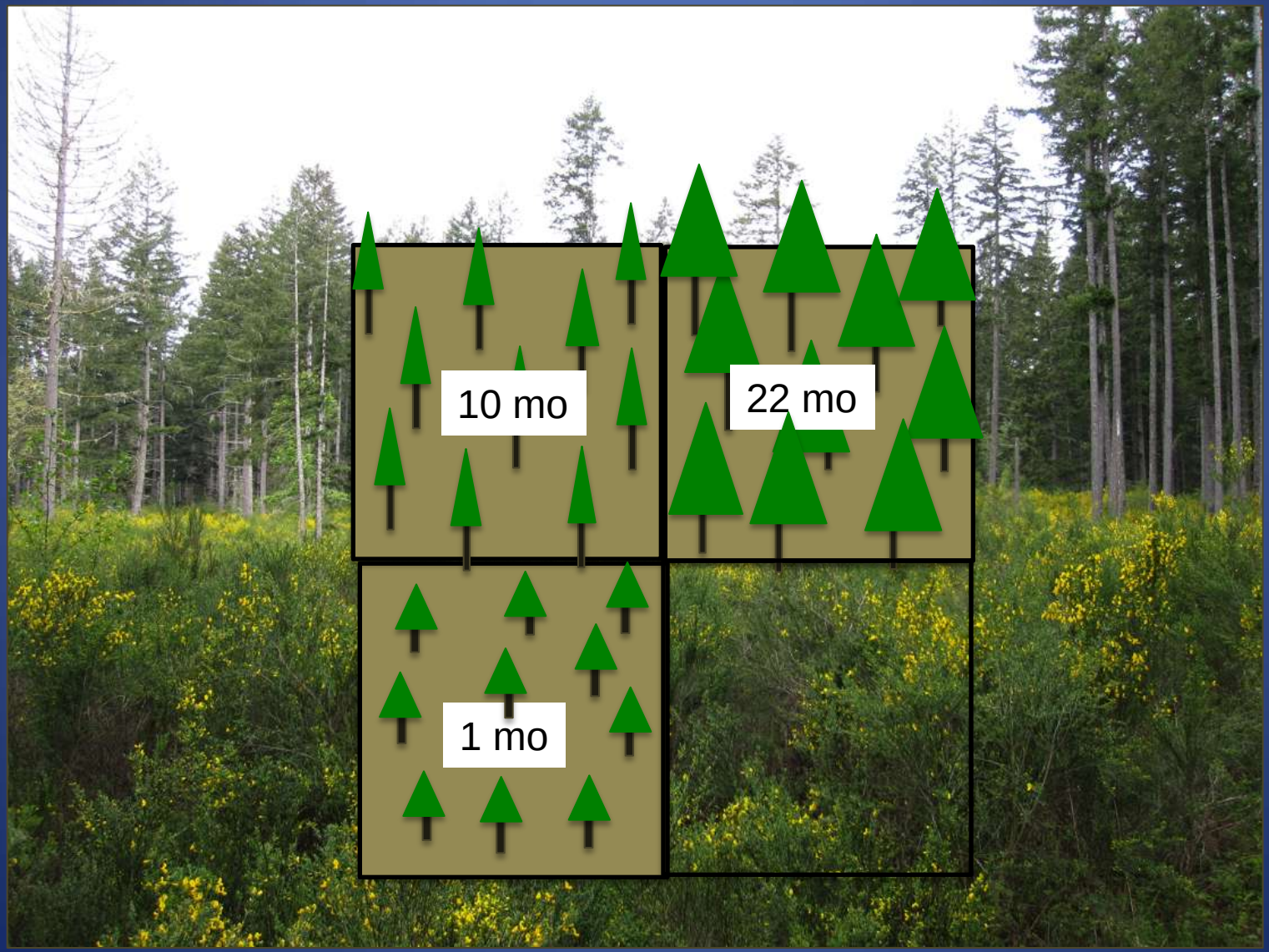


Grove et al. 2017 Journal of Plant Ecology

How long do the legacy effects of Scotch broom persist after its been removed?



