

# Assessing Forest Health in Central New Jersey: *Impacts of Deer and Invasive Plant Species*



**November 15, 2016**  
**Great Swamp Watershed Association**

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# *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



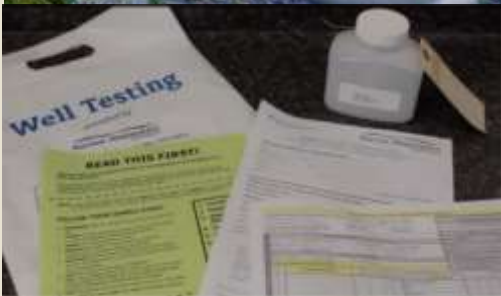
# Citizen Science Projects

Joint projects between New Jersey Audubon Society and collaborating organizations





# Community Well Test Program



# Endangered and Invasive Species Surveys

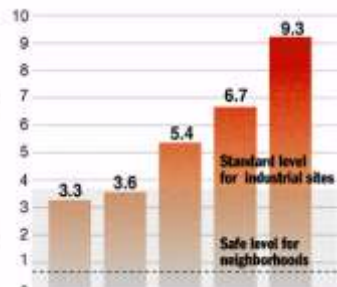


# Arsenic in Public Parks and Playgrounds



## Poison in the parks

Arsenic is leaching into the soil of five community parks. Independent analysis found arsenic levels higher than the 0.8 parts per million the state considers safe for neighborhoods. The state standard for



# Surveys of Microplastic on NJ Shoreline

## International Pellet Watch

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



# *Assessing Forest Health in Central NJ*

## **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**

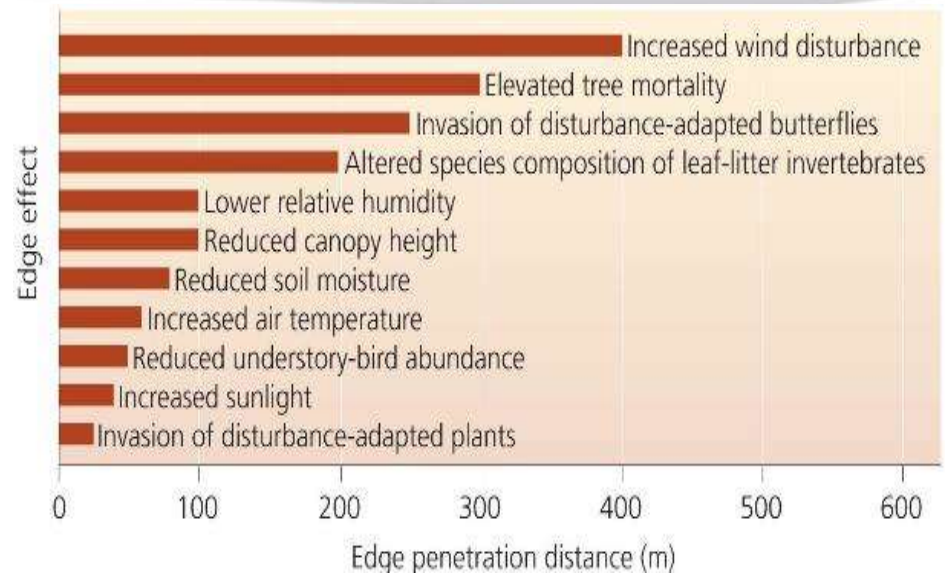






## Open Space Preservation

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  
(*Odocoileus virginianus*)**

**&**

***Exotic Invasive Species***





## Deer Overabundance

**>10 deer/mi<sup>2</sup>**

Impact preferred  
browse species

**>20 deer/mi<sup>2</sup>**

Prevent forest  
regeneration

**>100 deer/mi<sup>2</sup>**

Without deer  
management

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

Historic: **8-11 deer/mi<sup>2</sup>**



Healthy forest with dense understory  
vegetation and native plant species.

