Impacts of Deer and Invasive Plant Species on Forest Health in Central New Jersey

Flat Rock Brook Nature Center
October 11, 2017

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Raritan Valley Community College
Exotic Invasive Plant Species

2,200 native (indigenous) plant species in New Jersey...
4000 exotic species introduced to NJ
- 1,400 escaped into the wild
- 400 have become invasive

Ecological Impacts:
Compete with native species; Threat to endangered species; Disrupt ecosystem processes (nutrient cycling, pollination/dispersal, trophic interactions)
(Snyder and Kaufman 2004)

Economic Impacts:
Invasive species cause over $100 billion of damage in the United States every year with $290 million being in NJ alone!
(New Jersey Invasive Species Council 2009)
Deer Population Trends in the Northeastern US

Reasons for Deer Population Growth

1. Extermination of Predators
2. Cessation of Commercial Hunting
3. Warming Winters
4. Suburban Development

Infographic by Peter Smallidge, Berndt Blossey
Cornell University
Deer Population Benchmarks

Historic: **8-11 deer/mi²**
- Impact preferred browse species

Current: **13-76 deer/mi²**

>20 deer/mi²
- Prevent forest regeneration

>100 deer/mi²
- Without deer management

(Drake et al. 2002, Almendinger pers. Comm.)

Healthy forest with dense understory vegetation and native plant species.

Overbrowsed forest at Hutcheson Memorial Forest in Franklin Township (2012)

Overbrowsed forest with invasive barberry shrubs at Peter’s Tract in Bernardsville (2016)
Study Area and Design

- Raritan Watershed
- Piedmont Province
  105 Study Sites

Three Forest Types:
Riparian, Upland, Mountain

Soils = Alluvial & Sandstone
       Basalt, Diabase & Gneiss
Forest Age
“Old” and “Young” (before or after 1930)

Forest Development in Central NJ – late 1800’s to 2012
Historical Comparisons
Murray Buell Plant Ecology Lab
Rutgers University (1936-1972)

12 Studies
13 Locations; 48 Study Sites

NJ Deer Population Trends

Historic Forest Studies (1948-1972)
Forest Study Methodology

Four 100 m Transects (20 m apart)
Twenty 100 m² plots (~0.5 acres)
Forty 1 m² plots (herbaceous cover)
Minimum 30 m from edge

Size Class Categories

Seedlings: <1’ height
<1” diameter

Saplings: >1’ height
<1” diameter

Small trees: 1 - 3.9” dbh

Med-Lg. trees: > 4” dbh

Counted / Measured:
- >50,000 trees
- >550,000 seedlings
- >4,000 herb plots
- >22 km shrub/liana data
Comparison of Past and Present Forest Size Class Structure

% Change from Past (1948-72) to Present (2014-16)

<table>
<thead>
<tr>
<th>Size Class</th>
<th>1948-1972</th>
<th>2014-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seedlings</td>
<td>6000</td>
<td>5100</td>
</tr>
<tr>
<td>Saplings</td>
<td>1000</td>
<td>500</td>
</tr>
<tr>
<td>Small Trees</td>
<td>350</td>
<td>300</td>
</tr>
<tr>
<td>Medium - Large Trees</td>
<td>700</td>
<td>800</td>
</tr>
</tbody>
</table>

-13%  -85%  -90%  -6%
Why the lack of regeneration? Shade vs. Deer

% Composition of Forest Size Classes

Results:
Increases in *Shade Intolerant* species (i.e., more light than in past)
Increases in *Deer Resistant* species (i.e., more deer pressure than in past)
Effects of Deer – Experimental Evidence

- 9 Additional Study Sites in Deer Exclosures
  (Duke Farms, Great Swamp, Greenbrook Reservation)
- 10 Additional Sites with Intensive Hunting
  (Princeton Twp, Duke Farms)
Deer Densities
Spotlight Surveys

2016 Survey Results

# deer/mi²

Hunterdon: 90-386
Somerset: 74-210
Middlesex: 79-149
Mercer: 80-150
Union: 103
AVG: 161/mi²
Aerial vs. Ground Survey Results

Aerial – 21.8/mi² (Vision Air Research) February 2017

Ground – 22.6/mi² (RVCC) April 2017

Map showing aerial and ground survey results with markers for different groups.
Relationship of # Saplings to Deer Densities

\[
\text{R}^2 = 0.88
\]
Invasive Plant Species in Forest Understories

◆ More invasive than native on average

- Multiflora Rose – 62%
- Japanese Stiltgrass – 87%
- Japanese Honeysuckle – 89%
Invasive Plant Species in Forest Understories

