Alpine lupin (*Lupinus lepidus*)
Arrived: 1981

This lupin has many adaptations that allow it to succeed on pumice when no other plant can!

- N-fixation
- Phosphorus acquisition
- Drought avoidance mechanisms
- Self-fertile

- Compared other lupins: Better dispersed, less defended (tradeoffs!)

Lupins spread!

Is system nutrient limited?

Experiment: add nitrogen or phosphorus

(repeated 2002-2006)

- Community N-limited
- Lupin is P-limited

→ Ecosystem N is limited by P

7 years after stopping experiment – no visible effect.

Undeveloped soils cannot retain nutrients!

Other plants could only grow in dead lupins!

Sedum oreganum

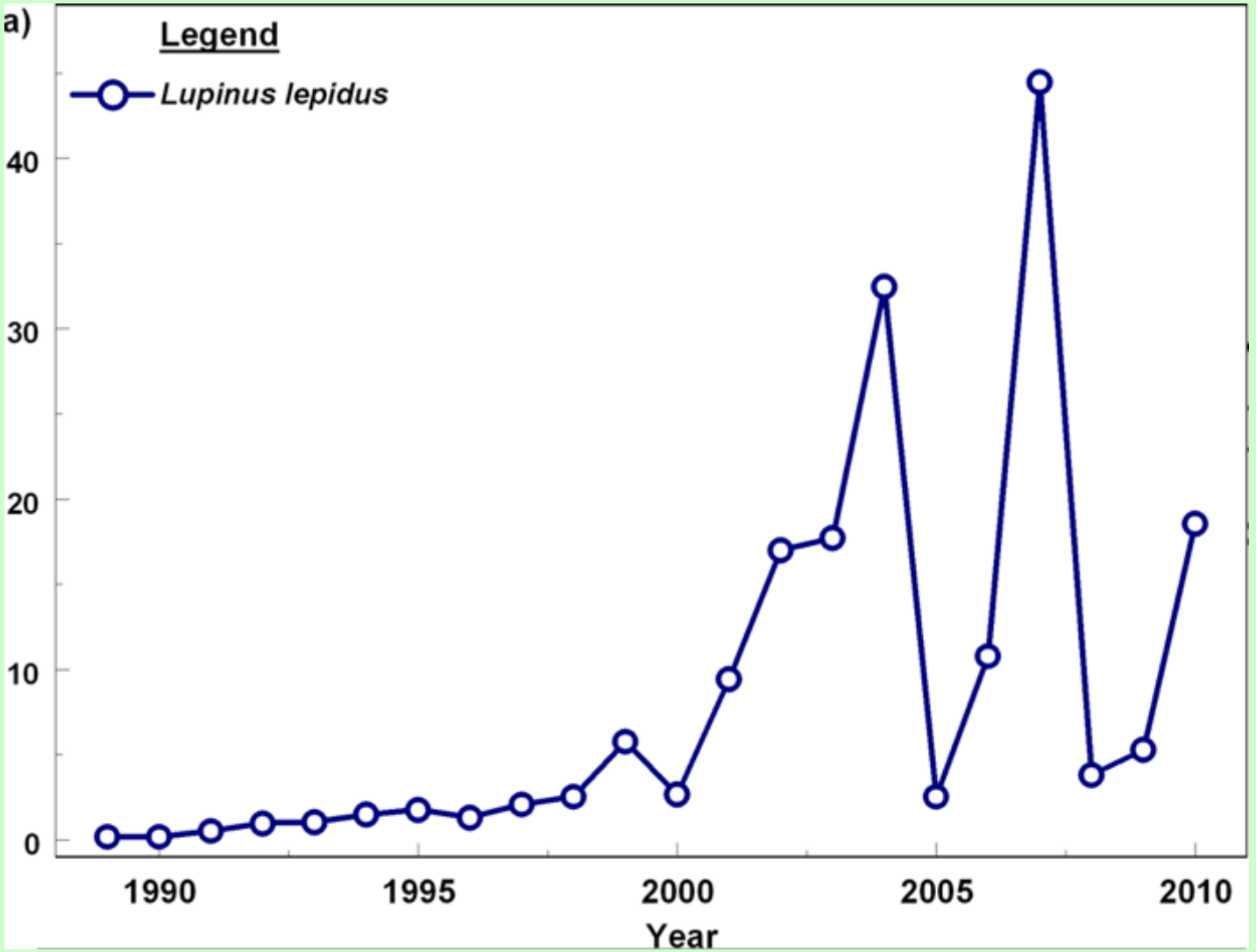
Spiranthes romanzoffiana

Western white pine

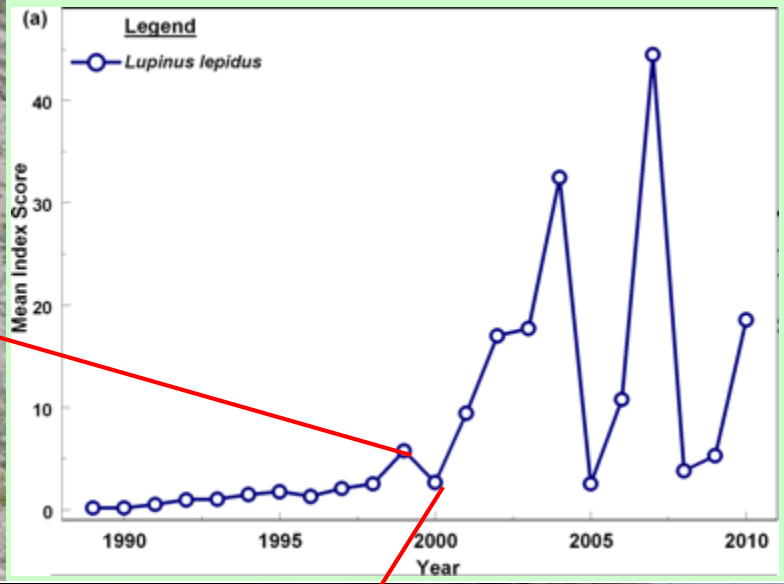
Lupins create soil that other species require to colonize