Current: **13-76 deer/mi<sup>2</sup>**



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



Overbrowsed forest with invasive  
barberry shrubs at Peter's Tract in  
Bernardsville (2016)





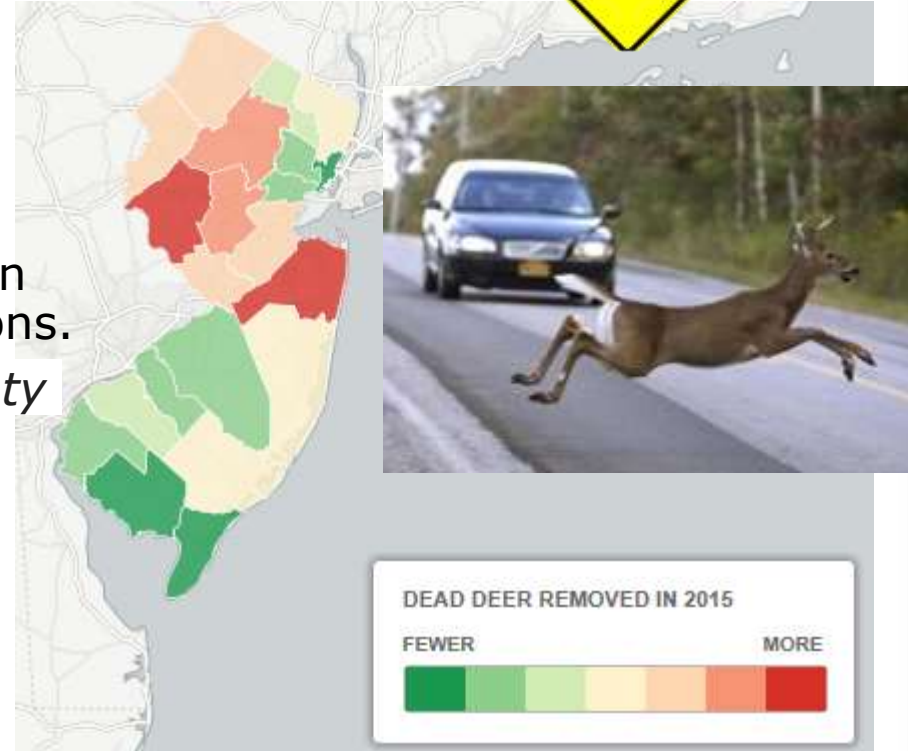
# Vehicle Damage from Deer Collisions

- 26,860 deer collisions reported in NJ in 2013 (State Farm Insurance)

*13-14% (3868 collisions) in Hunterdon County*

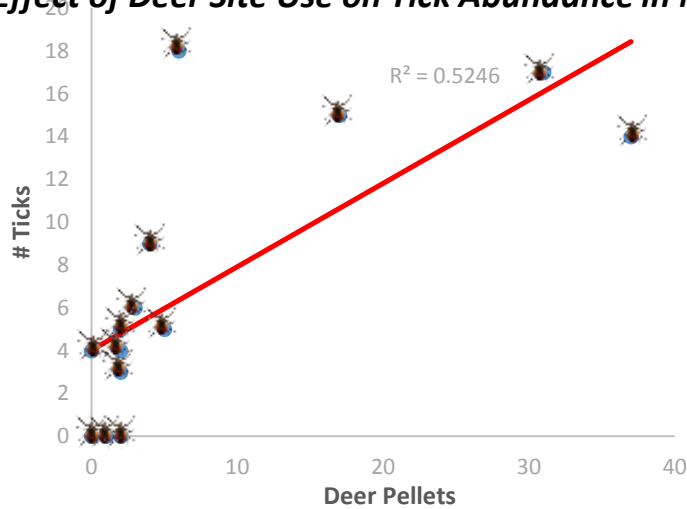
- New Jersey spends > \$111 million/yr. in insurance claims related to deer collisions.

