Citizen Science as a Way to Collect Data

**Purpose:** To collect broad scale data across many sites that can be used to answer scientific questions and to inform management and policy decisions.

Not a new concept. Citizen science type programs, such as the Christmas Bird Count (National Audubon) and the Breeding Bird Survey (USGS), have existed for decades.
Citizen Science as Informal Science Education

**Purpose:** To increase awareness, knowledge and skills and to engage the public

Connecting people with Nature
Citizen Science Projects

Joint projects between New Jersey Audubon Society and collaborating organizations
Arsenic in Public Parks and Playgrounds

Concentration of PCBs in beached plastic resin pellet (ng/g pellet)

Surveys of Microplastic on NJ Shoreline
SENCER

SENCER-ISE (Science Education for New Civic Engagements and Responsibilities, Informal Science Education) focuses on the improvement of undergraduate teaching and learning through the framework of civic engagement.

With funding from NSF and the Noyce Foundation, SENCER provided 10 grants to partnerships that integrate the higher education community with informal science opportunities to form long-term partnerships over issues of civic importance.
Open Space Preservation

1.2 million acres preserved or protected

BUT ... Highly Fragmented Landscape
i.e., Need for Management/Stewardship
Open Space Preservation

1.2 million acres preserved or protected from development...

but the *quality* of natural areas is not necessarily maintained.

The integrity of natural ecosystems is threatened by the physical and biological effects of fragmentation and other factors.
Fragmented Landscapes are Ideal Habitat for:

White-Tailed Deer
(\textit{Odocoileus virginianus})

&

Exotic Invasive Species
Deer Overabundance

>10 deer/mi$^2$
Impact preferred browse species

>20 deer/mi$^2$
Prevent forest regeneration

>100 deer/mi$^2$
Without deer management

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

Historic: 8-11 deer/mi$^2$

Current: 13-76 deer/mi$^2$

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)
Vehicle Damage from Deer Collisions

- 26,860 deer collisions reported in NJ in 2013 (State Farm Insurance)
  - 13-14% (3868 collisions) in Hunterdon County

- New Jersey spends > $111 million/yr. in insurance claims related to deer collisions.
  - i.e., $16 million in Hunterdon County (NJ.com, 2015)
Effect of Deer Site Use on Tick Abundance in NJ

Effect of Invasive Shrub Cover on Tick Abundance in NJ

207-528 cases/yr in Hunterdon since 2000

Highest rate in NJ for 10 out of past 15 yrs

36-91 cases/yr in Raritan Twp
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

Infographic by Peter Smallidge, Berndt Blossey

**Fig. 1** Timeseries of photos from Hutcheson 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*, *Cimicifuga racemosa*, and *Podophyllum peltatum* (Davison 1981) to, (b) a dense understory composed mostly of *Microstegium vimineum* and another exotic invasive, *Alliaria petiolata* (foreground) (2005) and (c) leaf litter with small patches of *Microstegium vimineum* (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.
Exotic Invasive Plant Species

Approximately 2,200 indigenous plant species, subspecies, hybrids or varieties in New Jersey... and ca. 1,300 non-indigenous species = 37% of state flora!!!

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

Economic Impacts:
Invasive species cause over $100 billion of damage in the United States every year with $290 million being in NJ alone!

(Density of Exotic Species - #/10,000 km²)
Exotic vs. Native Species – *Food Web Effects*

