Ecological effects of invasive plants on forest ecosystems

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Interstate 5 near Olympia
Reutebuch: Skagit River
TNC: Giant knotweed
Topics

• Invasion vectors & facilitators

• Ecological changes

• Mitigation approaches
Invasion vectors & facilitators
Disturbance can overcome physical and environmental barriers to invasion

Source: parent population of exotic species

Biological barrier

Invasion pathway

Physical barrier

Environmental barrier

Sink: invasion site

Parenedes and Jones 2000
Wildfire

High-severity wildfires provide an important mechanism for continued spread of invasive plants in the West

• Create extensive openings

• Enable less competitive species to reproduce
Roads and streams

• Act as corridors for propagule transport, provide habitat, and provide reservoirs of propagules

• Exotic species most common in areas with high light and high road use

Steve Reutebuch: Skagit River, WA

Parenedes and Jones 2000
Forest management

- Frequency of invasive species increased with decreasing stand density from clearcutting or thinning (Gray 2005)

- Richness of invasive species was greatest in thinned stands (Bailey et al 1998)
Wind dispersal

• Halpern et al.: Forest seed banks of the Olympic Peninsula were dominated by non-native, wind-dispersed species

• *Senecio sylvaticus*:
  - found on virtually all PNW forest sites
  - population explodes 2 yr after forest harvesting, then declines

Halpern et al 1997, 1999
Wildland-urban interface

Discarded plant debris on public lands: a common source of invasive species
Ecological changes

James Dollins: kudzu, Savannah River Site
Shade-tolerant invasive species are changing the fuel structure of Douglas-fir forests.
Competitive exclusion by Scotch broom

Douglas-fir mortality linked to soil water depletion by broom

\[ Y = 88 - 0.76X \]
\[ r^2 = 0.62, s_{y,x} = 9.6 \]

Harrington & Schoenholtz 2010
Competitive exclusion by giant knotweed

Native species richness was negatively correlated with stem density of giant knotweed

TNC

Urgenson et al. 2009
Competitive exclusion by Japanese knotweed

Two-year responses:
- ALRU: survival and growth ↓
- PISI, TSHE: growth ↓

Shade tolerant species surviving ... for now.

Knotweed present
- Survival: ALRU, PISI, TSHE
- Stem diam. RGR: ALRU, PISI, TSHE

Knotweed removed
- Survival: ALRU, PISI, TSHE
- Stem diam. RGR: ALRU, PISI, TSHE

TNC

Urgenson, UW, in progress
Altered soil chemistry under Scotch broom

Favors broom regeneration over native species

<table>
<thead>
<tr>
<th>Variable</th>
<th>Change</th>
<th>Variable</th>
<th>Change</th>
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<tr>
<td>Total carbon</td>
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<tr>
<td>C:N</td>
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<td>C:N</td>
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<tr>
<td>Nitrification</td>
<td>Increased</td>
<td>Inorganic phosphorus</td>
<td>Decreased</td>
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<td>N mineralization</td>
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<td>C:P</td>
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<tr>
<td><em>Achillea</em> biomass</td>
<td>Decreased</td>
<td>pH</td>
<td>Decreased</td>
</tr>
</tbody>
</table>

Haubensak & Parker 2004
Caldwell 2006
Altered riparian chemistry under giant knotweed

Reduced input of native litter
+ Higher nitrogen resorption by knotweed at senescence
= Poorer quality inputs for aquatic consumers

\[
NR = 100 \times \left( \frac{%N_{\text{fresh leaves}} - %N_{\text{senescent leaves}}}{%N_{\text{fresh leaves}}} \right)
\]

Urgenson et al. 2009
Mitigation approaches
Competitive exclusion

- Native grasses inhibited development of Scotch broom seedlings
- Prompt reforestation with site preparation, large stock, and close spacing

Grass density (plants per pot)

![Grass biomass graph](Harrington 2011)
Promising herbicide treatments

Newer herbicide treatments provide tools for controlling seedbank-origin Scotch broom

Harrington, WSWS 2011
Promising herbicide treatments

Aminopyralid is effective on many broadleaf invasive species

Harrington et al., WSWS 2011
Prescribed fire for prairie restoration

• Reduced number of Scotch broom germinants by 68%

• Repeated burning reduced soil N to pre-broom values

Dave Peter: Fort Lewis, 13th Division Prairie

Haubensak et al. 2004
Prevention via forest debris

Debris reduced development of Scotch broom

Harrington & Schoenholtz 2010
Logging debris dispersed 2 weeks after treatment

Logging debris removed 3 years after treatment
Summary: effects

• Plant invasions are symptomatic of disturbance:
  ▪ Wildfire
  ▪ Corridors
  ▪ Forest management

• Invasive plants:
  ▪ Alter fuel regimes
  ▪ Exclude native plants
  ▪ Change soil chemistry

• Impacts to forest ecosystems:
  ▪ Reduced biodiversity
  ▪ Reduced productivity
  ▪ Reduced resilience
Summary: mitigation approaches

• Manage forest disturbances wisely:
  ▪ Treat plant invasions when they are small
  ▪ Use best forestry technology: targeted herbicide treatments, large planting stock, close spacing
  ▪ Limit invasion opportunities: avoid exposed soils, open canopies

• Exploit species’ weaknesses:
  ▪ Germination requirements
  ▪ Seedling susceptibility

• Establish quarantine reaches and buffers to protect sensitive areas
Questions?