Effects of Landscape Pattern on Oak Dispersal and Regeneration in an Urban Landscape

Julia Michalak
Ph. D. Candidate
University of Washington
Urban Ecology Research Lab
Road Map

• Background and theoretical context
1) Do landscape patterns influence seedling abundance?
2) Do landscape patterns influence dispersal services?
• Summary and implications
Urban effects on ecological structure and function

Urbanization

- Indirect changes
- Direct land cover alterations

- Altered species communities
- Altered Ecosystem Function

Grimm et al. 2008
Garry Oaks (*Quercus garryana*)

- Ecologically significant species
- Population is declining due to urban development

Larsen and Morgan 1998
Acorn dispersal services

**Benefits to the oak**
- Carry acorns away from parent
- Bury acorns
- Colonize new habitat
- Expand range/adapt to climate change

**Cost to the oak:** Seed predation (Fuchs et al. 2000, Levin et al. 2003)

**Eastern Gray Squirrel** *(Sciurus carolinensis)*
- Urban and non-urban

**Steller’s Jay** *(Cyanocitta stelleri)*
- Urban and non-urban

**Western Gray Squirrel** *(Sciurus griseus)*
- Non-urban
Conceptual Model

Landscape Patterns – Canopy Cover

Landscape Patterns - % Urban

Dispersal Behavior

Presence, Absence and Abundance

Seed Dispersal Services

Seedling Patterns
1) Do landscape patterns influence seedling abundance?

Landscape Patterns – Canopy Cover

Dispersal Behavior

Landscape Patterns - % Urban

Presence, Absence and Abundance

Seed Dispersal Services

Seedling Patterns
Methods: Seedling Abundance

Summer 2009
30 oak woodlands
- Measured % urban land cover within 0.5 km buffer

157 vegetation plots
- Seedling abundance
- Visually estimated canopy cover

Analyzed using mixed-effects regression models
Effect of Canopy Cover

Seedling abundance (2009)

Mean # of seedlings (+ 1 sd)

Canopy type

Oak

Non-oak Forest

No Canopy

Seedling Canopy Cover

Seedling Urban Cover
Effects of Urban Development

Summary of seedling abundance by oak woodland

<table>
<thead>
<tr>
<th>Canopy Type</th>
<th>Estimate</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Urban</td>
<td>-0.9635</td>
<td>0.18 n.s.</td>
</tr>
</tbody>
</table>

No significant relationship

% urban land cover within 0.5 km

Seedling Canopy Cover Seedling Urban Cover
2) Do landscape patterns influence dispersal services?

Landscape Patterns – Canopy Cover

Landscape Patterns - % Urban

- Acorn removal
- Acorn predation
- Germination

Dispersal Behavior

Presence, Absence and Abundance

Seed Dispersal Services
Methods – Dispersal Behavior

Experimental acorn planting plots

• Flagged acorns facilitate relocation

• 2009 (mast year): 2 sites, 36 plots, 720 acorns

• 2010 (mast failure): 9 sites, 54 plots, 1680 acorns

Analysis with binomial mixed-effects regression models

Canopy cover type

Urban: > 50% urban land cover

Non-urban: ≤ 30% urban land cover

Open grassland

Non-oak forest

Oak
Canopy Cover
Higher Removal under Forest Cover

Acorn removal 2009 (mast year)

Acorn removal 2010 (mast failure)

Canopy Cover

Removal | Predation | Germination | Removal | Predation | Germination
--- | --- | --- | --- | --- | ---
Forest Cover | Urban Cover

% Acorns removed
No Difference in Predation

Predation 2009
(mast year)

Predation 2010
(mast failure)

Canopy Cover

% Removed acorns

Oak  Forest  Open Grassland

Predation

Removal

Germination

Forest Cover  Urban Cover

n.s.
Germination not different between forest and no canopy cover

Acorn germination (2009)

- Oak: 50%Remaining acorns (a)
- Forest: 30% (b)
- Open Grassland: 40% (b)

Acorn germination (2010)

- Oak: 30% (n.s.)
- Forest: 10% (Predation, Removal)
- Open Grassland: 20% (n.s.)

Canopy Cover

<table>
<thead>
<tr>
<th>Canopy Cover</th>
<th>Removal</th>
<th>Predation</th>
<th>Germination</th>
<th>Removal</th>
<th>Predation</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Urban Development
Higher Removal in Urban Sites - 2010

Acorn removal 2009 (mast year)

- Not urban
- Urban

Acorn removal 2010 (mast failure)

- Not urban
- Urban

Removal | Predation | Germination | Removal | Predation | Germination
---|---|---|---|---|---
Forest Cover | Urban Cover
Higher Predation in Urban Sites - 2010

Predation 2009 (mast year)

- % Removed acorns:
  - Non-urban: 80%
  - Urban: 60%

Predation 2010 (mast failure)

- % Removed acorns:
  - Non-urban: 30%
  - Urban: 50%

**Legend:**
- a
- b
- n.s.

**Comparisons:**
- Removal
- Predation
- Germination

**Cover Types:**
- Forest Cover
- Urban Cover
Higher Germination in Urban Sites - 2010

Acorn germination 2009 (mast year)

<table>
<thead>
<tr>
<th>% Remaining acorns</th>
<th>Not urban</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>n.s.</td>
<td>40%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Acorn germination 2010 (mast failure)

<table>
<thead>
<tr>
<th>% Remaining acorns</th>
<th>Not urban</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td></td>
</tr>
</tbody>
</table>

Forest Cover

<table>
<thead>
<tr>
<th>Removal</th>
<th>Predation</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Urban Cover

<table>
<thead>
<tr>
<th>Removal</th>
<th>Predation</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary of Forest Cover

• Squirrels and jays prefer forest cover (Fuchs et al. 2000, Ryan and Carey 1995)
• Oak seedling abundance is higher under forest cover
• Dispersal activity is higher under forest cover
• Germination does not differ between forested and non-forested sites

Forest cover appears to facilitate acorn dispersal
Summary of Urban Development

• Oak seedling abundance is no different depending on urban development

• Dispersal services are inferior in urban landscapes

• Possible explanations:
  – Germination is higher in urban landscapes
  – Inter-annual variability dampens influence of dispersal services

More research needed
Broader Implications

• Forest connectivity and spatial arrangement is likely to be important in facilitating dispersal

• Urban development may have long-term impacts on oak regeneration

• Multi-year studies are needed given the temporal variability of dispersal patterns
Acknowledgements

• Major Advisor: Dr. Marina Alberti, Director, Urban Ecology Research Lab, Urban Design and Planning, University of Washington

• Committee Members: Dr. Joshua Tewksbury (UW Biology), Dr. Joshua Lawler, Dr. Jerry Franklin (UW School of Forest Resources)

• Pierce County Parks and Recreation

• Cascade Land Conservancy

• Joint Base Lewis-McChord Department of Public Works

• Camp Murray Environmental Programs
Citations