*i.e., \$16 million in Hunterdon County (NJ.com, 2015)*





**Effect of Deer Site Use on Tick Abundance in NJ**

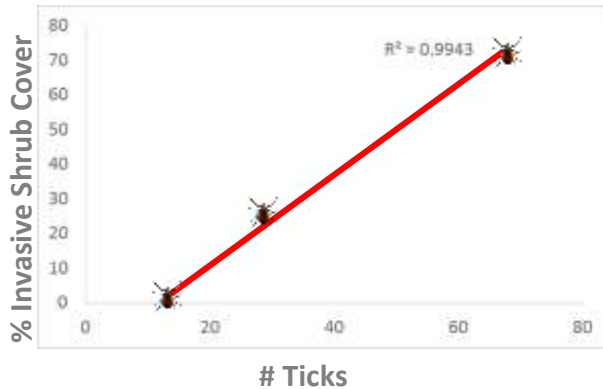


**Reported Cases of Lyme Disease -- United States, 2014**



1 dot placed randomly within county of residence for each confirmed case  
Center for Disease Control and Prevention

**Effect of Invasive Shrub Cover on Tick Abundance in NJ**



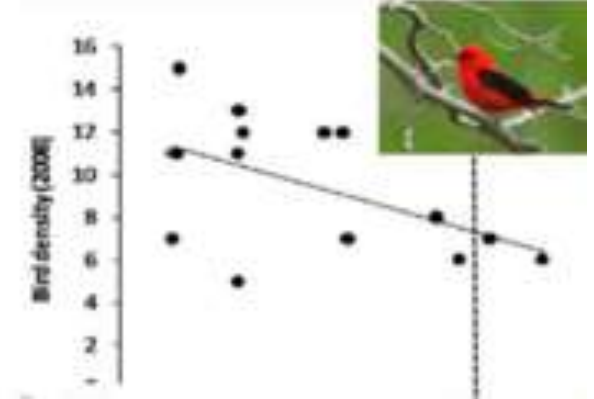
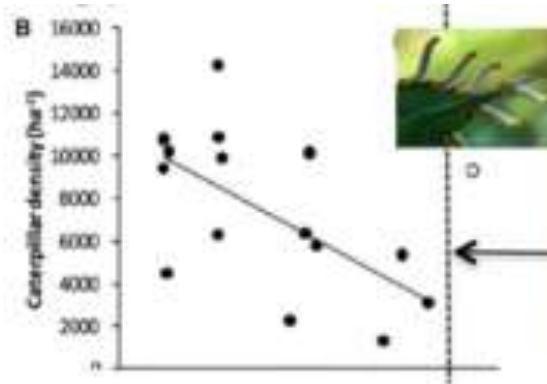
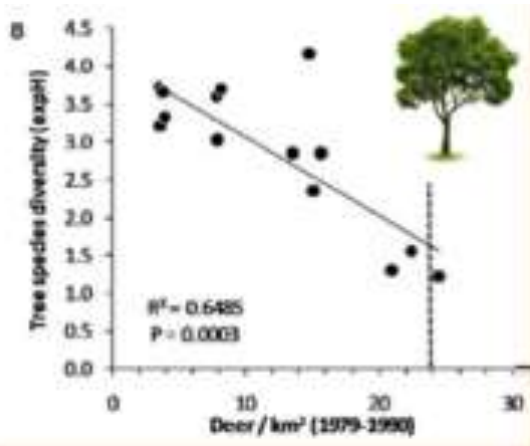
**207-528 cases/yr in Hunterdon since 2000**  
*Highest rate in NJ for 10 out of past 15 yrs*  
**36-91 cases/yr in Raritan Twp**



