Knotweed Invasion in PNW Riparian Forests: Ecological Effects and Restoration Outcomes

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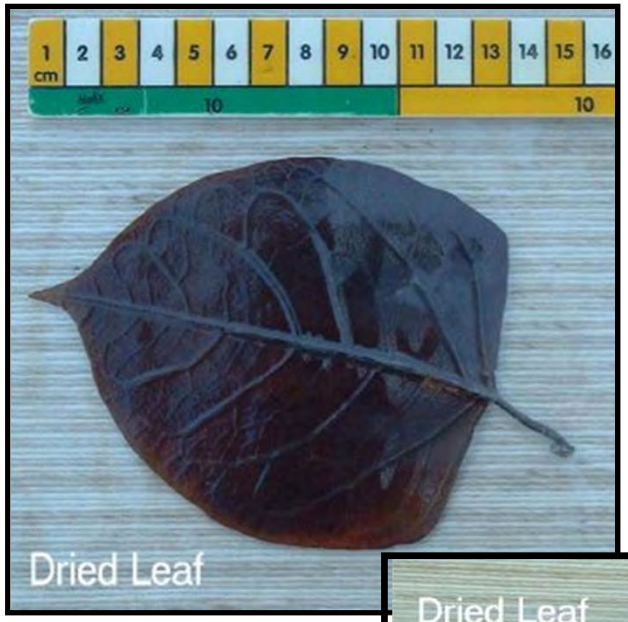
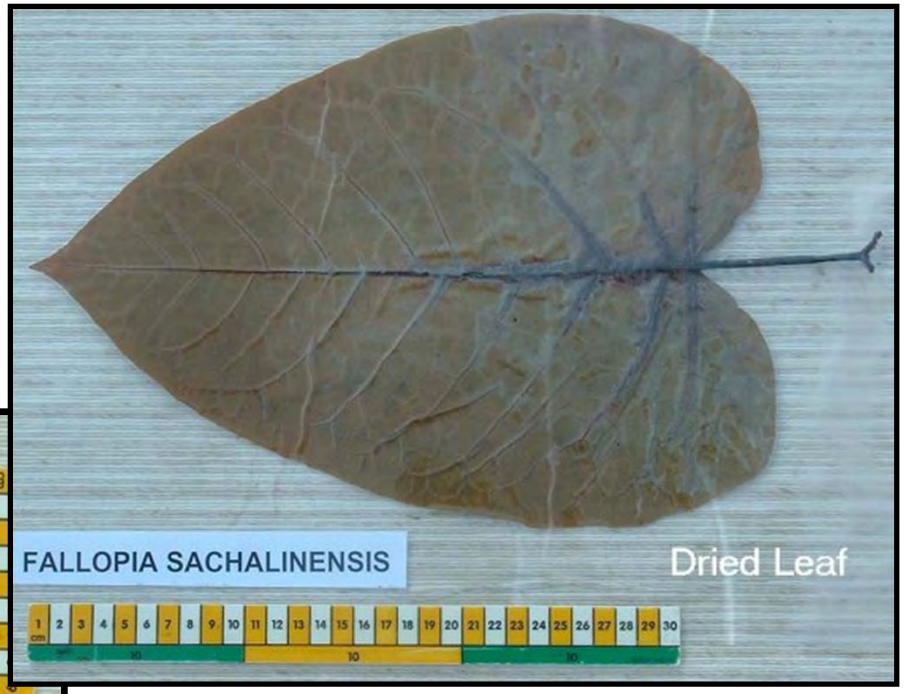
Japanese Knotweeds

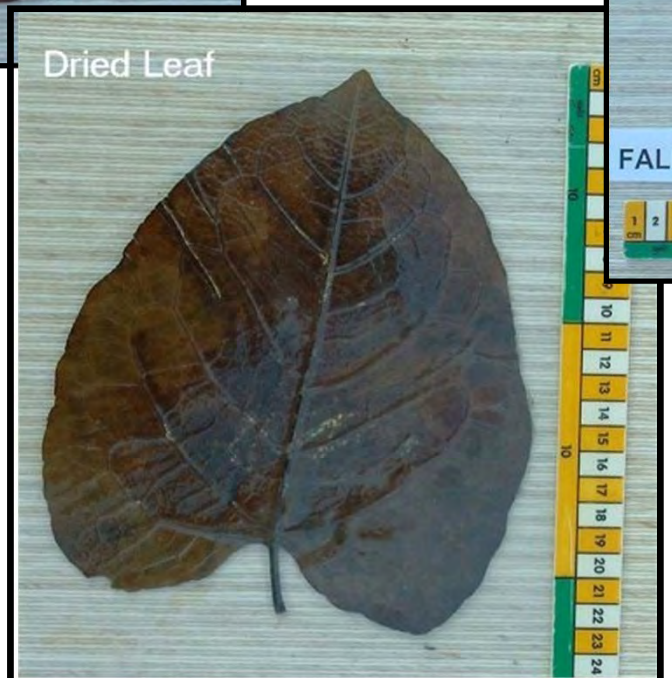


Japanese Knotweed

(*P. cuspidatum*)

Giant Knotweed (*P. sachalinense*)





Bohemian

Knotweed (*P. x bohemicum*)

http://www.ex.ac.uk/knotweed/

Knotweed Characteristics

Tall herbaceous perennial
Early, rapid emergence
Forms dense, thickets
Extensive rhizome system
Vegetative regeneration
Woody ligneous stems
Allelochemicals

My Research

I. Vegetation response to knotweed removal

- Is knotweed removal alone adequate to support native recovery?
- Variation in response?

II. Effects on tree regeneration

- Does knotweed inhibit tree seedling survivorship and growth?
- Why?
- Differences across species?

I. Understory response to bohemian knotweed (*Polygonum x bohemicum*) removal

Introduction

Knotweed removal is a common approach to riparian restoration

Often assume removal alone will promote native recovery

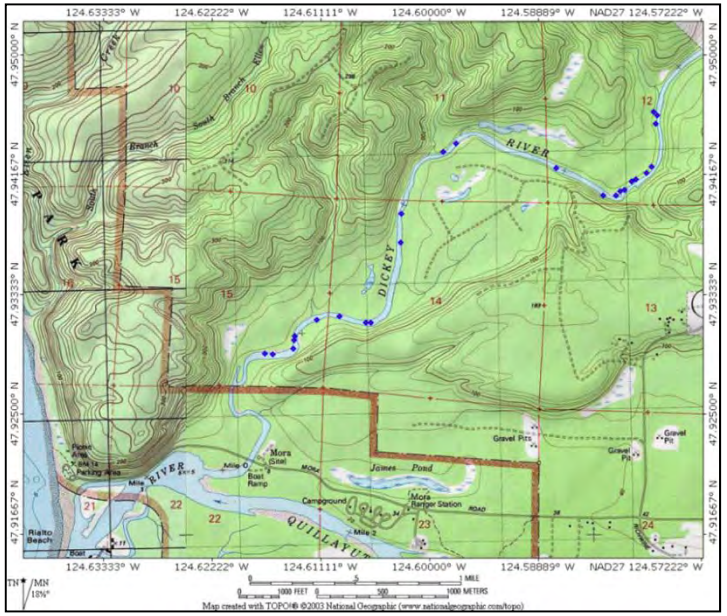
Study Questions

1. How do riparian understories respond to knotweed removal?
    - Deciduous and coniferous tree seedlings
    - Native and nonnative shrubs
    - Native and nonnative forbs