Lupinus lepidus population dynamics

% Cover by Lupin



Data from Roger del Moral, University of Washington


(a)
Legend
Lupinus lepidus
Mean Index Score
0
10
20
30
40
1990
1995
2000
2005
2010
Year

Specialist Root Boring Caterpillars

Hystricophora nr. *roessleri* (Tortricidae)

Grapholita lana (Tortricidae)

LEAF MINER REMOVAL → Density explosion

Removal: 3.3x increase yr^{-1}

Control: 0.36x decrease yr^{-1}

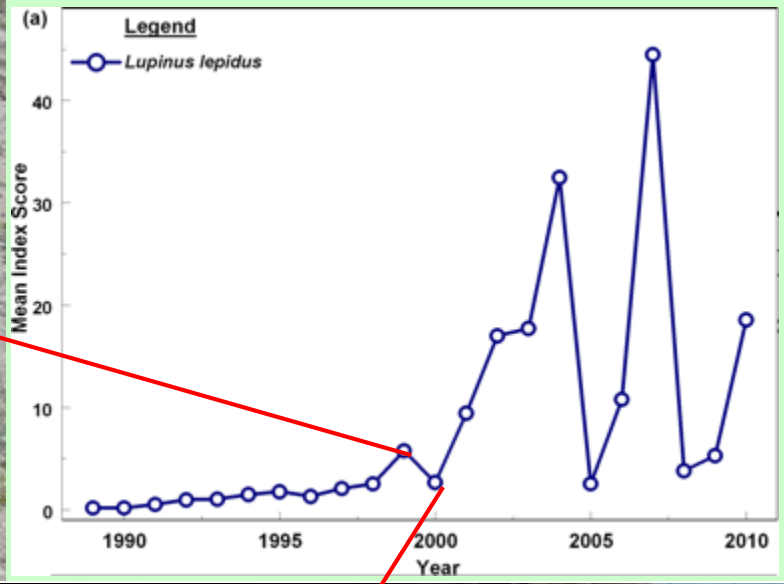
August 3, 2004

Fagan and Bishop 2000. *American Naturalist* 153: 238-251

Bishop 2002. *Ecology. 83: 191-202*

Bishop et al. 2005. *in Ecological Responses to the 1980 Eruptions of Mount St. Helens*

Fagan et al. 2005. *American Naturalist.* 166: 669-685

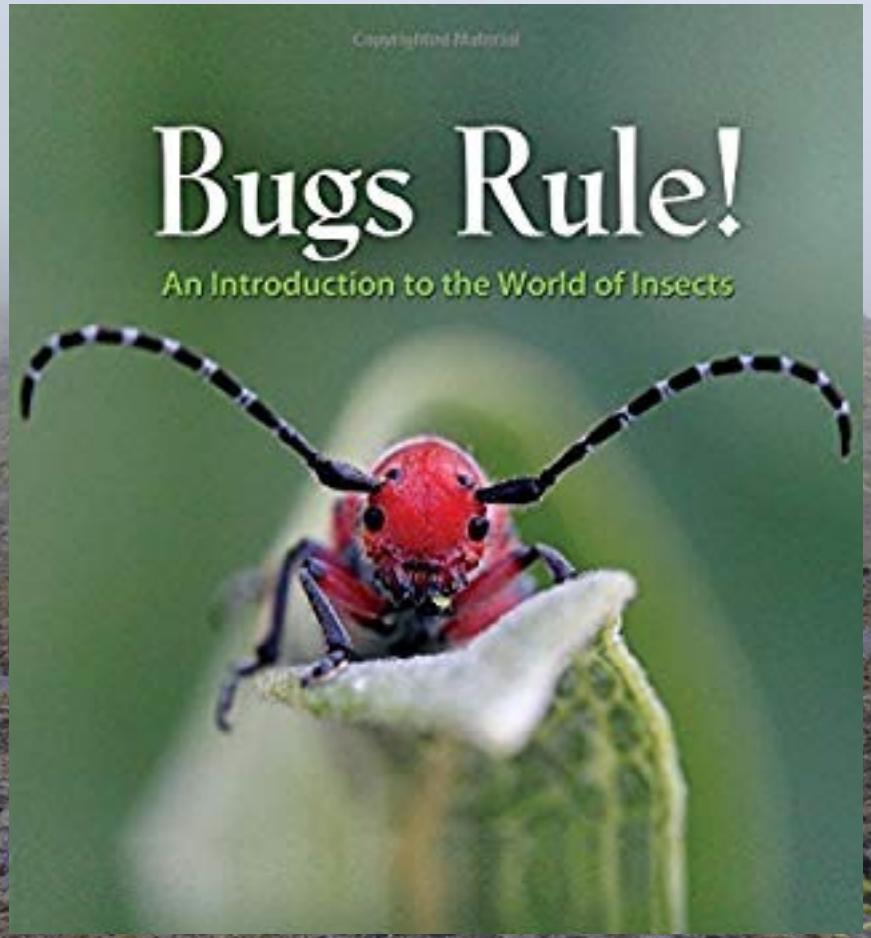


Our data show:

- Each crash caused by insects
- Crashes slowed spread across landscape
- Still occurring after 25 years! (but in smaller areas)

Conclusion:

Conclusion:



Sitka Willow *(Salix sitchensis)*

July 2010


Cryptorhyncus lapathi
(Curculionidae)


Paranthrene robiniae (Sesiidae).

After 10 years of borer exclusion (2017)

Sprayed

Not
Sprayed

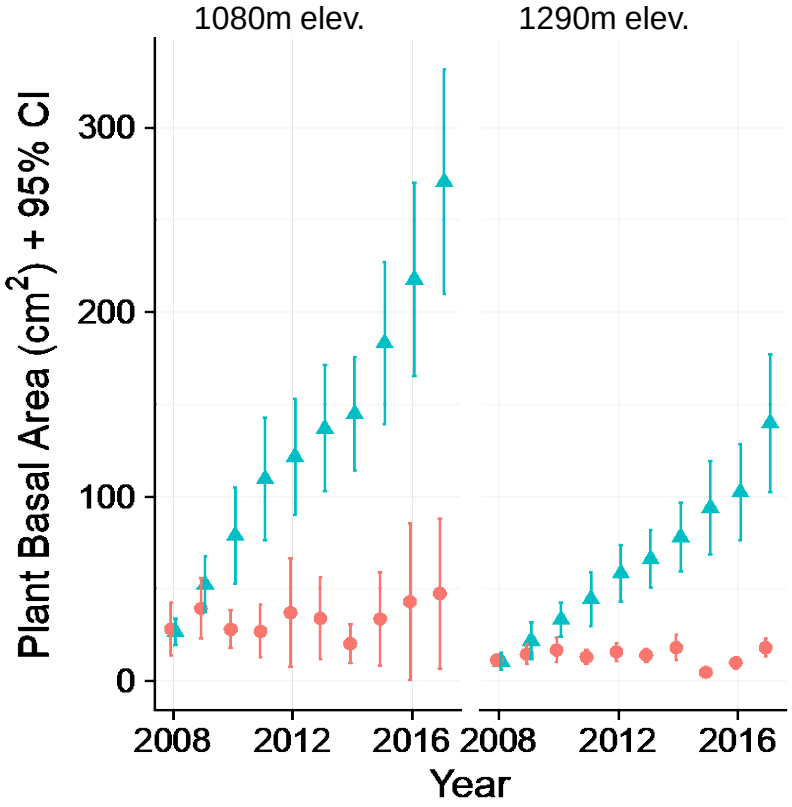
Control plot, 2014

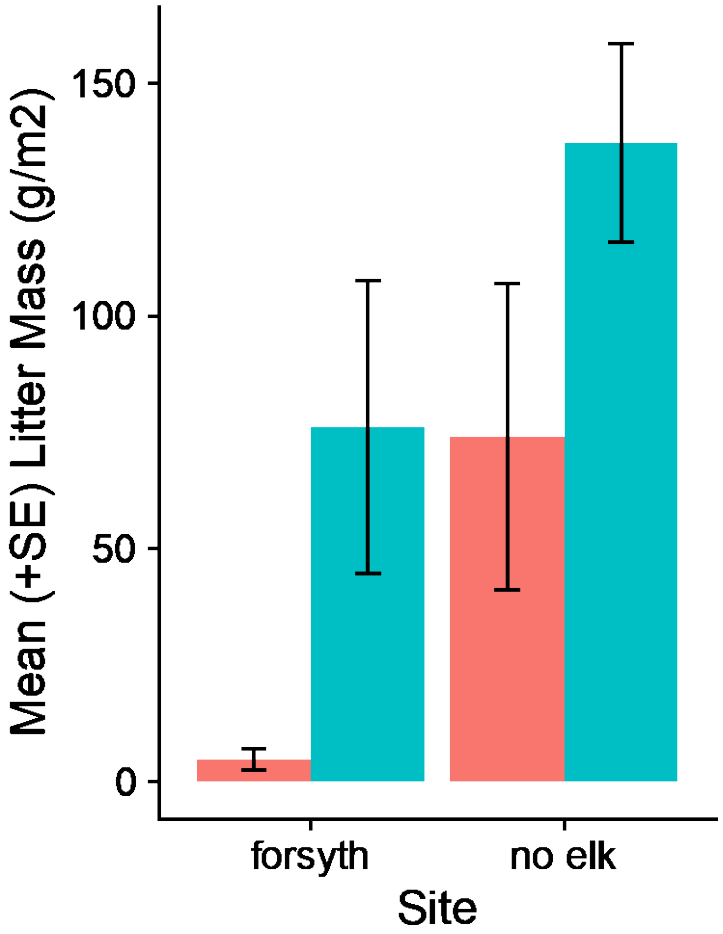
71 willows in 2008, 4 in 2016

Willow borer exclusion (2018, year 11)