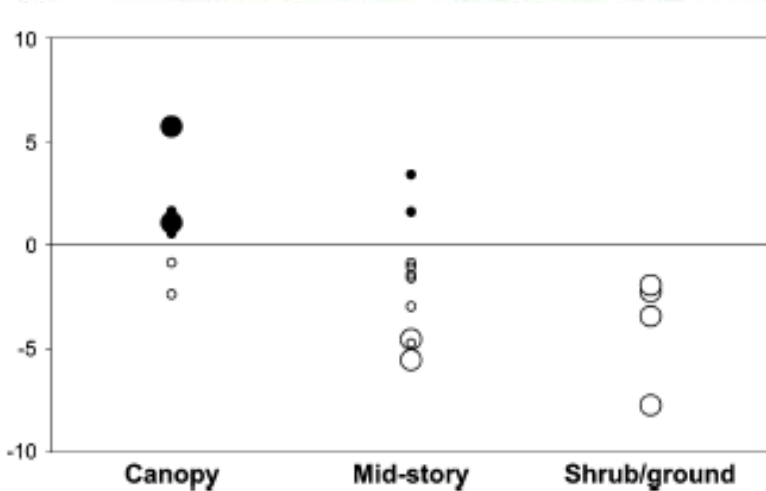
# Effects of Deer on the Food Web

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



## Effects of Deer on Ground/Shrub Nesting Birds - HMF



**Fig. 1** Time series 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

**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

herbs such as *Viburnum acerifolium*, *Circaea lutetiana*, 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





## *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)

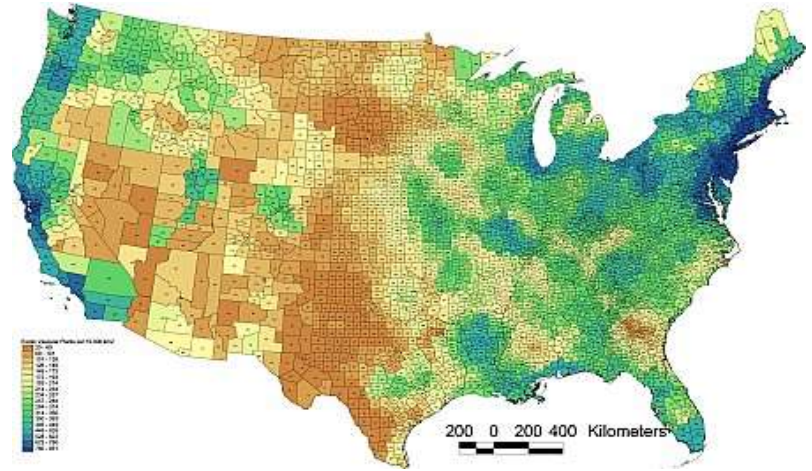
(Snyder and Kaufman 2004)

### **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)

(Snyder and Kaufman 2004)



**Density of Exotic Species - #/10,000 km<sup>2</sup>**

(BONAP 2011)



# 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.



# Invasive Plant Species Value for Native Wildlife

HOSTING CAPACITY OF ALIEN PLANTS INTRODUCED TO NORTH AMERICA				
Plant Species	Herbivores Supported in Homeland	Herbivores Supported in North America	Years Since Introduction to North America	Reference
<i>Clematis vitalba</i>	40 species	1 species	100	Macfarlane & van den Ende 1995
<i>Eucalyptus stellulata</i>	48 species	1 species	100	Morrow & La Marche 1978
<i>Melaleuca quinquenervia</i>	409 species	8 species	120	Costello et al. 1995
<i>Opuntia ficus-indica</i>	16 species	0 species	250	Annecke & Moran 1978
<i>Phragmites australis</i>	170 species	5 species	300+	Tewksbury et al. 2002