2. Do habitat factors and species traits influence responses to knotweed removal?
    - **Native and non-native species

Study Site

Dickey River
Olympic Peninsula



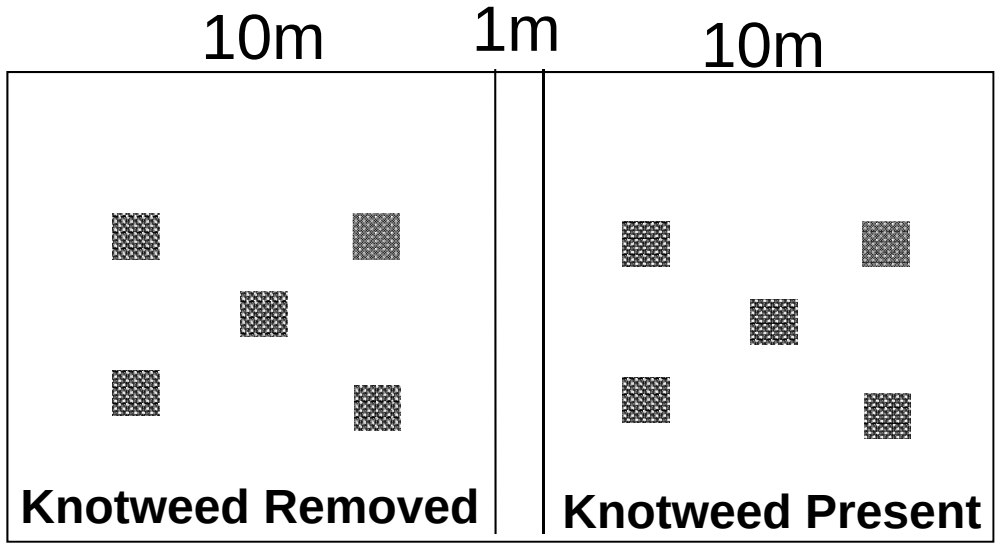
Quileute Tribe restoration project (2003)

Methods - Experimental Design

25 plot pairs (blocks)

½ knotweed removed

Before, 1 & 2 years after



Methods - Habitat Factors

Habitat factors

Height above channel

Litter depth

Canopy light

Flood disturbance

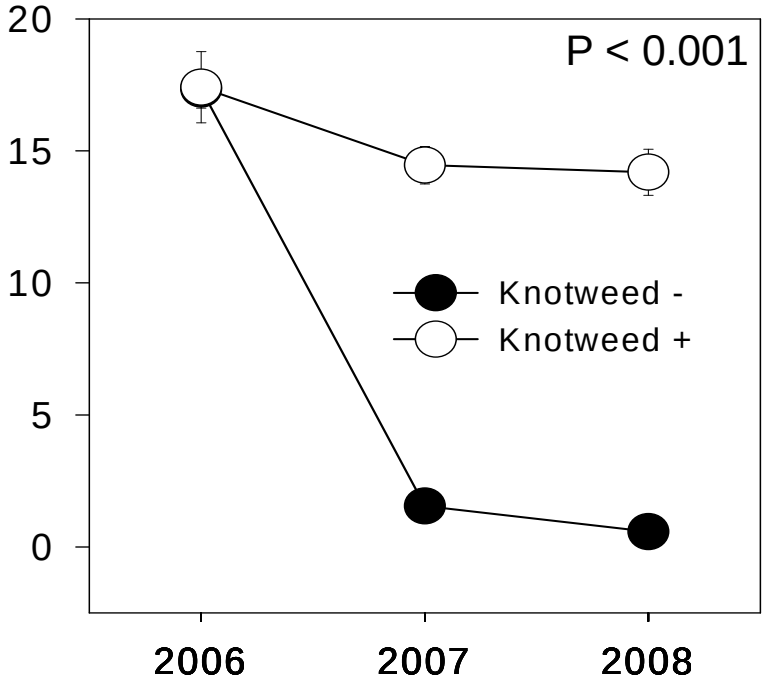
Methods – Species Traits

<u>Plant traits</u>
Life-form
Origin
Habitat
Life-span

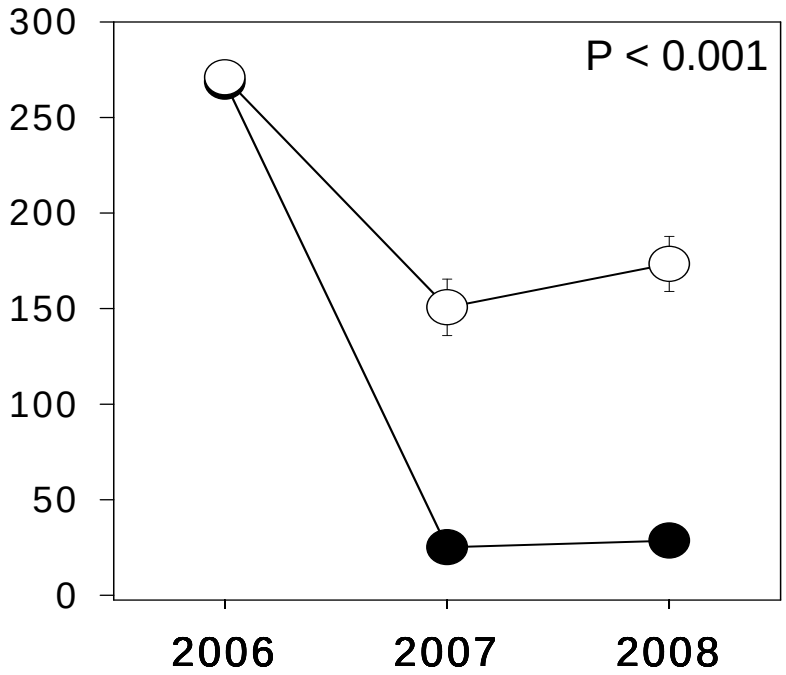
Results – Knotweed Treatment

Knotweed treatment is effective

Knotweed Density #/m^2



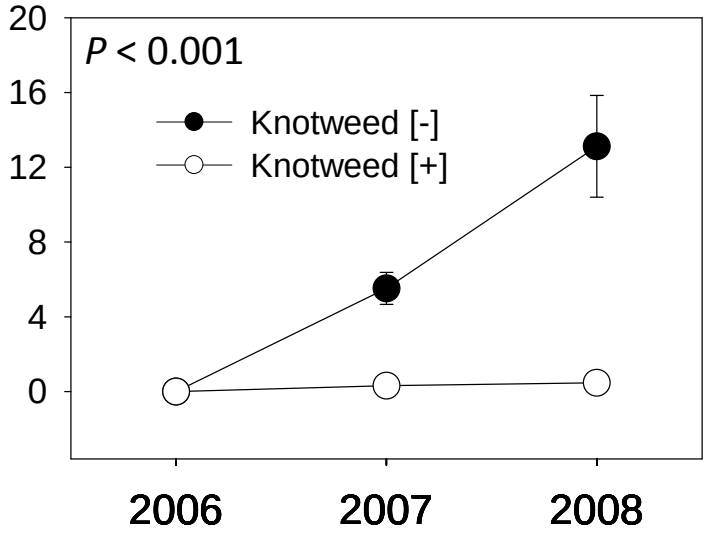
Knotweed Height (cm)