Same plots in Google Earth →

Control plot in foreground, Protected plot in background


1080m elev.
1290m elev.
Plant Basal Area (cm^2) + 95% CI
300
200
100
0
2008
2012
2016
2008
2012
2016
Year

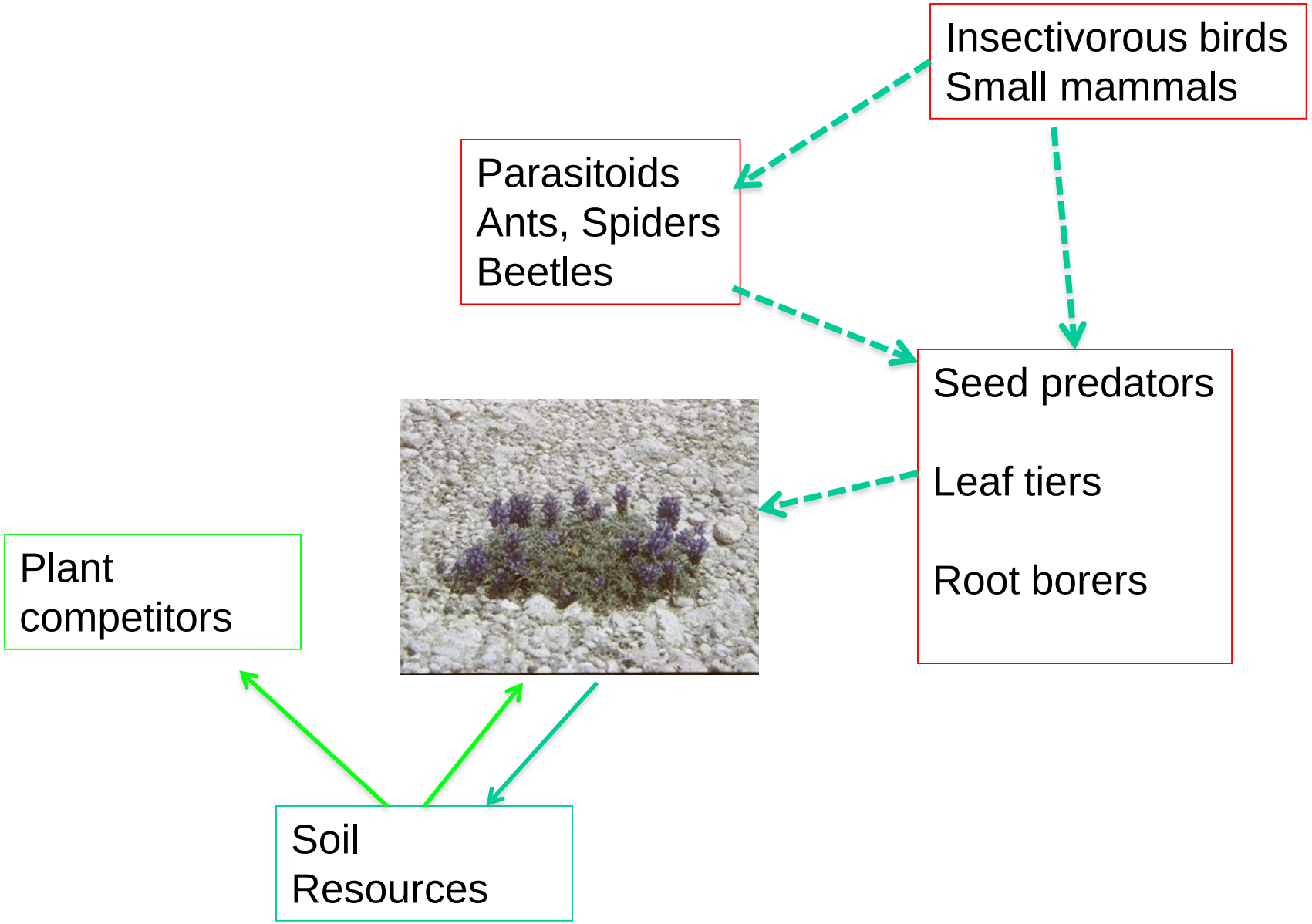

Mean (+SE) Litter Mass (g/m2)
150
100
50
0
forsyth
no elk
Site

Year 11 Litter Layer in 400 cm^2 @ 0.5m from base

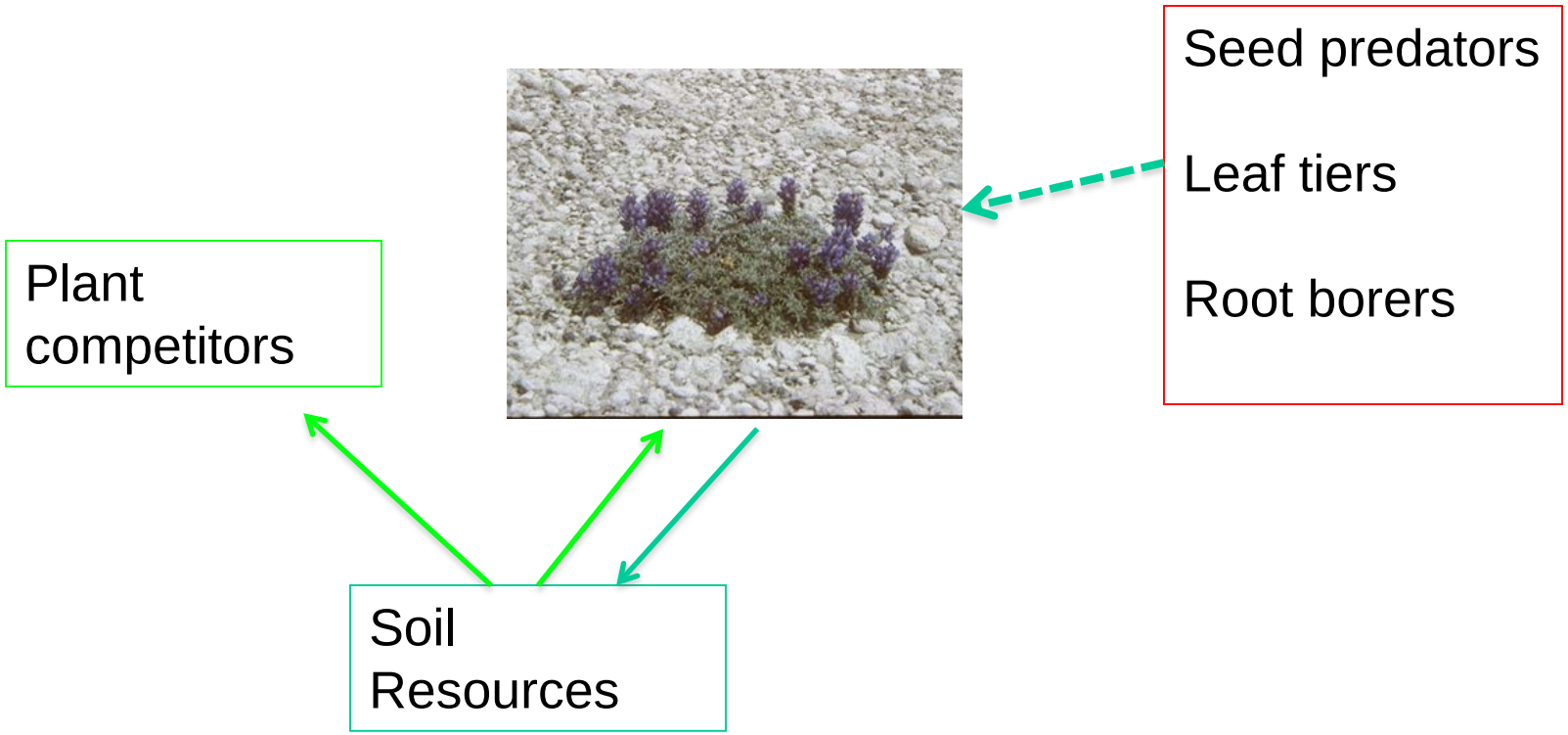
Typical control

Typical sprayed plant

Do early successional interaction webs promote extreme dynamics?



Do early successional interaction webs promote extreme dynamics?



Hypothesis: Low community complexity in early succession promotes extreme interactions

If true →

- Extreme herbivore effects involving multiple hosts
- Effects should diminish with system maturity
- Less effect in secondary succession
- Should occur in other primary successions