**Zelkova**
Zelkova
Supports **0** different species of moths and butterflies.

**Ulmus**
Elm
Supports **206** different species of moths and butterflies.

**Sorbaria**
False Spiraea
Supports **2** different species of moths and butterflies.

**Spiraea**
Meadowsweet
Supports **86** different species of moths and butterflies.

(Tallamy n.d.)
### Invasive Plant Species Value for Native Wildlife

#### Hosting Capacity of Alien Plants Introduced to North America

<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><em>Clematis vitalba</em></td>
<td>40 species</td>
<td>1 species</td>
<td>100</td>
<td>Macfarlane &amp; van den Ende 1995</td>
</tr>
<tr>
<td><em>Eucalyptus stellulata</em></td>
<td>48 species</td>
<td>1 species</td>
<td>100</td>
<td>Morrow &amp; La Marche 1978</td>
</tr>
<tr>
<td><em>Melaleuca quinquenervia</em></td>
<td>409 species</td>
<td>8 species</td>
<td>120</td>
<td>Costello et al. 1995</td>
</tr>
<tr>
<td><em>Opuntia ficus-indica</em></td>
<td>16 species</td>
<td>0 species</td>
<td>250</td>
<td>Annecke &amp; Moran 1978</td>
</tr>
<tr>
<td><em>Phragmites australis</em></td>
<td>170 species</td>
<td>5 species</td>
<td>300+</td>
<td>Tewksbury et al. 2002</td>
</tr>
</tbody>
</table>
Assessing Forest Health: Structure and Composition

Central New Jersey
- Raritan Watershed
- Piedmont Province

Three Forest Types: Riparian, Upland, Mountain

Mountain = Rocky (Basalt and Diabase)
Upland = Clay (Shale, Mudstone and Sandstone)
Floodplain = Alluvial
Forest Age
“Old” and “New” (before or after 1930)

Forest Development in Central NJ – 1899 to 2012
Assessing Forest Health: Structure and Composition

Historical Forest Studies (1936-1957)

NJ Deer Population Trends

- Monk (1956-57)
- Buell and Wistendahl (1954-55)
- Cantlon (1948-49)

- Van Vechten and Buell (1956)
- Millstone River

- Moldenke (1936)
- Watchung Reservation

- Buell and Wistendahl (1954-55)
- Burnt Mills, Duke Island Park, Johnson Park

- Mettlars Woods
Forest Study Methodology
2014-2016 Vegetation Studies: Forest Ecology Interns

**Counted / Measured:**
- 39,859 trees
- 509,650 seedlings
- 4,120 herb plots
- 20.6 km shrub/liana data
Trees – Size/Age Class Structure Patterns and Regeneration

**Size Class Categories**

- **Seedlings:** <1’ height <1” diameter
- **Saplings:** >1’ height <1” diameter
- **Small trees:** 1 - 3.9” dbh
- **Med. trees:** 4 - 9.9” dbh
- **Large trees:** > 10.0” dbh
Comparison of Past and Present Forest Size Class Structure

% Change from Past (1940-50) to Present (2014-16)

<table>
<thead>
<tr>
<th>Age</th>
<th>Seedlings</th>
<th>Saplings</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>“New”</td>
<td>25%</td>
<td>-91%</td>
<td>-62%</td>
<td>-2%</td>
<td>12%</td>
</tr>
</tbody>
</table>
% Decline in tree size class from past to present in old and new forests

**Floodplain**

- **Seedlings**
  - Old Saplings: -88%
  - New Saplings: -91%

- **Saplings**
  - Old Small: -81%
  - New Small: -80%

**Upland**

- **Seedlings**
  - Old Saplings: -81%
  - New Saplings: -84%

- **Saplings**
  - Old Small: -26%
  - New Small: -14%

**Mountain**

- **Seedlings**
  - Old Saplings: -98%
  - New Saplings: -99%

- **Saplings**
  - Old Small: -74%
  - New Small: -84%
Why the lack of regeneration? *Shade Intolerance vs. Deer*

**% Composition of Forest Size Classes**

**Results:**

- Increases in *Shade Intolerant* species (i.e., more canopy gaps than in past)
- Increases in *Deer Resistant* species (i.e., more deer pressure than in past)
Deer Densities
Spotlight Surveys

2016 Survey Results - # deer/mi²
Relationship of # Saplings to Deer Densities

![Graph showing the relationship between saplings and deer densities with an R² value of 0.88.](image)
Experimental Evidence for Effects of Deer: *Exclosures and Other Ecological Deer Management*

### Seedlings
- **Managed**: 5000
- **Historic**: 4000
- **Other**: 3000

### Saplings
- **Managed**: 1500
- **Historic**: 1200
- **Other**: 800

### Small Trees
- **Managed**: 30
- **Historic**: 20
- **Other**: 10
Experimental Evidence for Effects of Deer: Effects of Ecological Deer Management on # Saplings

- Historic: # Saplings/2000m²
- Exclosures (12)
- Duke Farms (19)
- Princeton (35)
- Hopewell (60)
- Others (161)
**Deer Overabundance**

>10 deer/mi²  
Impact preferred browse species

>20 deer/mi²  
Prevent forest regeneration

>100 deer/mi²  
Without Deer Mgmt.