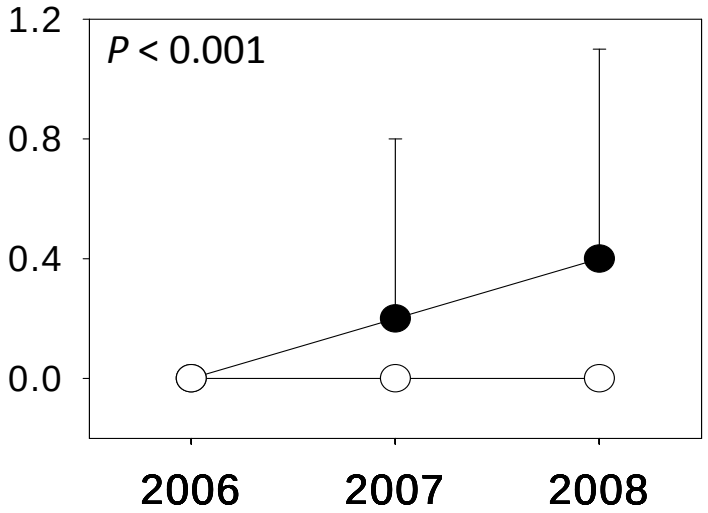
Paired permutation tests $P \leq 0.05$

Results – Vegetation Response

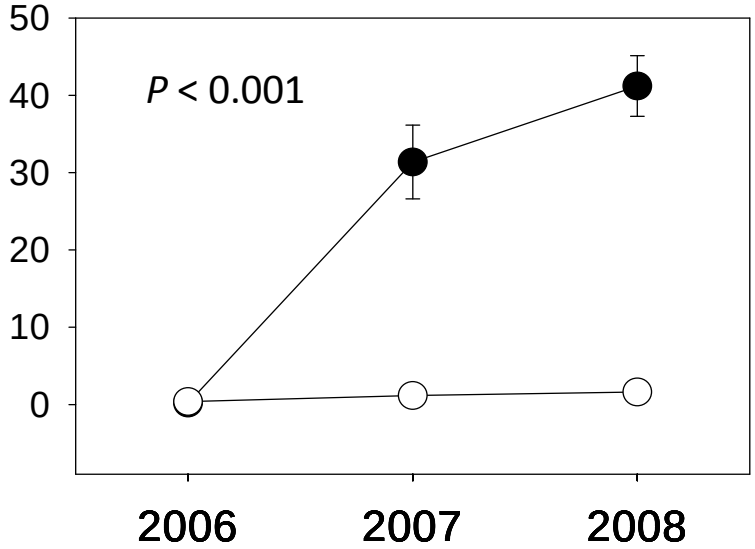
Deciduous Seedlings (#/5m^2)



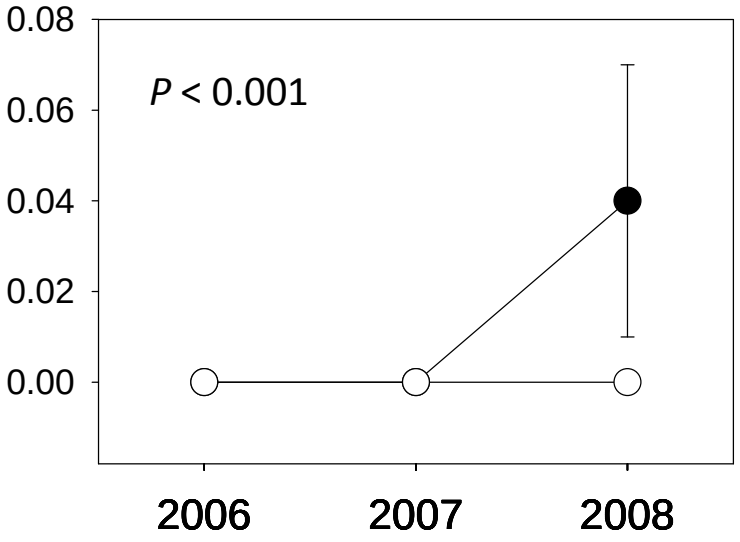
Coniferous Seedlings (#/5m^2)



Native Shrub Cover (%)

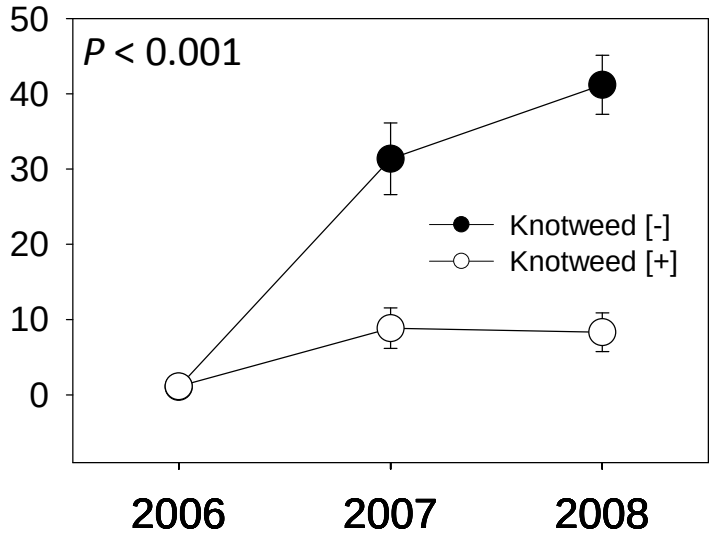


Nonnative Shrub Cover (%)