Expected soils to recover following removal, and trees to grow better where broom had been absent the longest

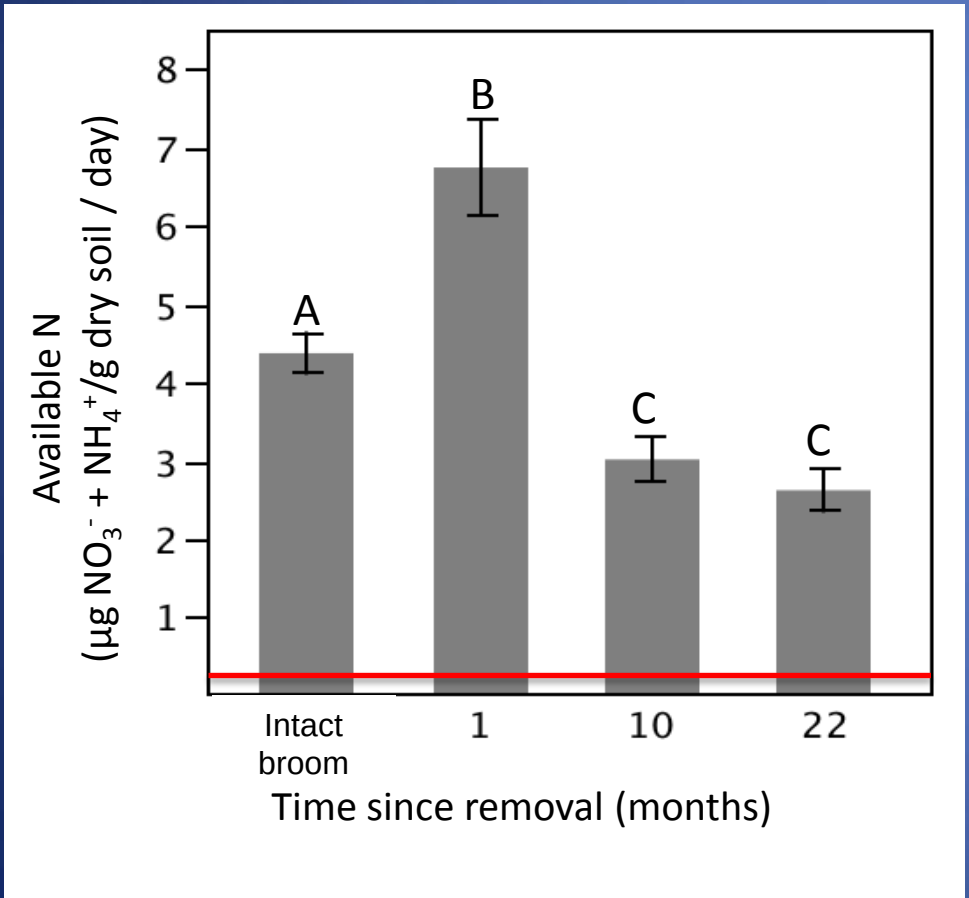


How long does the nitrogen legacy persist after broom removal?

