Terrestrial-Aquatic Connections: Invasive *Ailanthus altissima* leaf decomposition in freshwater ecosystems and impacts on macroinvertebrate communities

Jonathan Juarez and R.E. McNeish
California State University, Bakersfield
McNeish Research Lab
Terrestrial-Aquatic Connections

- Interactions between terrestrial and aquatic ecosystems
- Resources are exchanged between ecosystems
- Cross-ecosystems subsidies (e.g. nutrients, organic matter)

Photo Credit: J. Juarez
Riparian Zones

• Riparian (streamside) zones serves as a buffer between terrestrial and aquatic ecosystems

• Can reduce nutrient pollution into aquatic ecosystems

• Healthy riparian zones support increased biodiversity of aquatic biota
Invasive Species

• A non-native organism to an ecosystem whose introduction causes or is likely to cause economic or environmental harm or harm to human health

Water Hyacinth
American Bullfrog
Brown Trout

Source: Public Domain, J. Juarez
Ailanthus altissima  
(Tree of Heaven)

• Native to China and North Vietnam

• First introduced in the US during the late 1700s

• Introduced to California in 1890s during the Gold Rush
**Ailanthus altissima**  
(Tree of Heaven)

- Difficult to remove (Kowarik 1995)
- Uses allelochemicals for a competitive advantage (Lawrence et.al 1991)

Photo Credit: J. Juarez  
Credit: USDA  
https://plants.usda.gov/home/plantProfile?symbol=AIAL
Aquatic Macroinvertebrates

• Use leaf litter as both food and habitat

• Important to both aquatic and terrestrial food webs (Baxter et.al. 2005)

• Specialized to fill different niches (Functional Feeding Group) (Anderson & Seddell 1979)

• Indicator species for stream pollution (Wallace & Webster 1996)

Source: Public Domain, J. Juarez
Research Questions

Does leaf litter from Tree of Heaven decompose at a different rate compared to leaves from two native California species, and are these decomposition patterns consistent across different freshwater ecosystems?

Does leaf litter from the invasive plant support unique aquatic macroinvertebrate communities compared to leaf litter from native plants, and is this pattern consistent across freshwater habitats?
Research Sites

CSUB Pond

El Paso Creek

Photos Credit: J. Juarez
Native Species

- Fremont Cottonwood (*Populus fremontii*) and London Planetree (*Platanus acerifolia*)

- Leaves break down fast (cottonwood) or slow (planetree)

Photo Credit: J. Juarez
Methods
Pond Pilot Study

• Due to uncharacteristic rain in 2023, stream site was lost

• Study redeployed in January and sampling ongoing

Photos Credit: J. Juarez, R. McNeish
Leaf Decomposition

- Leaf litter decomposition was different among leaf pack treatments ($P < 0.0001$)

- Decomposition of Tree of Heaven leaf litter was:
  - $\sim 7.4\times$ faster than native leaf packs
  - $\sim 6.5\times$ faster than the mix leaf packs
Macroinvertebrate Community Dynamics

- Macroinvertebrate taxonomic community structure was similar across leaf pack treatments.
- Mix leaf pack treatment was the most similar to the other treatments.

\[ F_{2,13} = 1.59, P = 0.072 \]
Macroinvertebrate Taxa Dynamics

The relative abundance of taxa was different among all treatments and dates ($\chi^2 = 1,232.9, df = 38, P < 0.0001$).

Invasive Mix Native Mix Native
47 Days 104 Days

Relative Abundance (%) of Taxa
- Psychodidae
- Planorbididae
- Planariidae
- Physidae
- Ostracoda
- Oligochaeta
- Naididae
- Limpet
- Libellulidae
- Hirudinea
- Gastropoda
- Cladocera
- Curculionidae
- Copepoda
- Collembola
- Coenagrionidae
- Chironomidae
- Ceratopogonidae
- Amphipoda
- Acari

Sources: Public Domain, J. Juarez

Photos Credit: J. Juarez
Macroinvertebrate Functional Feeding Group Dynamics

- FFG relative abundance was different among all treatments and dates ($\chi^2 = 203.19$, df = 10, $P < 0.0001$)

Invasive Mix Native Mix Native

<table>
<thead>
<tr>
<th>47 Days Leaf Pack Treatment</th>
<th>104 Days</th>
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</thead>
<tbody>
<tr>
<td>Invasive</td>
<td>Mix</td>
</tr>
<tr>
<td>Mix</td>
<td>Native</td>
</tr>
<tr>
<td>SH</td>
<td>SG</td>
</tr>
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<td>CG</td>
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</tbody>
</table>

Sources: Public Domain, J. Juarez

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Potential Implications

• Tree of Heaven leaf litter may be an easy to access energy source for aquatic macroinvertebrates

• Replacement of riparian vegetation with Tree of Heaven may lead to changes in macroinvertebrate communities

Photo Credit: J. Juarez
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