◆ More Invasives in Young Forests Than Old

166% more for Shrubs

158% more for Lianas

55% more for Herbs
Effects of Deer Exclosures on Understory Plant Species

◆ Dramatic Reduction of Invasive Herbs and Lianas

<table>
<thead>
<tr>
<th></th>
<th>FORESTS</th>
<th>EXCLOSURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHRUBS</td>
<td>Native: 20%</td>
<td>Native: 10%</td>
</tr>
<tr>
<td></td>
<td>Invasive: 80%</td>
<td>Invasive: 90%</td>
</tr>
<tr>
<td>LIANAS</td>
<td>Native: 30%</td>
<td>Native: 5%</td>
</tr>
<tr>
<td></td>
<td>Invasive: 70%</td>
<td>Invasive: 95%</td>
</tr>
<tr>
<td>HERBS</td>
<td>Native: 40%</td>
<td>Native: 5%</td>
</tr>
<tr>
<td></td>
<td>Invasive: 60%</td>
<td>Invasive: 95%</td>
</tr>
</tbody>
</table>
Possible Solutions for Forest Restoration: Deer Fencing

Approximate Cost for Fencing 76 Acres of Forest on RVCC Campus:

Welded Wire & Posts: $144,100

or Plastic Fencing & Trees: $28,500

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Cost (Per Item)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden Posts (8’)</td>
<td>2,827</td>
<td>$7.50</td>
<td>$21,203</td>
</tr>
<tr>
<td>Wire Fencing</td>
<td>28,269 ft.</td>
<td>$4.00 - 4.50/ft.</td>
<td>$120,143</td>
</tr>
<tr>
<td>or Plastic Fencing</td>
<td></td>
<td>$0.91/ft.</td>
<td>$25,699</td>
</tr>
<tr>
<td>Gate</td>
<td>1</td>
<td>$250.00</td>
<td>$250.00</td>
</tr>
</tbody>
</table>

TOTAL: $28,449 - $144,096

Estimate done by BASH Contracting, in conjunction with NJ Ecological Solutions. Gate: Brenner’s Gardens, Pressure treated wood: Lowes
Possible Solutions for Forest Restoration: Re-Planting

Approximate Cost for Replanting 76 Acres of RVCC Forest: $567,996

Replanting Understory Trees on a 76 Acre Plot

<table>
<thead>
<tr>
<th>Plantings</th>
<th>Approximate Quantity</th>
<th>Average Cost (Per Tree) 1,2</th>
<th>Total Cost 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saplings</td>
<td>232,408</td>
<td>$2.29</td>
<td>$532,214</td>
</tr>
<tr>
<td>Small Trees</td>
<td>8,968</td>
<td>$3.99</td>
<td>$35,782</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$567,996</strong></td>
</tr>
</tbody>
</table>

1 Tree prices based off Rutgers Nursery (Rt. 202)
2 Medium trees not included in total cost
3 Browse protection (pictured) not included in total cost (An additional $2.50 - 3.00 per unit not including installation)
Possible Solutions for Forest Restoration: Hunting Programs

Recreational Hunting (Private Clubs/Permit) – Readington, Raritan, County Pks

Revenue-positive/low cost but less effective

Sharpshooters/Community-Based Deer Management – Princeton, Bernards, Millburn, Duke Farms, others

High-cost ($208-292/deer) but very effective

Ecological Deer Management – Duke Farms, HLT, FoHVOS, some County Pks

Low cost and effective

Non-lethal Methods (Contraceptives) – Princeton, Rutgers, Jockey Hollow

High-cost ($430-1,100/deer) and ineffective/experimental
Effects of Different Methods of Deer Management on Forest Regeneration

Saplings/2000m²

<table>
<thead>
<tr>
<th>Method</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic</td>
<td>893</td>
</tr>
<tr>
<td>Exclosures</td>
<td>2003</td>
</tr>
<tr>
<td>Duke</td>
<td>1042</td>
</tr>
<tr>
<td>Princeton</td>
<td>575</td>
</tr>
<tr>
<td>Hopewell</td>
<td>435</td>
</tr>
<tr>
<td>Others</td>
<td>125</td>
</tr>
</tbody>
</table>

Intensive Deer Mgmt.
Public Safety - Vehicle Damage from Deer Collisions

>1,000,000 DVCs/yr in U.S.; >200 deaths

(Conover et al. 1995, Luedke 2011)

26,860 deer collisions in NJ in 2013
#1 - Monmouth County  
#2 - Morris County  
#3 - Somerset County  
#4 - Hunterdon County  
#5 - Middlesex County  

(State Farm Insurance, NJ.com 2014, NJTPA 2015)

New Jersey spends > $111 million/yr. in insurance claims related to deer collisions.