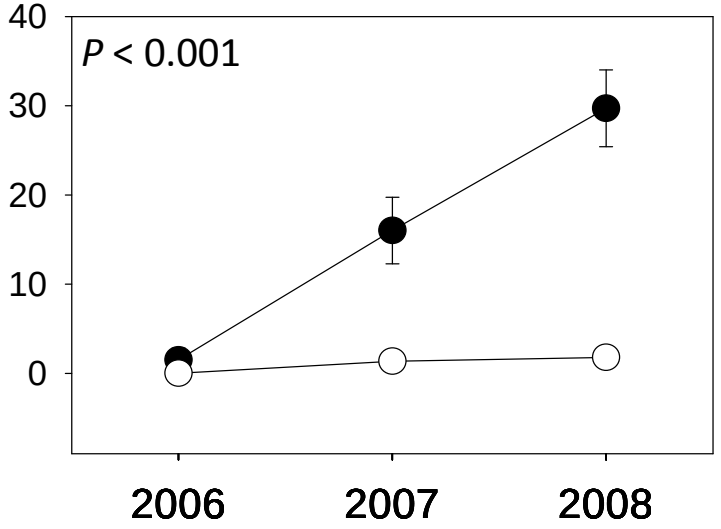


Results – Vegetation Response

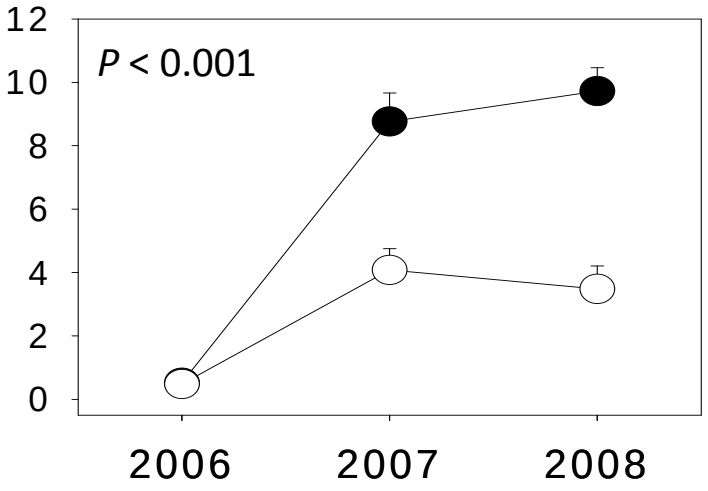
Native Forb % Cover



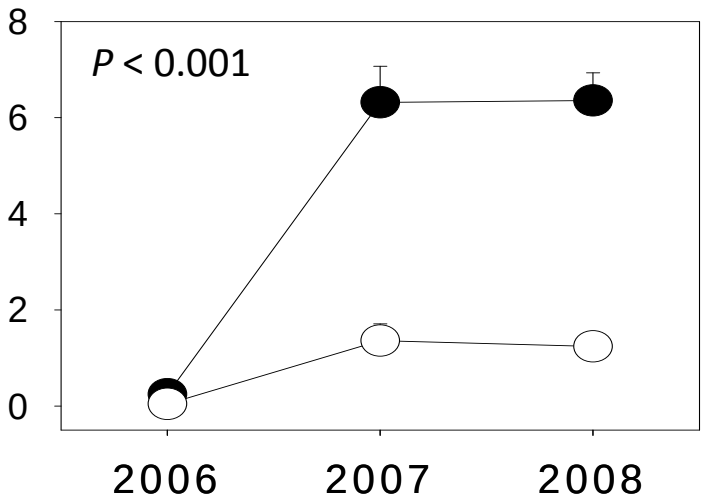
Nonnative Forb % Cover



Native Forb Species Richness



Nonnative Forb Species Richness



Results – Habitat Factors

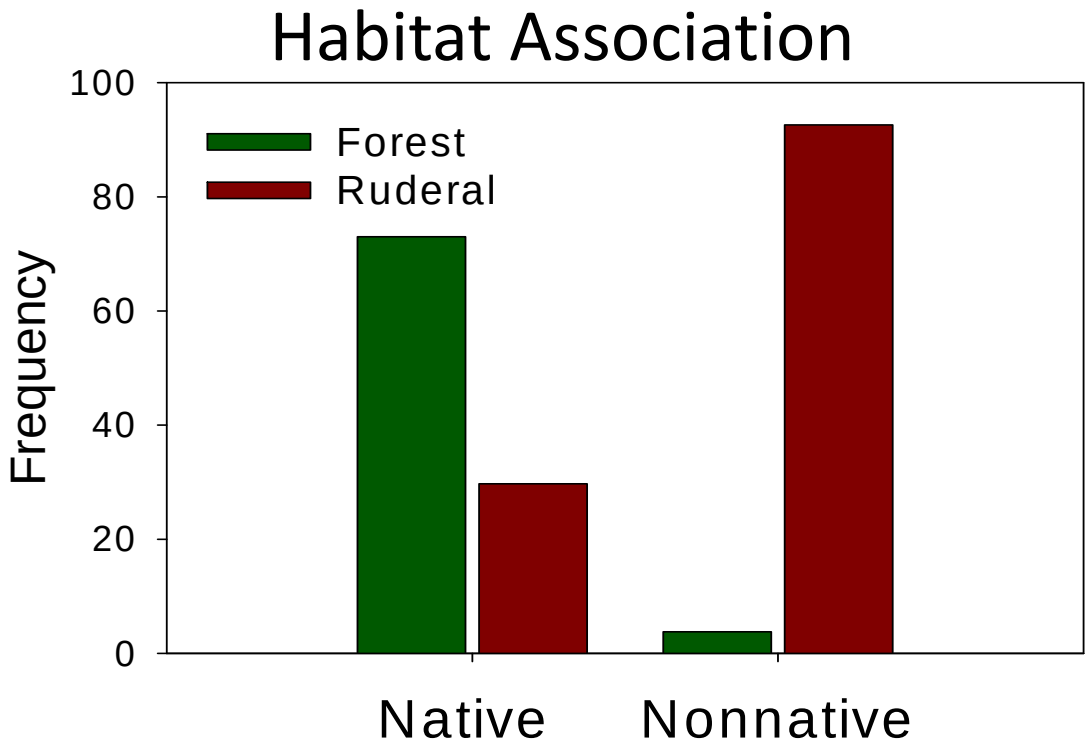
Knotweed Litter Depth was a Key Factor

	R^2	*P*
Native:Nonnative Cover	0.52	<0.001
Native:Nonnative Richness	0.52	<0.001

Results – Plant Traits

Natives - Forest associated species

Nonnatives - Ruderals



$\chi^2 < 0.001$

Summary and Conclusions

1. How do riparian understories respond to knotweed removal?
    - Significant and immediate response
    - Native and nonnative species
    - Base-line data
2. Do habitat factors and species traits influence understory responses – particularly the responses of native and nonnative species?
    - Yes
    - Knotweed litter benefitted natives
    - Species traits influenced response

II. Effects *Polygonum x bohemicum* on native tree seedlings

Introduction

Knotweed seedling interactions

Shade Tolerance & Seral Stage

Picea sitchensis

Alnus rubra

Tsuga heterophylla

Nitrogen Deficiency Tolerance

(Minore 1979)

Introduction

Multiple mechanisms

Direct competition

- Light
- Soil resources

Allelopathic interference

- Disruption of fungal symbionts

Knotweed-seedling interactions

- Knotweed effects
- Natives response

Mycorrhizal Non-Mycorrhizal

Study Questions

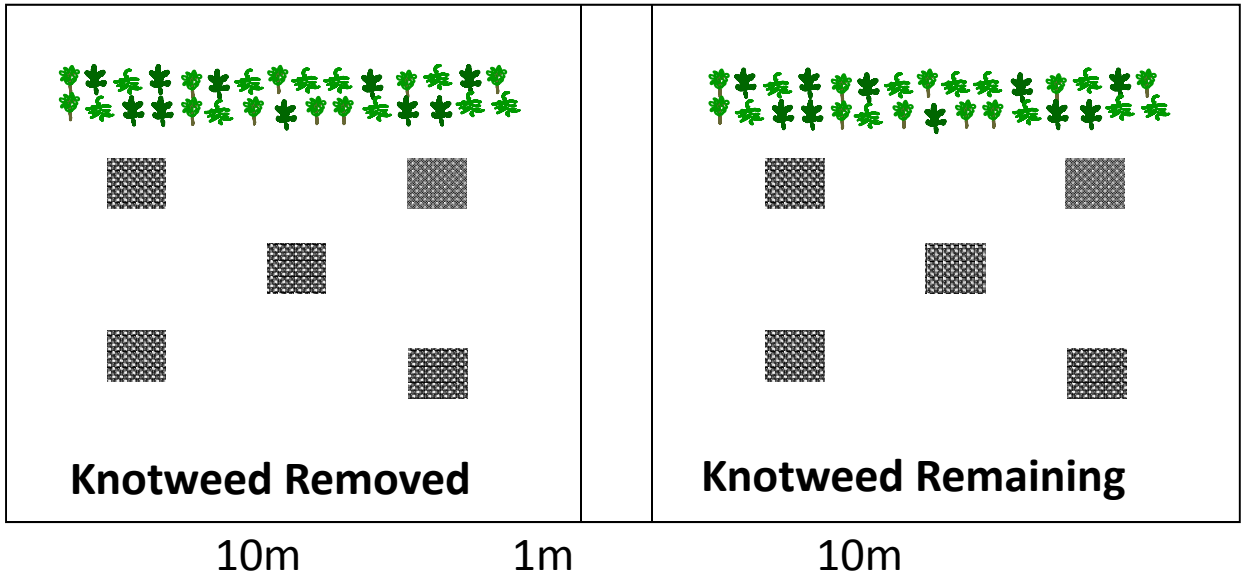
1. What are the effects of knotweed on understory light and soil properties?

