Wildlife Values and Management Ramifications

The Enduring Role of American Beech

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Outline

• Overview of beech ecology
• Role as wildlife food and habitat
• Spatio-temporal cycles and masting
  • Population demographics
  • Predator-prey relations
  • Human-wildlife conflict
• Beech Bark Disease impact on forest system
• Conclusions & Implications
• Current Projects
American Beech Range

Pre-Colonial Forest

Modern Forest

Thomson et al. 2013
American Beech
Basal Area per Acre

Sawtimber, paper, firewood, ornamental tree

Wildlife values
Food
Cavities for nesting
Downed wood

Oft-maligned species
Beech Bark Disease

- Model predicted 37% decline in nut production from BBD
- Significant and widespread impacts on wildlife and forest

Costello 1992

Unmanaged Stand Changes

↓ Large northern hardwoods dominating canopy
↑ Beech saplings
↑ More, smaller beech logs
↓ Recent beech snags
↑ Advanced stages of BBD
↑ Shrub richness
↑ Beech nut production trend

McNulty and Masters 2004
### Plant Diversity and BBD

<table>
<thead>
<tr>
<th>Component</th>
<th>Non-thicket</th>
<th>Thicket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean beech sapling density (stems/m²)</td>
<td>0.12</td>
<td>0.55</td>
</tr>
<tr>
<td>Mean litter depth (cm)</td>
<td>1.48</td>
<td>2.25</td>
</tr>
<tr>
<td>Plant species</td>
<td>34</td>
<td>22</td>
</tr>
<tr>
<td>Fern species</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Mean shrub species</td>
<td>6.5</td>
<td>1</td>
</tr>
</tbody>
</table>

Cale et al. 2012

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### Plant Diversity

- **Beech thicket**
  - Light levels lower; competition higher?
  - Dense, lignin-rich beech litter makes herb establishment difficult – phytotoxic?

- **Higher diversity**
  - Non-thicket had a third more species
  - Caveat: mechanism that caused a thicket not studied (soil, drainage, land use history…?)
A Dead Beech is a Good Beech?

- Vertebrates – runways, refugia
- Fungi, insects – decomposition rate
- Woodpeckers, chickadees – cavity nests in snags

Beech Consumption

- About 40 species
- Deer eat nuts, but rarely browse leaves
Beech Nuts

- Hard mast
- Produced at age 40-60
  - Ripe in late August - November
- Beech Mast Cycle
  - 2-8 years
  - Northeast = 2 year cycle
  - Weather affected

Overwinter Survival

Pre-denning period of hyperphagy

Stored Cache
- Non-hibernators
- Torpor-employers
### Nutritional Comparison

<table>
<thead>
<tr>
<th>Component</th>
<th>Beech nut</th>
<th>Oak</th>
<th>Herbs</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>11%</td>
<td>6%</td>
<td>16%</td>
<td>11%</td>
</tr>
<tr>
<td>Fat</td>
<td>17</td>
<td>14</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>30</td>
<td>61</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Fiber</td>
<td>27</td>
<td>18</td>
<td>26</td>
<td>2</td>
</tr>
</tbody>
</table>

**Beech nuts:** 1.2 - 6 x more fat!

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### Beech Defense from Herbivory

- Lignin – difficult to digest
- Secondary plant compounds
  - Polyphenolics
    - Allelopathic, impacts sugar maple seed development
- Structural
  - Tough husk, seed coat
  - Beech nuts vs. oak acorns

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*Hane 2003*
Black Bears
**Beech Nuts and Bear Population**

- Sow’s fat store winter influences number of cubs next spring
- Maine: 80% of sows reproduced after mast, 22% after poor nut year
- Beech mast density in the autumn before birth best explained annual Adirondack bear population size

**Mustelid Family**

- Weasels, marten, fisher

Jakubas et al. 2005  LaMere et al. 2012
Other Predators

- Indirectly impacted by beech mast
  - Consume small mammals
  - Time lag for predators
- Owls
- Raptors
- Bobcats
- Coyotes
- Otters – direct!