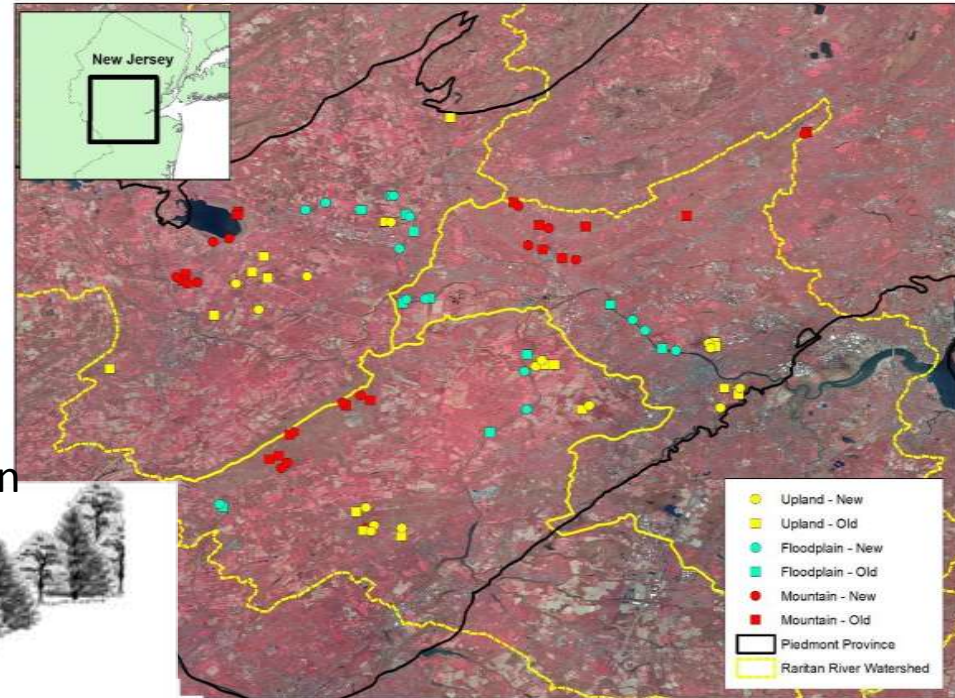
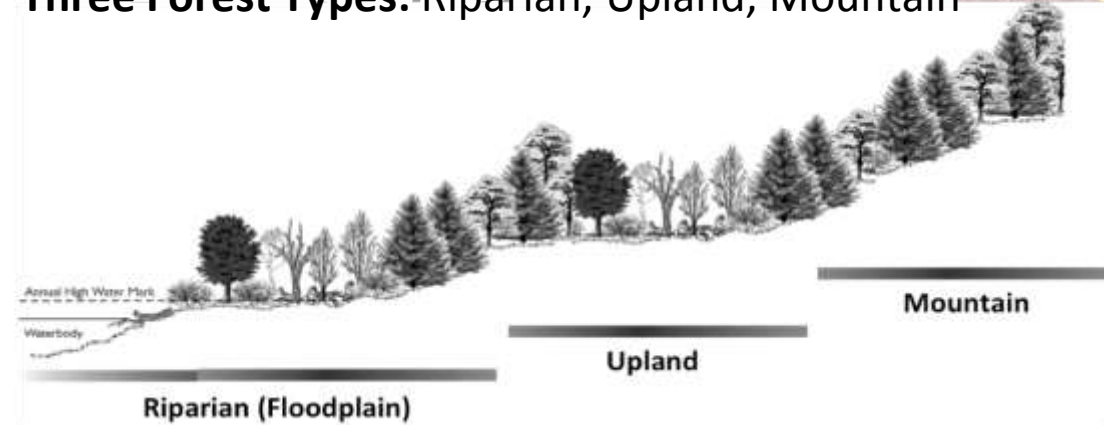