2. Does knotweed reduce the survival and growth of native tree seedling?

3. Do tree species differ in their response to knotweed?

Experimental Design

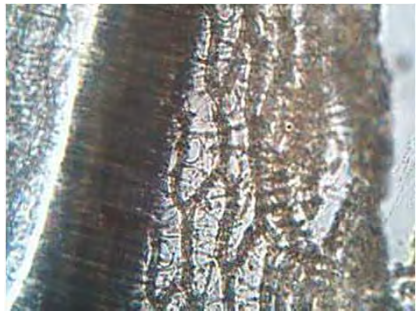
9 blocks x 2 treatment plots
3 tree species
2 growing seasons
Compared survival and growth



Methods - Mechanisms

Light

Soil Nutrients



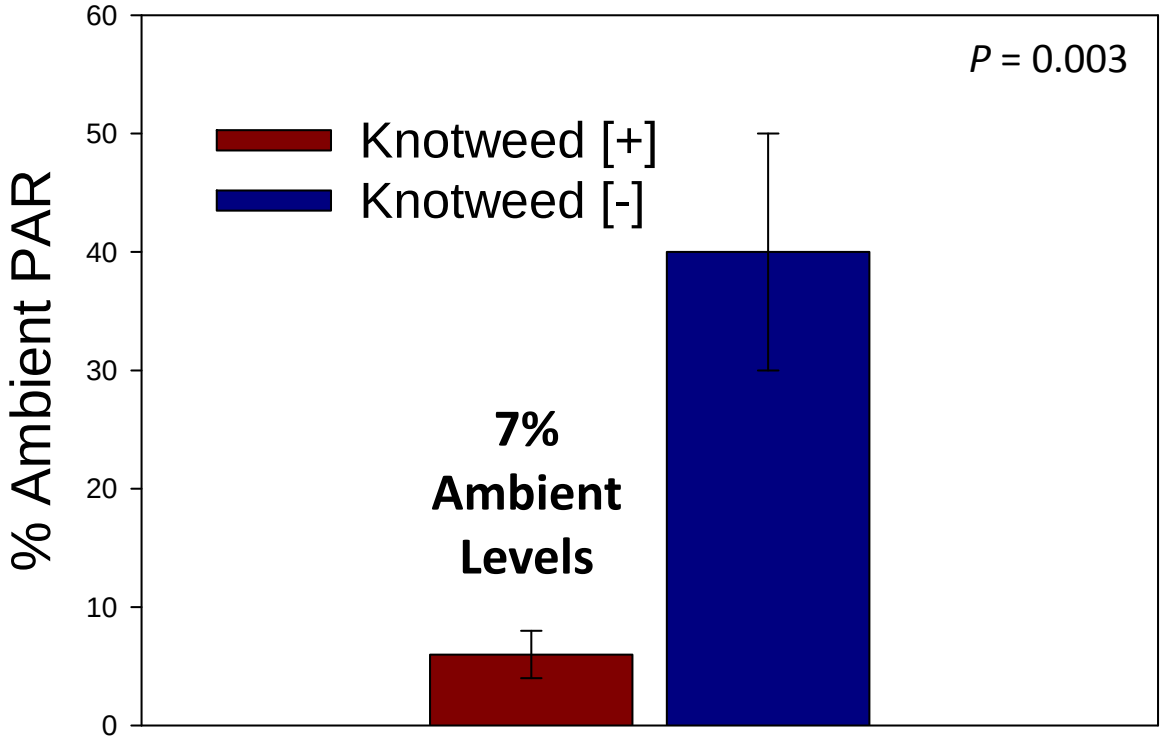
Biomass allocation

Root:shoot

Foliar C & N

Mycorrhizal colonization

Results - Light

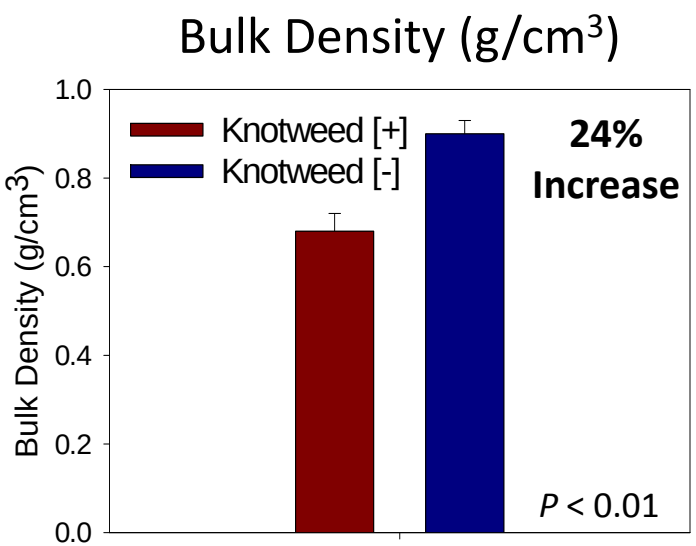


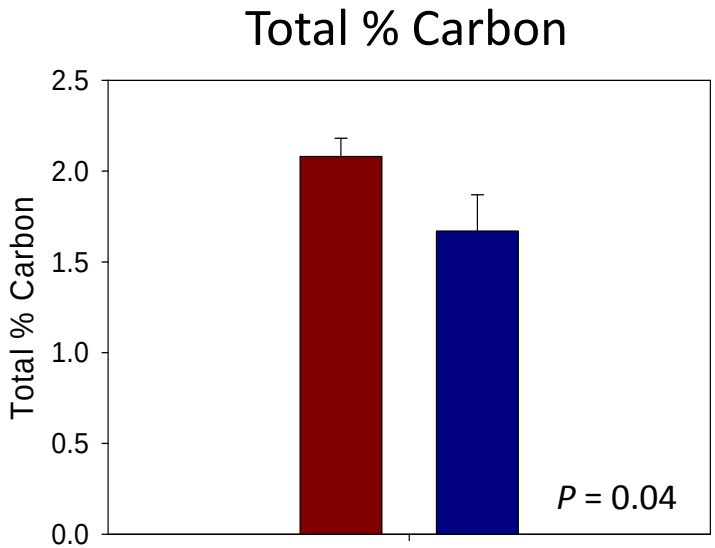
Strong reductions in light

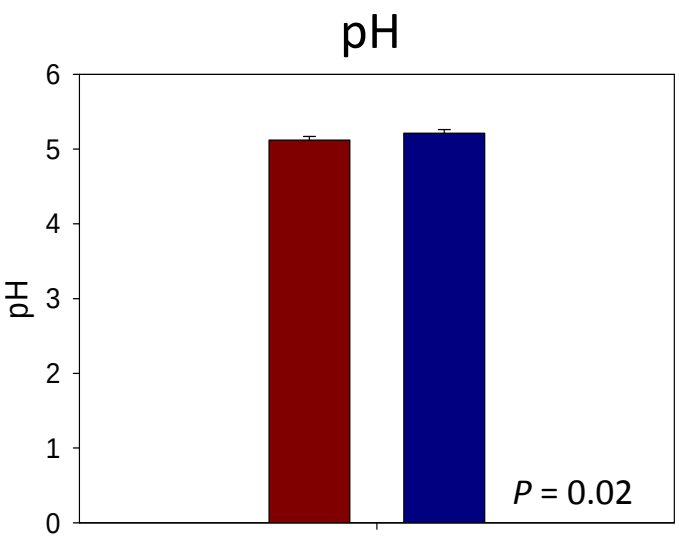
Coastal hardwood forests—10.8±10% & 16±2%