- **$10-13 million/county in central NJ**

(NJ.com 2015)
Other Benefits of Intensive Deer Management – Public Safety

Case studies of Organized Hunting in NJ (deNicola et al. 2008)

Duke Farms – reduced deer from 80-350/mi$^2$ to 12/mi$^2$

Princeton – reduced deer from 43/mi$^2$ to 17/mi$^2$

Bernards – reduced deer from 34/mi$^2$ to 18/mi$^2$

Proportionate Reduction in Deer Collisions
e.g., 60% Reduction in Princeton
Public Health - Lyme Disease

330-640 cases/yr in Morris County since 2000
207-528 cases/yr in Hunterdon County

Center for Disease Control and Prevention (2016)

Effect of Deer on Tick Abundance

Reported Cases of Lyme Disease -- United States, 2014

R² = 0.62
p = 0.0003*
Effects of Deer on the Food Web

90% of insects are specialists and feed on one or few species of plants

96% of terrestrial bird species rely on insects, spiders, and other arthropods as a food source
Effects of Deer on Ground/Shrub Nesting Birds

Fig. 1 Timeseries of photos from Huteson Memorial Forest (HMF) in Somerset County, New Jersey. HMF is mixed oak-hickory forest with 26 ha of old growth surrounded by secondary forest, old fields, and farm fields. (a) Shows the forest in 1976 with an intact shrub layer. Overbrowsing by deer and non-native plant invasion have changed the forest understory and midcanopy from native saplings, shrubs and herbs such as Viburnum acerifolium, Circaa lutetiana, and Podophyllum peltatum (Davison 1981) to, (b) a dense understory composed mostly of Microsogium virginicum and another exotic invasive, Alliaria petiolata (foreground) (2005) and (c) leaf litter with small patches of Microsogium virginicum (2005). Photograph (a) is courtesy of Jim Quinn and (b) and (c) are courtesy of Myla Aronson

Fig. 3 Plotted abundance trend estimates from 1980 to 2005 for 21 forest breeding bird species in New Jersey. Estimates are classified based on dominant vertical nesting location (canopy, midcanopy, or shrub/ground). Solid circles indicate species that show a positive trend in annual abundance change, whereas open circles represent species experiencing a negative trend. The zero line represents no change in abundance through time. Large circles indicate that the trend is statistically significant, whereas small circles indicate nonsignificance. On the y-axis labels can be translated as a percentage. For example, a species sitting at the −5.0 level can be said to declining in abundance by an estimated 5% per year.
HOW WOLVES CHANGE RIVERS

http://www.youtube.com/watch?v=ysa5OBhXz-Q
<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Species Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zelkova</td>
<td>0</td>
</tr>
<tr>
<td>Ulmus (Elm)</td>
<td>206</td>
</tr>
<tr>
<td>Sorbaria (False Spiraea)</td>
<td>2</td>
</tr>
<tr>
<td>Spiraea (Meadowsweet)</td>
<td>86</td>
</tr>
</tbody>
</table>

(Tallamy n.d.)
Invasive Plant Species Effects on Food Web

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Herbivores Supported in Homeland</th>
<th>Herbivores Supported in North America</th>
<th>Years Since Introduction to North America</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clematis vitalba</td>
<td>40 species</td>
<td>1 species</td>
<td>100</td>
<td>Macfarlane &amp; van den Ende 1995</td>
</tr>
<tr>
<td>Eucalyptus stellulata</td>
<td>48 species</td>
<td>1 species</td>
<td>100</td>
<td>Morrow &amp; La Marche 1978</td>
</tr>
<tr>
<td>Melaleuca quinquenervia</td>
<td>409 species</td>
<td>8 species</td>
<td>120</td>
<td>Costello et al. 1995</td>
</tr>
<tr>
<td>Opuntia ficus-indica</td>
<td>16 species</td>
<td>0 species</td>
<td>250</td>
<td>Annecke &amp; Moran 1978</td>
</tr>
<tr>
<td>Phragmites australis</td>
<td>170 species</td>
<td>5 species</td>
<td>300+</td>
<td>Tewksbury et al. 2002</td>
</tr>
</tbody>
</table>

(Tallamy 2009)
An Ounce of Prevention

Planting Natives Instead of Exotic Invasives

Hasse and Lathrop (2010)
Acknowledgements

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• Public Partners: Duke Farms; Great Swamp Watershed Association; Somerset, Hunterdon and Middlesex County Parks Systems; NJDEP; Readington Twp Open Space Advisory Board; Rutgers University; Raritan Township; Greenbrook Sanctuary


Tallamy, Doug. Professor and Chair of the Department of Entomology and Wildlife Ecology at the University of Delaware in Newark, Delaware. Deer Management Handout