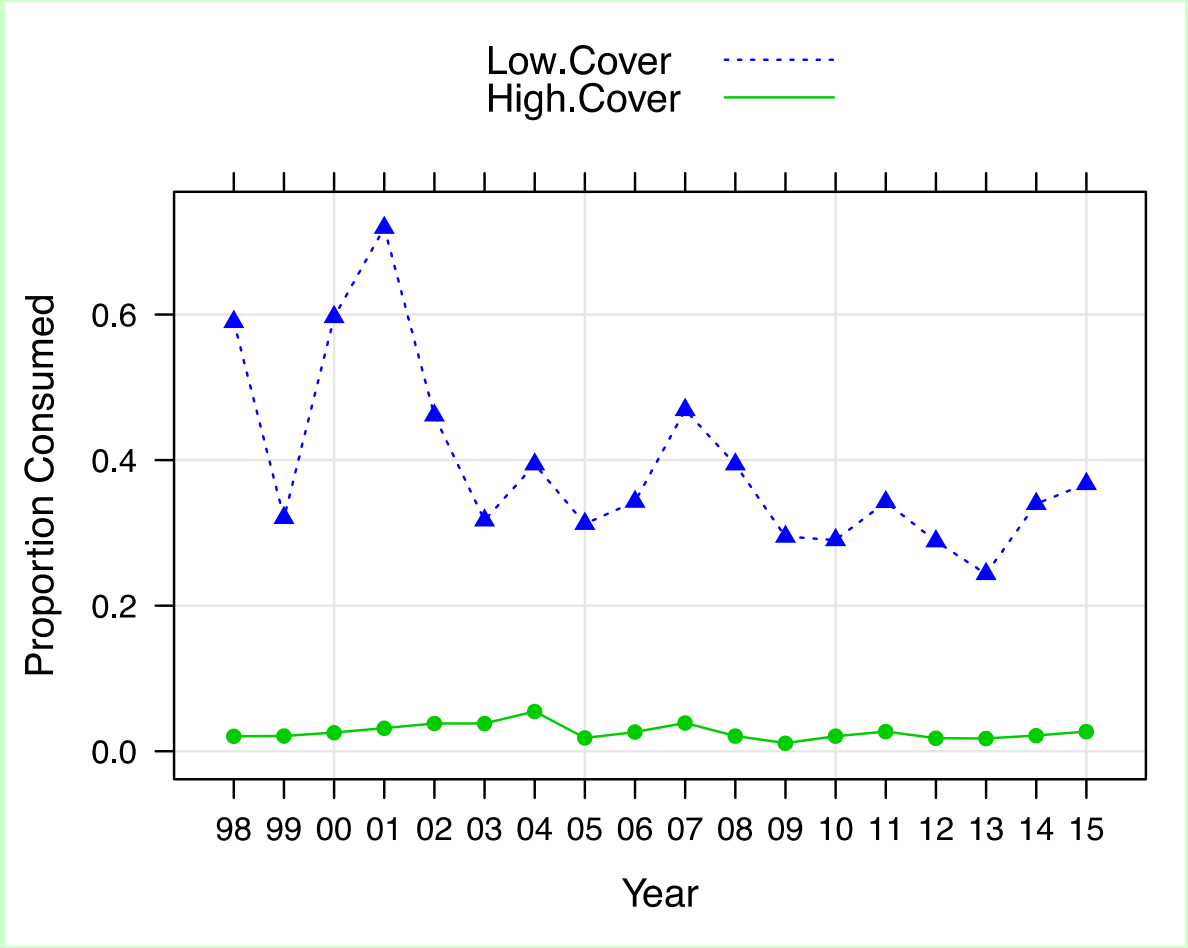
Seed predators

Leaf tiers

Root borers

Soil Resources

Leaf Miner Damage Surveys: ~160 sites/year for 17 years

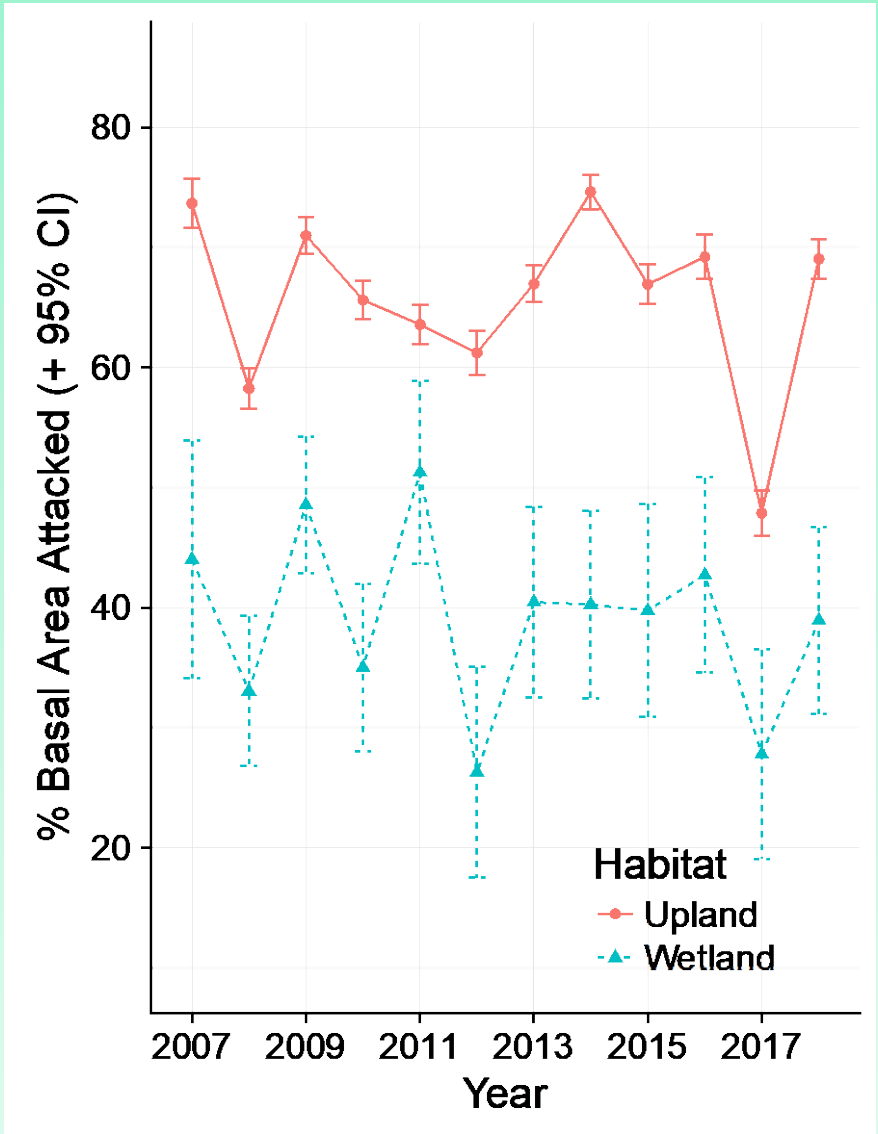


- High chronic damage
- High heterogeneity
- Diminished by community development

Weevil Damage Survey: 154 plots on 9km transects

~620 plants/year

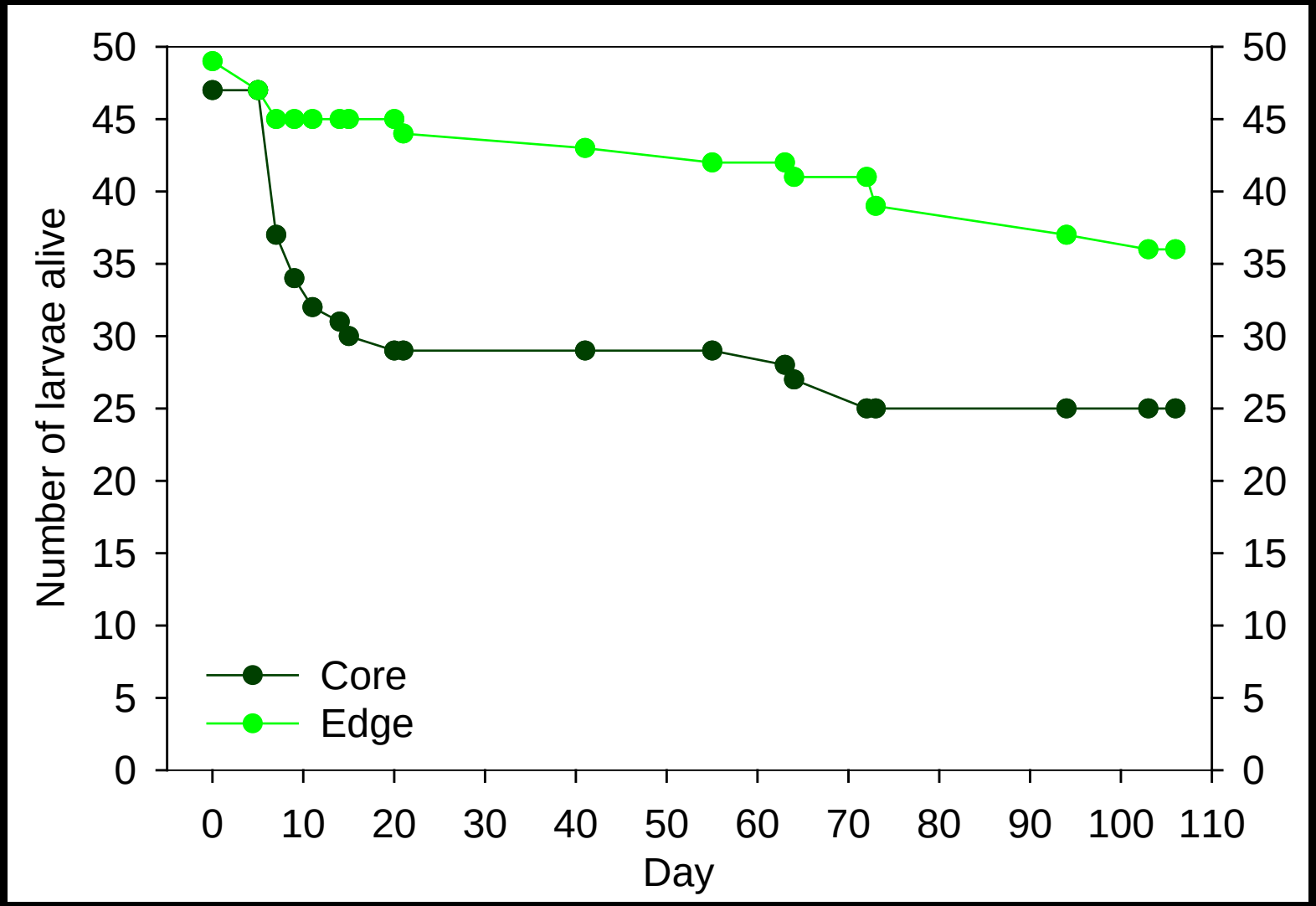
~64% of all stem area is attacked




High density patch


Low density patch

Larval mortality

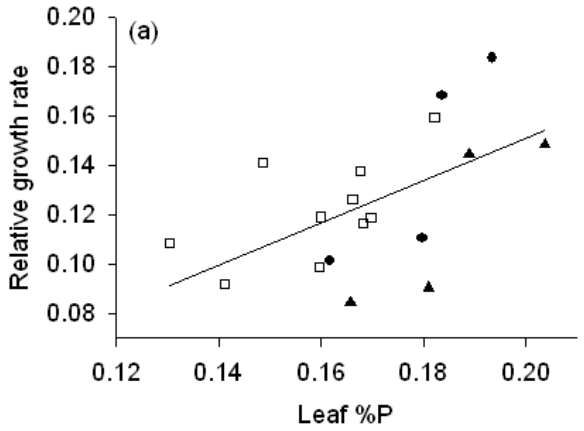


Tarone-Ware log-rank test:
$\chi^2 = 4.888$, $p = 0.027$