Small Mammals

Squirrels  Deer Mice  Jumping Mice  Voles  Shrews
Blue Jays
• Cache nuts up to 4 km away - can expand a tree's range
  • Creates clusters of related beech
• Chose 100% sound, green nuts vs. just 11% sound nuts hand-picked from tree

Ruffed Grouse
• Overwinter survival

Turkeys
• Increasing in northern regions
  Johnson and Adkisson 1985

Passenger pigeons ate beech nuts and acorns
  Mott 1901
Seed Collecting

- Unmanaged >300-year-old northern hardwood forest
  - Annual since 1988
  - Mid-November, 25 plots
- Five managed beech stands - 1989-present

Annual Beech Seed Production

- Mast crop = 100x more nuts produced than during a mast failure
- Tree seed production synchronized ($r = 0.48 – 0.64$)
  - Beech, sugar maple, mountain ash, conifers

1-year lag (first order autocorrelation) = -0.54
4-year lag (fourth order autocorrelation) = 0.61
Synchronicity

Beech nuts collected vs. Mice per 100 Trap Nights from 2002 to 2015.

Bear Nuisance Complaints

Conflict during nut crop failure
“Stay calm... It’s obvious he’s just looking for food.”
Adirondack Park

Wildlife Management Units

New York

Maine

New Brunswick

Marten/Fisher

Consume
• Small mammals
• Nuts and berries
• Birds, amphibians, etc.

• Impacted directly and indirectly by beech masting

• Fur trappers’ data
Small Mammal Abundance

Mean Small Mammal Catch-per-unit Effort (CPUE; total captures/100 TN)

Summer CPUE, all 8 species combined

Lagged Population Response to Tree Seed Production

American Beech
Sugar Maple
Coniferous Trees
**Marten Harvest Rate**

<table>
<thead>
<tr>
<th>Mast Category</th>
<th>Mean (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mast Failure</td>
<td>1.82 (0.17)</td>
</tr>
<tr>
<td>Intermediate Mast</td>
<td>0.80 (0.14)</td>
</tr>
<tr>
<td>Large Mast</td>
<td>0.33 (0.04)</td>
</tr>
</tbody>
</table>

![Graph showing Marten Harvest Rate over time with regression line and equation](image)

**Marten Harvest and Beech Nuts**

*Harvest rates: strongly correlated with beech mast*

![Graph showing relationship between Marten Harvest Rate and American Beech Mast Production](image)

\[
y = -0.000004x + 0.473
\]

\[r^2 = 0.84, P < 0.0001\]
Fisher Harvest Rate

Harvest rates: weakly correlated with beech mast

\[ y = -0.000003x + 4.194 \]
\[ r^2 = 0.40, P = 0.008 \]
Regional Harvest Trends

Marten

Total Marten Harvest (Maine/New Brunswick)

Fisher

Total Fisher Harvest (New York; Central Adirondacks)
Conclusions

• Cycles in beech mast production initiated immediate and time-lagged effects on mustelids, their small mammal prey, bear demography...
  • Animals’ reliance on beech nuts affected by alternate food sources (also competition, habitat quality...)
• Synchronicity in space and time – environmental factors
• BBD/nut model: correct for single trees; wrong on landscape scale
• Forest continues to change with BBD

Implications

• The cascading effects of an invasive disease complex can negatively affect the diversity of non-host species
• Monitoring mast availability can be used to predict animal populations and periods of human-wildlife conflict and to inform harvest regulations
• Trophic interactions are affected by the beech mast cycle, e.g.
  • Herbivore-carnivore relationships
  • Interguild relationships: fewer beech nuts → predation of bird nests by mammals
Rehabilitation Harvest

- Dominant sugar maple, yellow birch, white ash (& beech) being replaced by a less-diverse forest of degraded beech
- Soils are high-quality (Skerry, Becket series)

- Is mechanical control possible and feasible?
- Can desirable species be retained and promoted?
- At what price?
Components

Commercial beech control

Study treatment impacts on
- Forest structure and composition
- Vascular plant/epiphyte diversity
- Beech seed production by tree
- Microclimate
- Wildlife taxa
  - Bats
  - Small mammals
  - Songbirds

‘The Sky is Falling’

The project is designed to meet the challenge of retaining and encouraging a desirable mix of forest species and structure for both ecosystem function and economic value.
Additional Avenues

- Beech growth, mortality and reproduction
- Management ramifications
  - Which beech can be retained to produce nuts/wildlife value
  - How long might a beech tree survive given its BBD rating
  - Integrate management objectives
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