Soil cores collected in field

Extracted plant available N

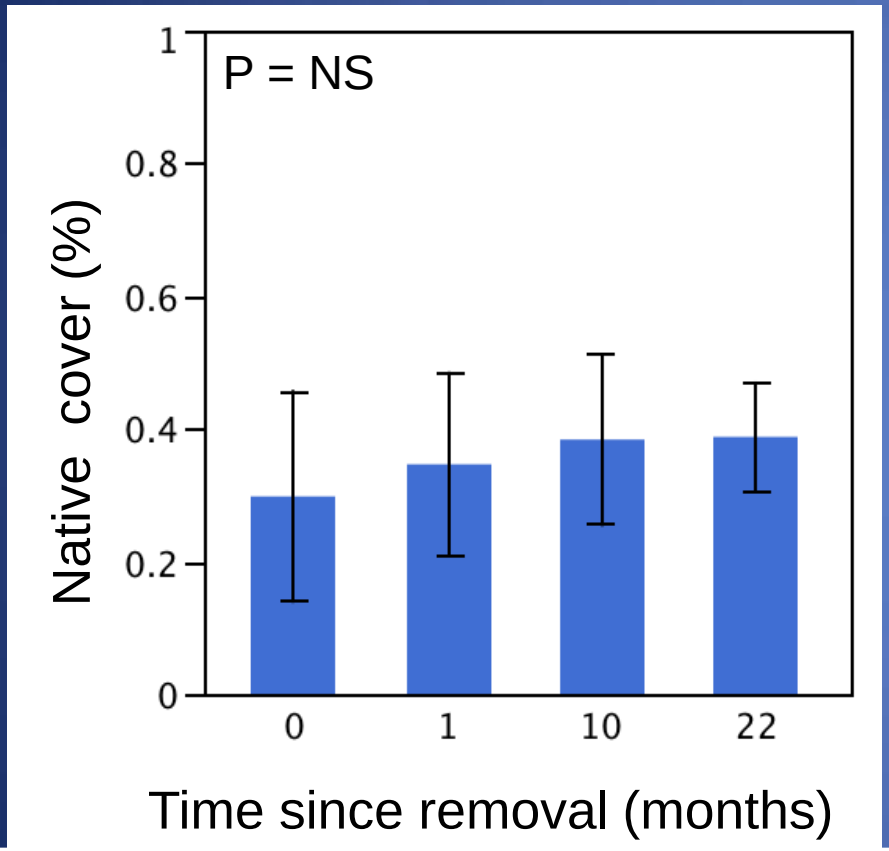
How did **N** change following broom removal?

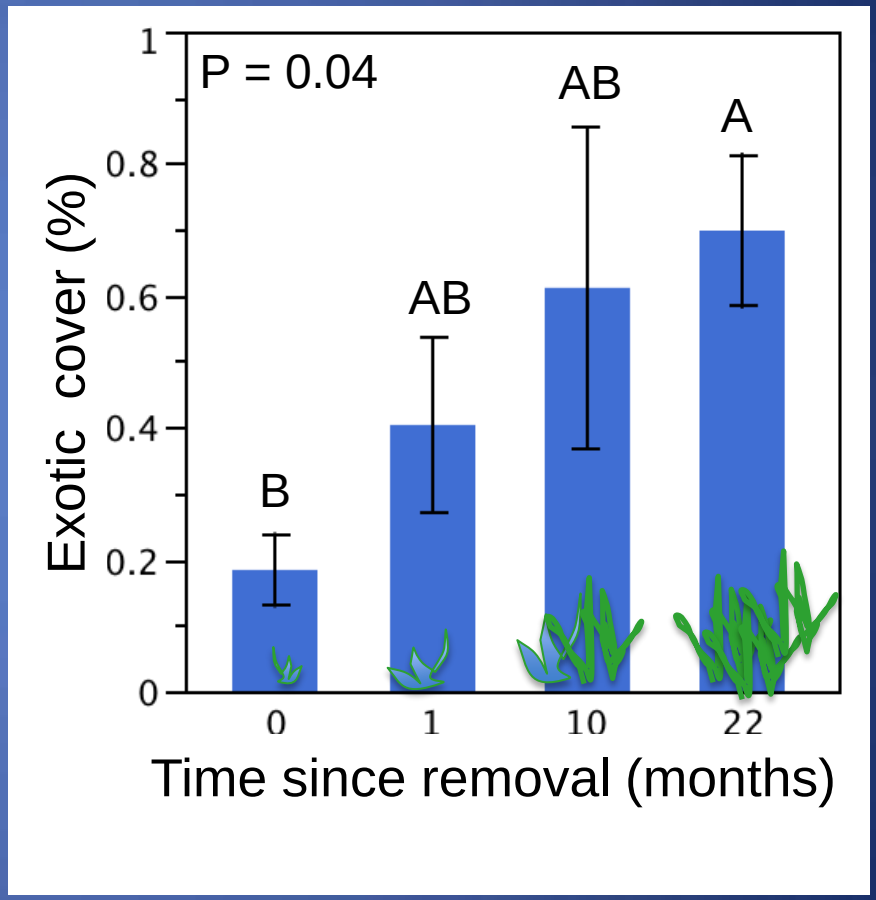


- An initial increase in N followed by a rapid drop at 10 months
- Rate of decline is either stabilizing or slowing.
- Elevated compared to uninvaded nearby forest soils (mean = 0.15 ug/g/day, SE = 0.04)