# Assessing Forest Health: Structure and Composition

## Central New Jersey

- *Raritan Watershed*
- *Piedmont Province*

Three Forest Types:-Riparian, Upland, Mountain



**Mountain** = Rocky (Basalt and Diabase)

**Upland** = Clay (Shale, Mudstone and Sandstone)

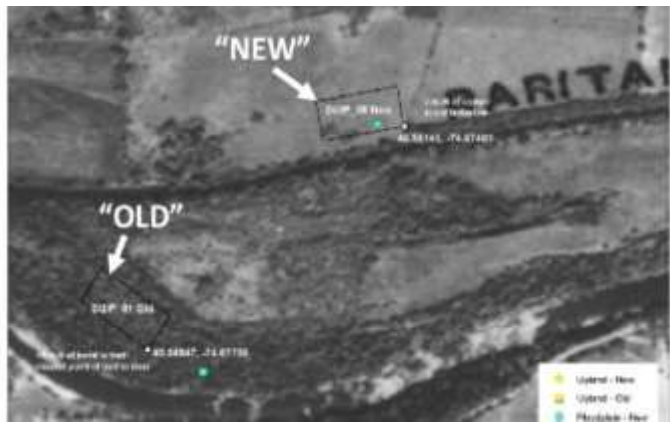
**Floodplain** = Alluvial



# Forest Age

“Old” and “New” (before or after 1930)

# Forest Development in Central NJ – 1899 to 2012



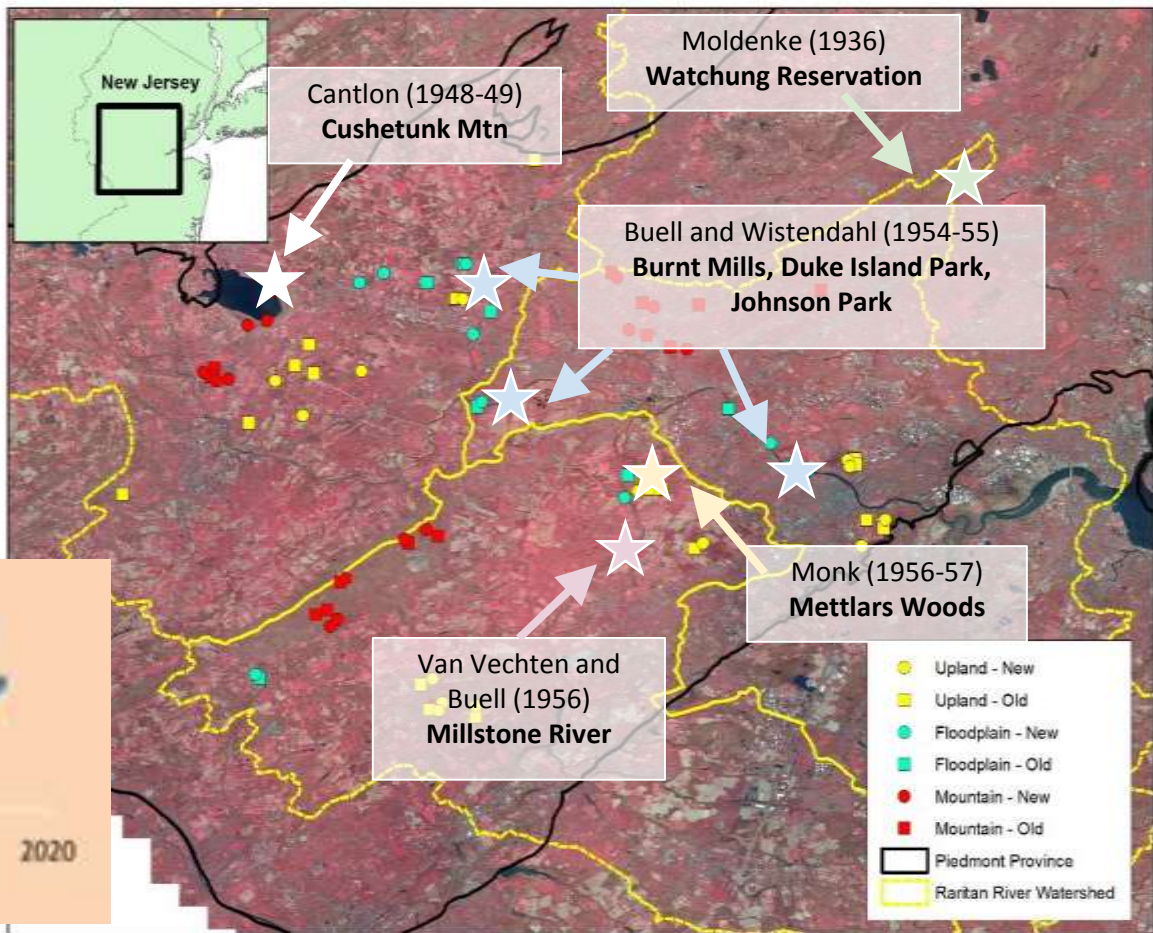
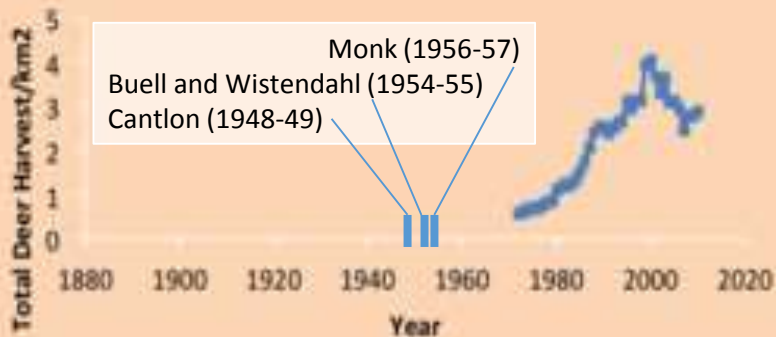