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

Historic: **8-11 deer/mi²**  
Healthy forest with dense understory vegetation and native plant species.

Current: **13-76 deer/mi²**  
Overbrowsed forest at Hutcheson Memorial Forest in Franklin Township (2012)

Overbrowsed forest with invasive barberry shrubs at Peter's Tract in Bernardsville (2016)
Forest Understory Layers:  
*Relative Cover of Shrubs, Herbs, and Lianas*

◆ More invasive than native  
◆ Greater proportion of invasives in “Young” forests
Herb Layer - 55% *more* Invasive Herbs in Young vs. Old Forests (237% more in Upland Forests)

Dominant Herbaceous Invasive - *Japanese Stilt Grass* (*Microstegium vimineum*)
Lianas - 158% more Invasive Lianas in Young vs. Old Forests (650% more invasive lianas in New Mountain Forests)

Dominant Invasive Liana - Japanese Honeysuckle (*Lonicera japonica*)
Shrubs - 166% more Invasive Shrubs in Young vs. Old Forests
466% more invasive shrubs in New Mountain Forests

Dominant Invasive Shrub - **Multiflora Rose** (*Rosa multiflora*)
Bird surveys are conducted using Fixed-Radius Point Counts

Surveyed during the ‘safe’ breeding dates

Pre-Survey Scouting to determine point accessibility

1st Survey (May 25-June 15):
   Bird point count, habitat assessment

2nd Survey (June 16-30):
   Bird point count, habitat assessment

Citizen Scientists are assigned to 5-10 points
2014-2015 Field Research: *Citizen Science Results*

~300 points surveyed at 25 sites

~7500 *birds counted!*

94 *Species*
Edge and Area Effects: *Forest Interior and Ground Nesting Birds*

<table>
<thead>
<tr>
<th>Closest Edge</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>Count</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Forest Interior</th>
<th>Ground Nesters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acadian Flycatcher</td>
<td>Black and White Warbler</td>
</tr>
<tr>
<td>American Redstart</td>
<td>Blue Winged Warbler</td>
</tr>
<tr>
<td>Broad Winged Hawk</td>
<td>Chestnut Sided Warbler</td>
</tr>
<tr>
<td>Hooded Warbler</td>
<td>Eastern Towhee</td>
</tr>
<tr>
<td>Kentucky Warbler</td>
<td>Louisiana Waterthrush</td>
</tr>
<tr>
<td>Ovenbird</td>
<td>*Worm Eating Warbler</td>
</tr>
<tr>
<td>Pileated Woodpecker</td>
<td>White Eyed Vireo</td>
</tr>
<tr>
<td>Red Eyed Vireo</td>
<td>Wild Turkey</td>
</tr>
<tr>
<td>Scarlet Tanager</td>
<td>Veery</td>
</tr>
<tr>
<td>White Breasted Nuthatch</td>
<td>Wood Thrush</td>
</tr>
</tbody>
</table>

*Table 1 is a list of the forest interior and ground nesting bird species that our data focuses on. The names with an * signify the species is both a forest interior and ground nester.* (Rittenhouse et al. 2010)

**Forest-Interior Birds (n = 13) and Ground Nesters (n = 11)**
Significantly greater Abundance of Forest-Interior Birds in:

a) Large Forests (>300 acres) and b) Far From Edges (>220 m) (p < 0.0001*)
Significantly greater Diversity of Forest-Interior Birds in a) Large Forests (>300 acres) and b) Far From Edges (>220 m) \((p < 0.0001^*)\)
Edge and Area Effects: *Ground Nesters*

**Abundance**

**Diversity**

![Graphs comparing edge and area effects on ground nesters' abundance and diversity.](image-url)
Effects of Forest Age: *Forest Interior and Ground Nesters*

**Abundance**
- Forest Interior
- Ground Nesters

**Diversity**
- Forest Interior
- Ground Nesters

*Image: Box plots showing the comparison of abundance and diversity between new and old forest interiors and ground nesters.*
Outreach to Local Officials – Deer Management Options