Paradox of Enrichment:
High Density compete for P!
Have less P/g leaf

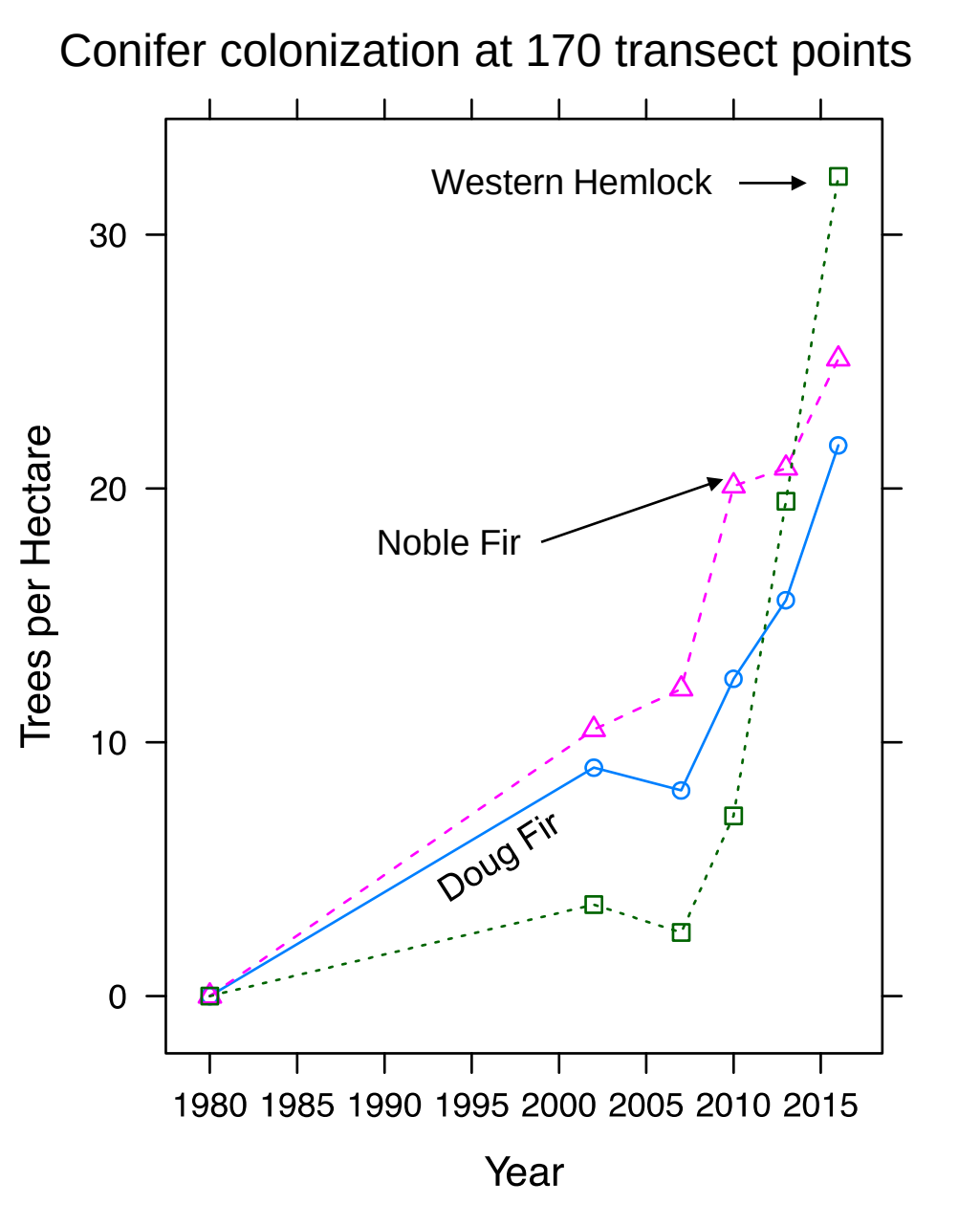
- Larvae are P limited

Figure 1



Summary of 151 un-redisturbed sites	1980	2007	2010	2013	2016	2018 Exclusions
Cover	0%	40%	45%	48%	67%	>100%
# of Species	0	78	107	137	155	
Moss %	0%	13%	26%	27%	26%	40%
Lupin %	0%	24%	11%	4%	18%	20%
Willow %	0%	6%	4%	4%	5%	50%

What Controls Establishment of a New Conifer Forest?



- <u>Three factors controlling conifers</u>

(Titus & Bishop 2014, Birchfield & Bishop unpub., Wenke & Bishop unpublished)

Seed limitation: adding Doug fir seeds led to high density of doug fir.

Competition: Doug fir couldn't establish in thick lupins or under shrubs

Environmental conditions:
1) Fir trees more likely on steep north facing slopes (higher moisture availability)

2) Hemlock seeds have always blown in, but only started establishing in year 30! Typically in locations where soil is developing.

Monument Act (1983):
allow “the natural recovery of the volcanic landscape, to the benefit of public and scientific understanding”

“protect the geologic, ecologic, and cultural resources.”