Grove et al. 2015 Biological Invasions

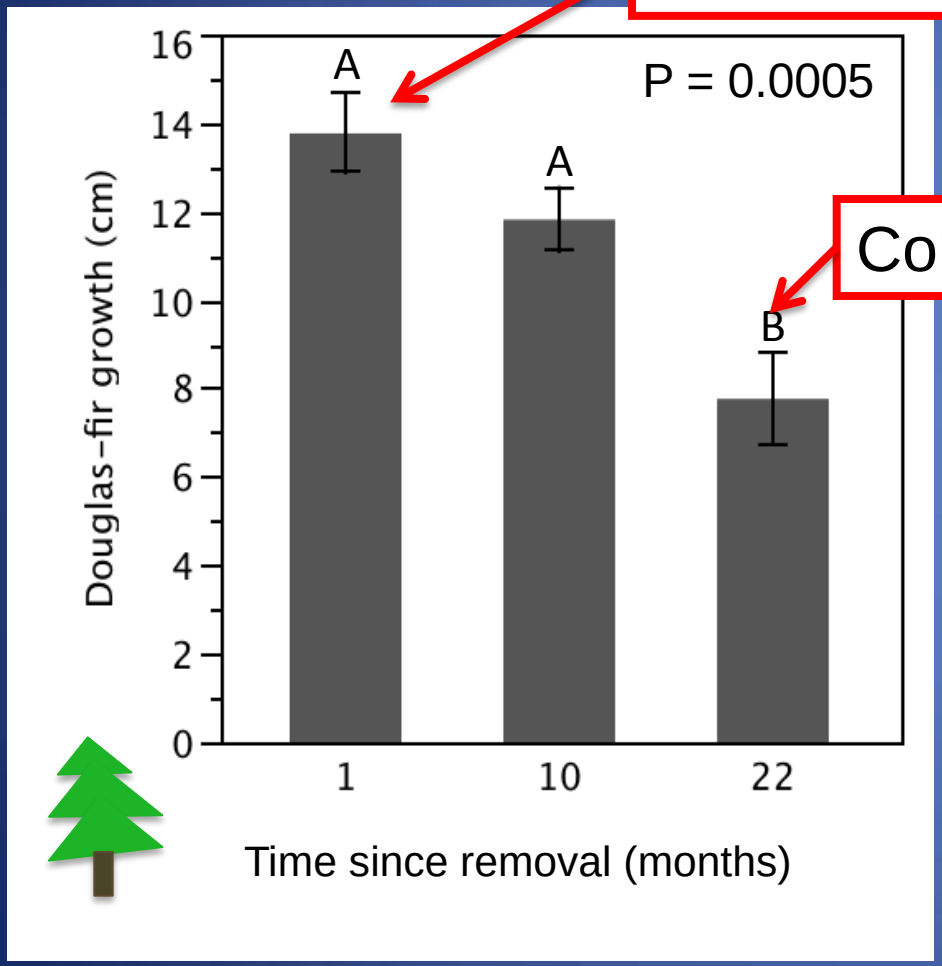
Exotic herbaceous species increased with time following broom removal





Grove et al. 2015 Biological Invasions

Doug-fir seedling growth



- Doug-fir grew larger in soils where broom was more recently removed
- After broom has been gone for ~2 years growth is suppressed

Grove et al. 2015 Biological Invasions

Conclusions

- Scotch broom changes nutrient pools, mycorrhizal fungal abundance, and these **impacts persist** following invader removal
- These persistent effects on soil **limit reforestation**
- These impacts of broom on nitrogen, EMF and DF growth **do not change with invasion age**
- Remove Scotch broom before they establish because the impacts they have on ecosystems **may not be (easily) reversible**

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Questions?