Readington Twp, Raritan Twp, Bernardsville Borough
Highlands Coalition, NJ Native Plant Society, Partnership for NJ Plant Conservation, GSWA
Hunting Options for Deer Management:  
**Hunting Lease Agreements on Town Lands**

Recommended changes in hunting policies

- Increased Take
  
  2 to 1 “earn a buck”

- Hunting Targets (0.25/acre) & Harvest Reports

- Enforcement

- Monitoring Deer Population

- Community Based Deer Management (NJDEP)
  
  - Sharpshooters, Extended Season/Nocturnal Hunting

**Case studies of deer-forest management**

- Duke Farms – reduced deer from 80/mi² to 12/mi²

- Princeton Twp – down from 43/mi² to 17/mi²

- Bernards Twp – down from 34/mi² to 18/mi²
Cost Analysis: Deer Fencing

Approximate Cost for Fencing a 10 Acre Area:
Welded Wire & Posts: $22,400
or Plastic Fencing & Trees: $4,300

<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>433</td>
<td>$7.50</td>
<td>$3,322.50</td>
</tr>
<tr>
<td>Wire Fencing</td>
<td>4430 ft.</td>
<td>$4.00 - 4.50/ft.</td>
<td>$18,827.20</td>
</tr>
<tr>
<td>(or Plastic Fencing)</td>
<td></td>
<td></td>
<td>$4027.27</td>
</tr>
<tr>
<td>Gate</td>
<td>1</td>
<td>$250.00</td>
<td>$250.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$22,399.70</td>
</tr>
</tbody>
</table>

Charlotte Hill - Bernardsville Borough

Estimate done by BASH Contracting, in conjunction with NJ Ecological Solutions. Gate: Brenner’s Gardens, Pressure treated wood: Lowes
Cost Analysis: Planting

Approximate Cost for Replanting a 10 Acre Area: $74,700

Replanting Understory Trees on a 10 Acre Plot

<table>
<thead>
<tr>
<th>Plantings</th>
<th>Approximate Quantity</th>
<th>Average Cost (Per Tree)</th>
<th>Total Cost ³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saplings</td>
<td>30,580</td>
<td>$2.29</td>
<td>$70,028.20</td>
</tr>
<tr>
<td>Small Trees</td>
<td>1,180</td>
<td>$3.99</td>
<td>$4,708.20</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$74,736.40</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)
But Is This Humane?

Deer Mgmt. vs. Recreational Deer Hunting
- Overall healthier deer – more competition for mates; More food/deer

Less Deer = More Habitat for 1,000’s of other Species
- Yellowstone National Park - Reintroduction of wolves led to greater numbers of birds, wildflowers, trees, insects, mammals, and more

Hunters Helping the Hungry:
- Since the program’s inception [1997], hunters have donated over 234,000 pounds of venison to the HHH providing approximately 936,000 servings of protein to those in need
An Ounce of Prevention
Planting Natives Instead of Exotic Invasives
Native gardening and biodiversity matter.

This site supports the lecture series and book *Bringing Nature Home* by University of Delaware professor Doug Tallamy.

Why should you consider planting native?

www.bringingnaturehome.net
An Ounce of Prevention
Natives Alternatives to Invasives

Invasive vs. Native

Japanese Wisteria
- *Wisteria floribunda*

Invasive deciduous vine
Destroys canopy cover and kills trees.

American Wisteria
- *Wisteria frutescens*

Native deciduous vine
Can be used same as invasive cousin but does not spread to local forests.

(Tallamy n.d.)
Invasive vs. Native

**Callery Pear**  - *Pyrus calleryana*

Classic white flowering tree that often lines the edge of a residential road.

Has colorful fall foliage.

Disrupts food web, takes over fields and forests, does not support native insects  (Summers 2010)

**Flowering Dogwood**  - *Cornus florida*

Supports 118 different species of moths and butterflies.

Red foliage in the fall.

* Attractive landscape feature and also...
* Visual cue for birds as the lipid rich berries are an important food source during migration.

(Tallamy n.d.)
Acknowledgements

• SENCER-ISE Program – Hailey Chenevert, Ellen Mappen
  • NJ Audubon – Kelly Wenzel, Mike Allen, Dale Rosselet; Citizen Scientists
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  • RVCC Environmental Club; RVCC Foundation; Private Donations from RVCC and Local Community
References


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