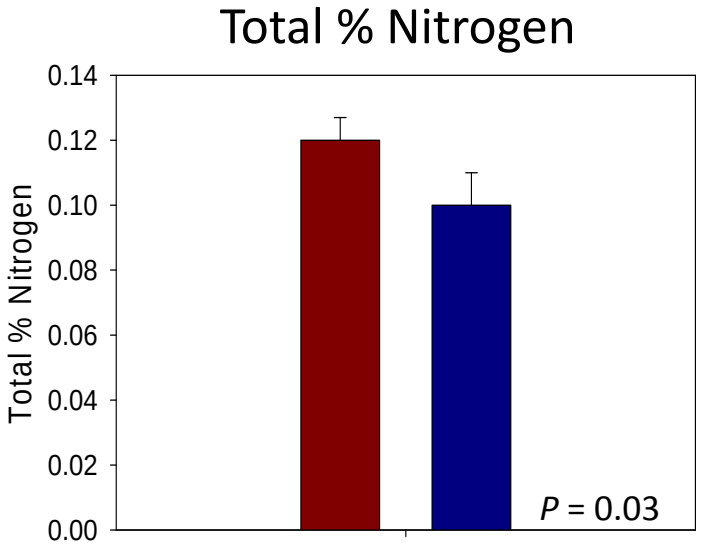
(Drever 2005, Roburn 1997)

Results – Soil Analysis



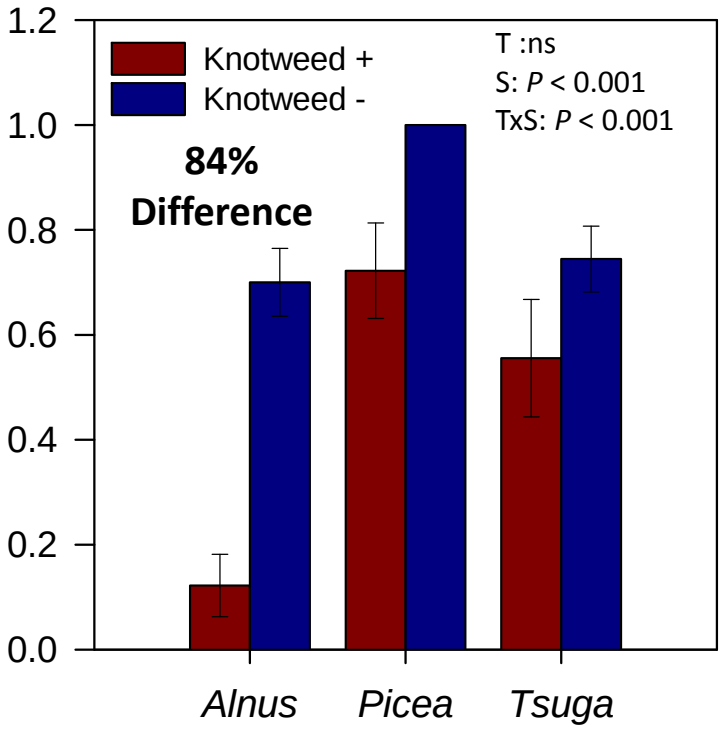




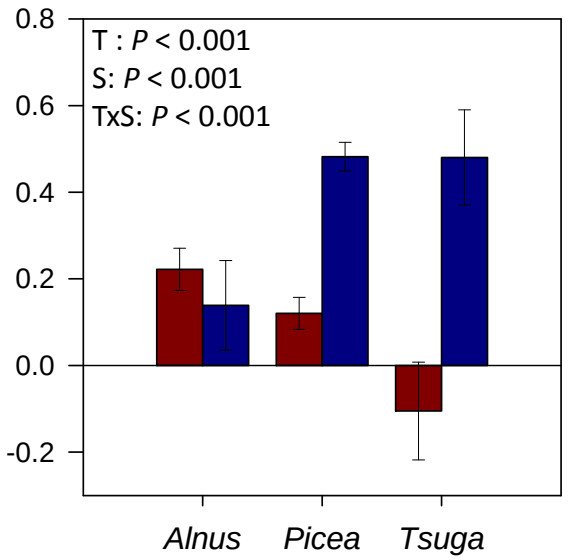


Results - Seedling Survivorship & Growth

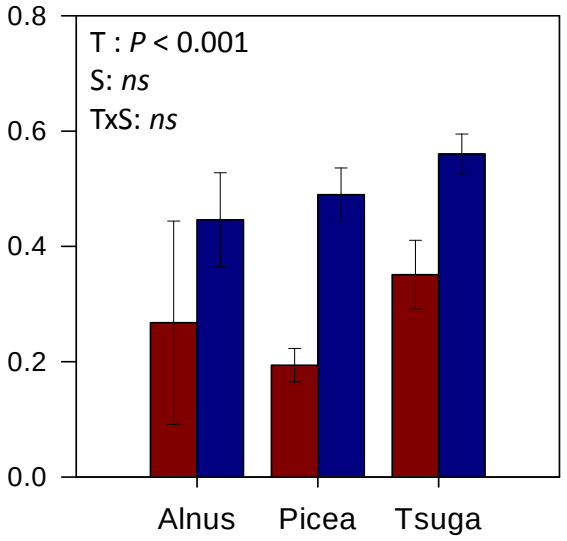
Seedling Survivorship (#/10)



Ln Height Growth (cm)



Ln Diameter growth (cm)