# Assessing Forest Health: Structure and Composition

## Historical Forest Studies (1936-1957)

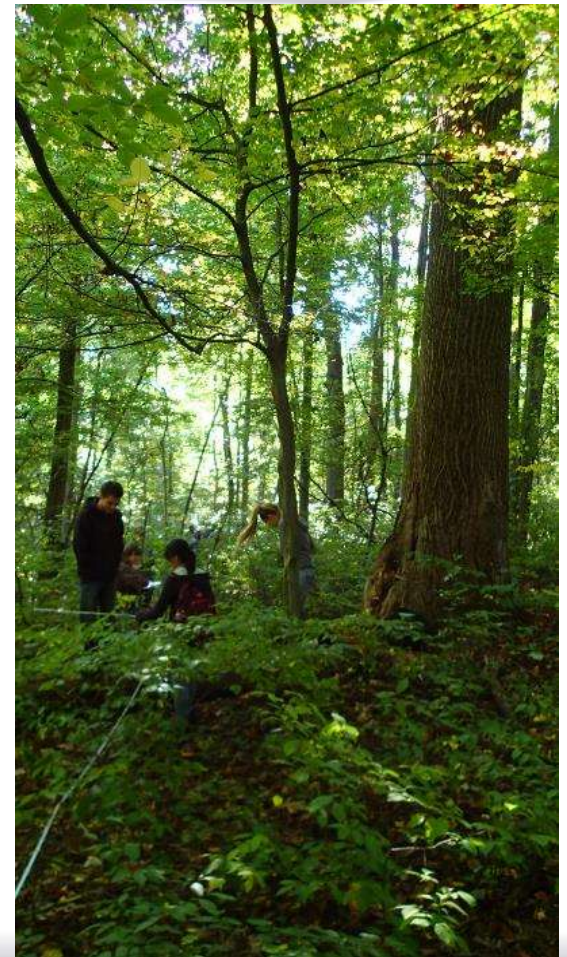
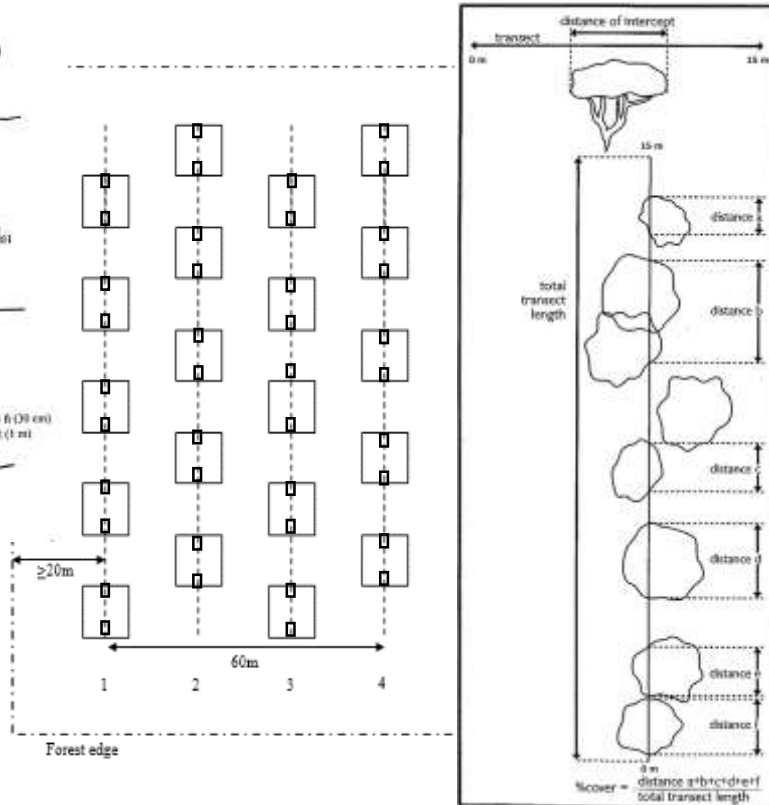
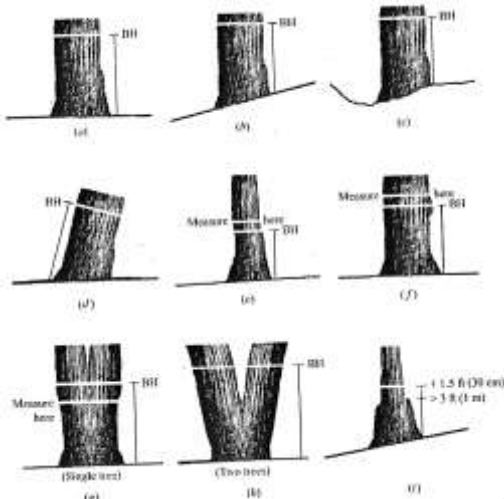