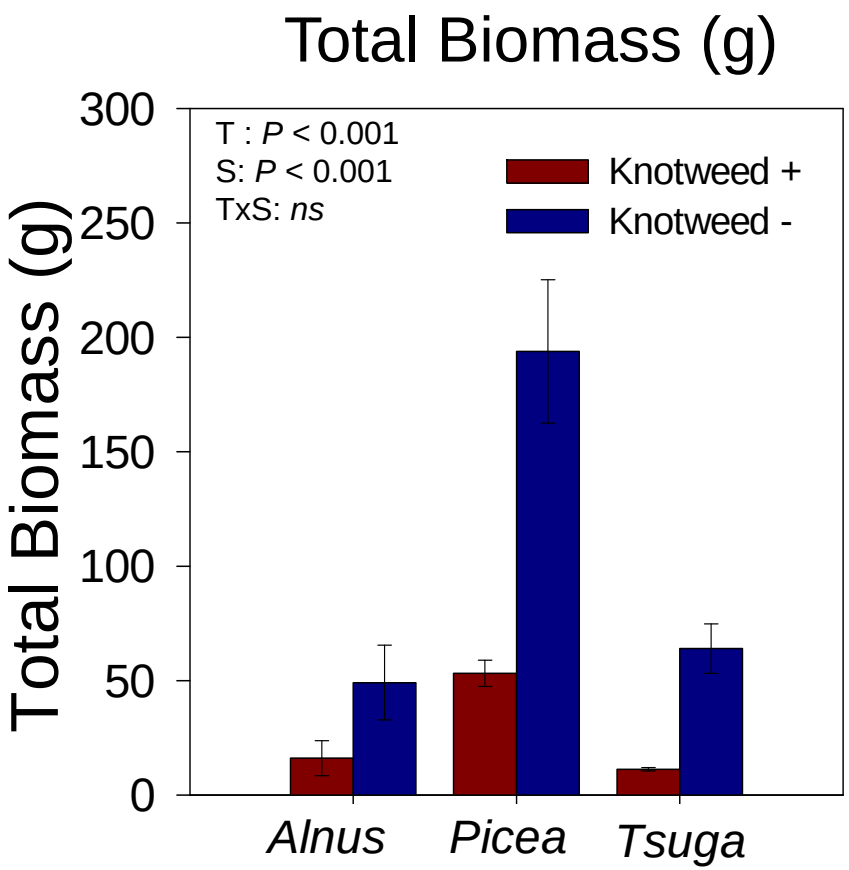
Reduced survivorship & growth

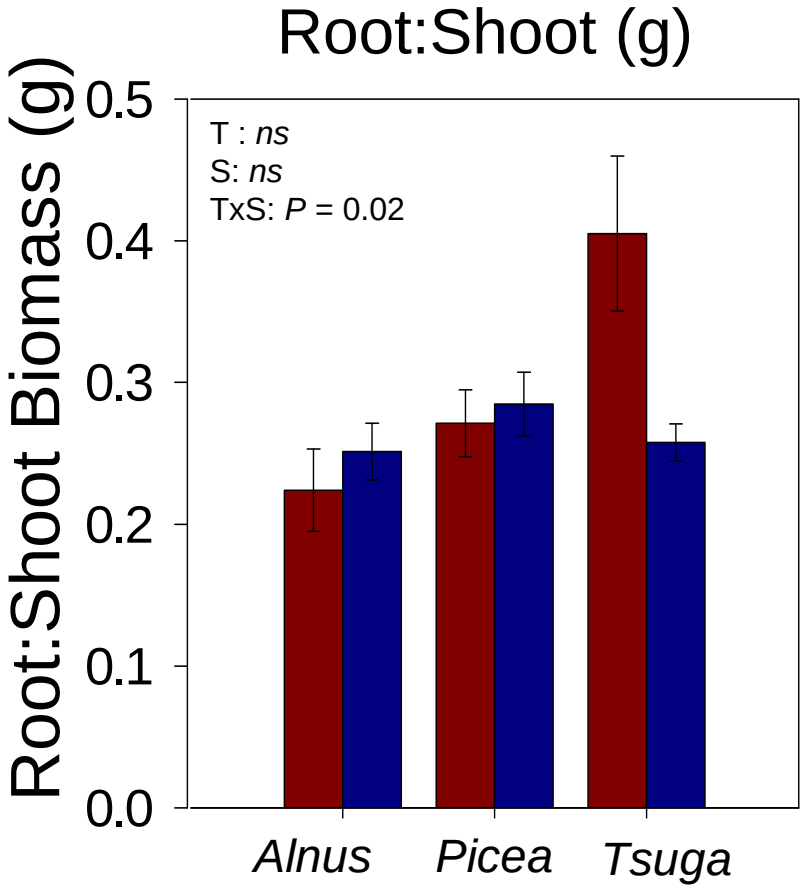
Differences across species

Greater mortality in alder

Reduced height growth in hemlock

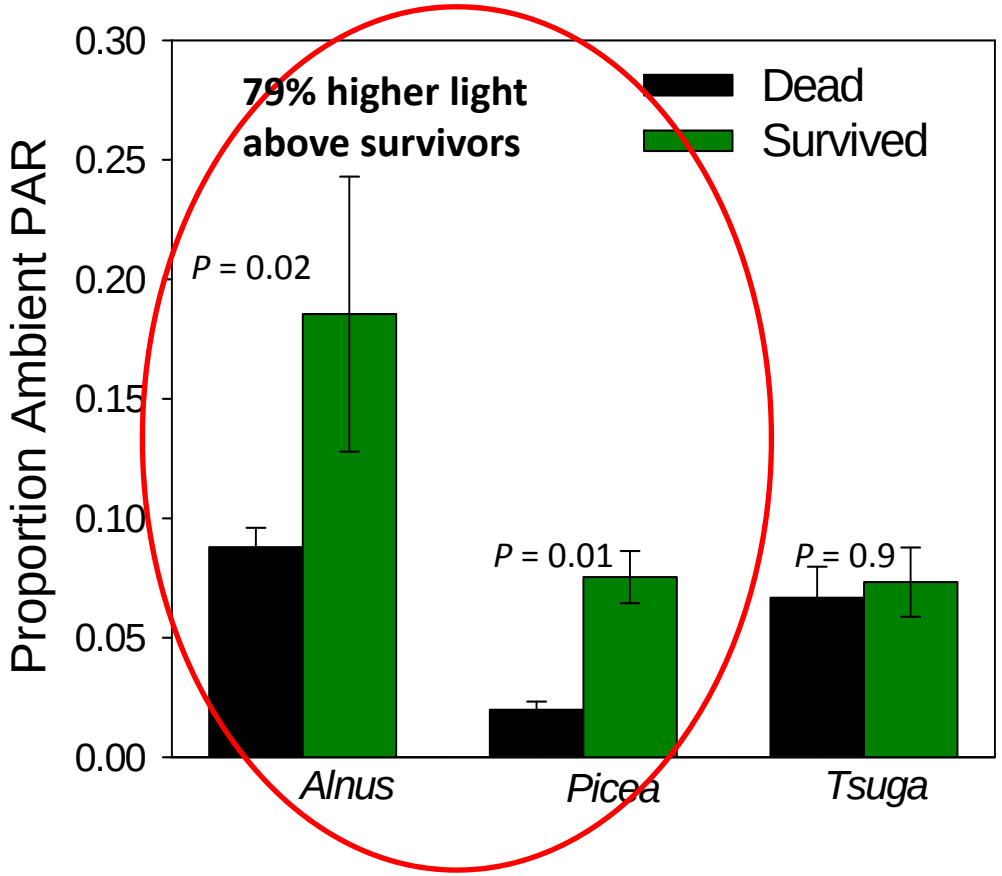
Results – Biomass & Allocation





Tsuga allocates greater resources to roots

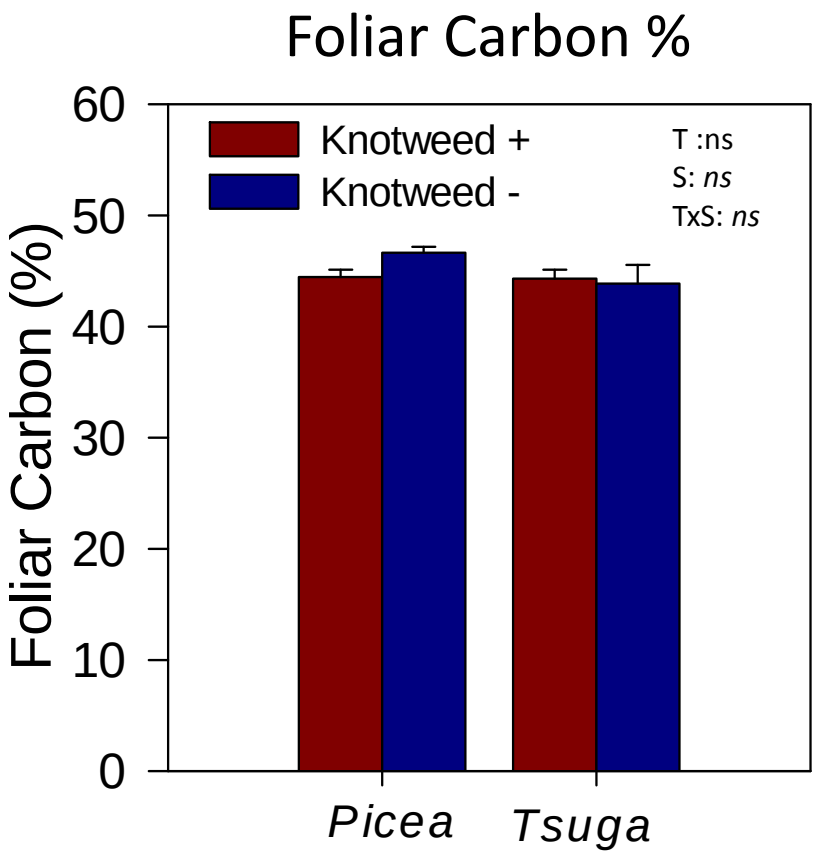
Results – Seedling Response to Light

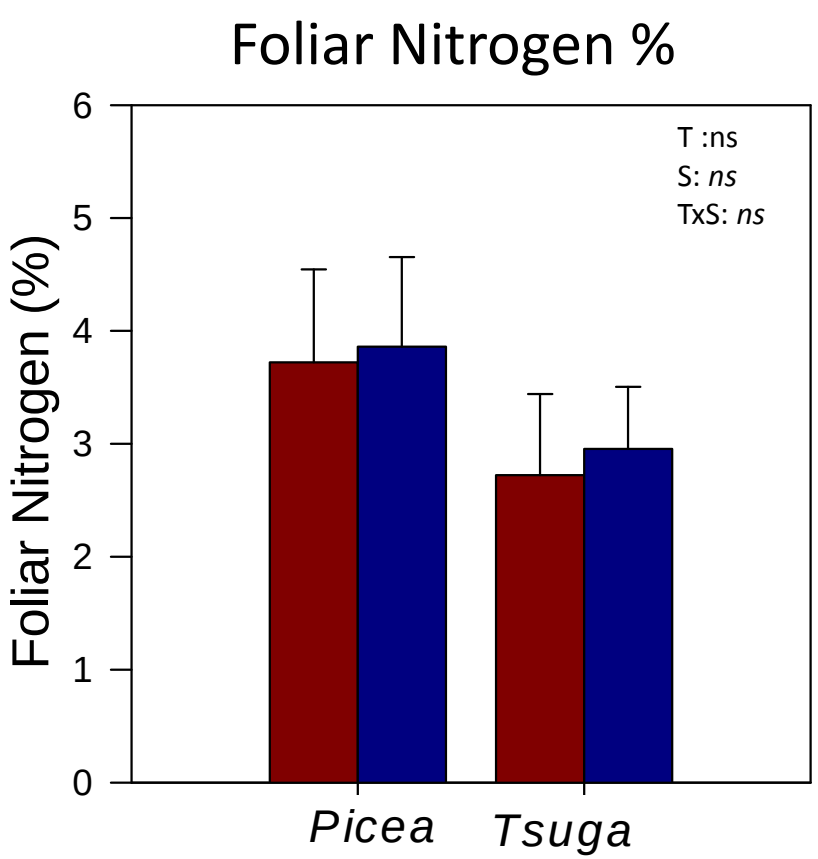


Every seedling in knotweed + plots

Early and mid-seral species responded to light

Results – Seedling Foliar Nutrients

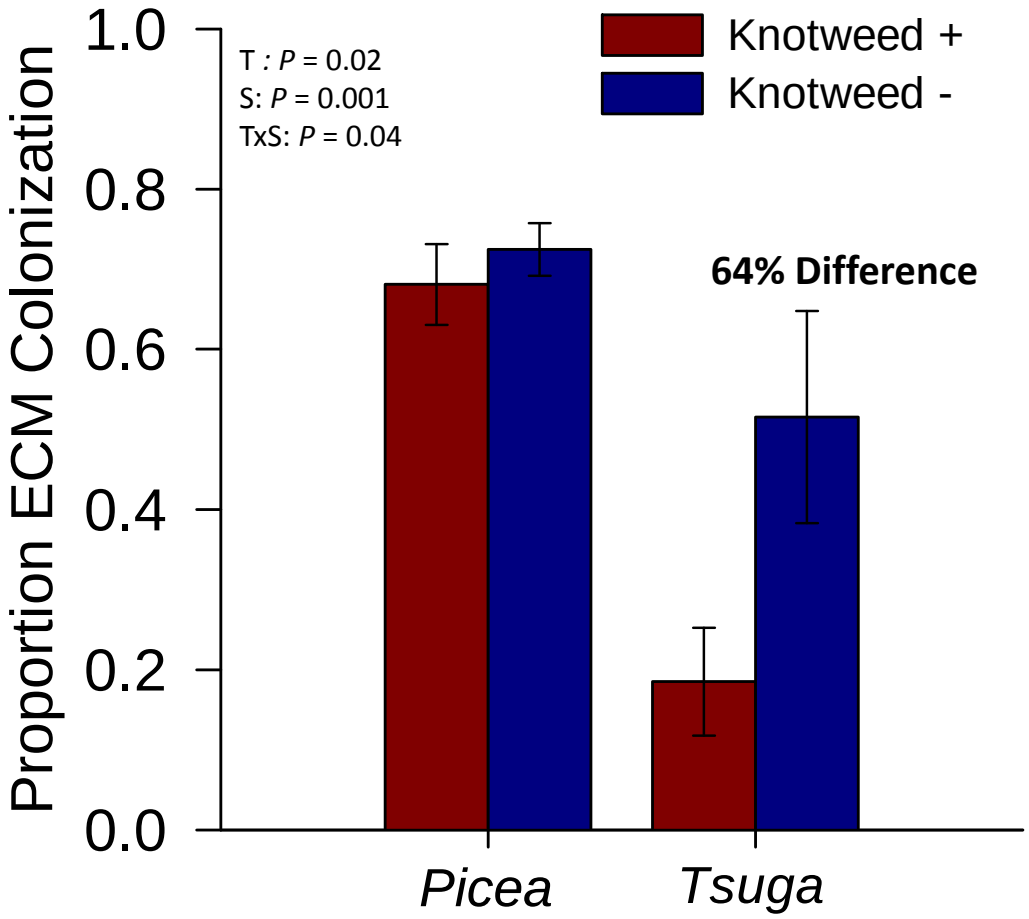


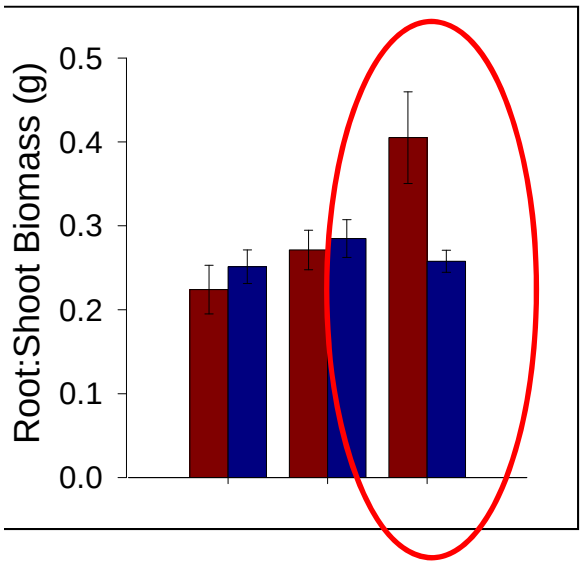


No Differences

Results – Ectomycorrhizal Colonization

Lower ECM colonization on shade tolerant *Tsuga*





Conclusions

1. What are the effects of knotweed on light transmittance and soil physical and chemical properties?

   Strong reductions in light

   Weaker soil effects

2. Does knotweed reduce native tree seedling performance?

   Yes, all three species

Conclusions

3. Do tree seedlings differ?

Yes, *Alnus* - survivorship

Tsuga - height growth

Yes, early & mid seral – light

late seral – below ground resources

Strong implications for forest structure and function

Invasion success - modify resources & interfere with fungal mutualisms

Final Summary

Community Response

Effective restoration approach

Strong influence of habitat factors and plant traits

Interactions with tree seedlings

Invasion success – multiple mechanisms

Reductions in light & plant mutualisms

Acknowledgements

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