### NJ Deer Population Trends







# Forest Study Methodology







## 2014-2016 Vegetation Studies: Forest Ecology Interns



### Counted / Measured:

39,859 trees

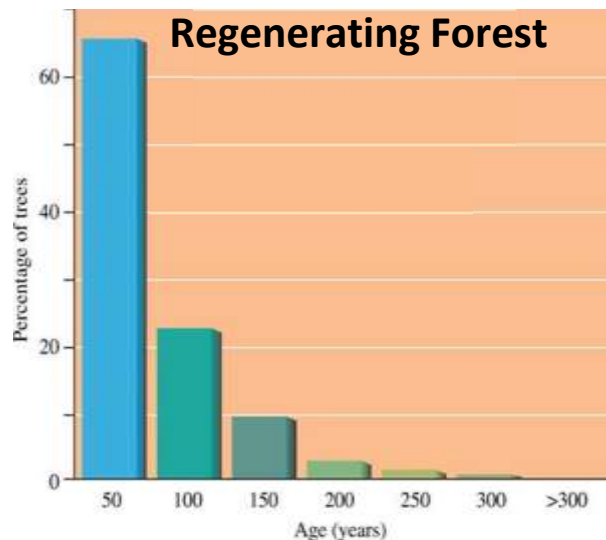
509,650 seedlings

4,120 herb plots

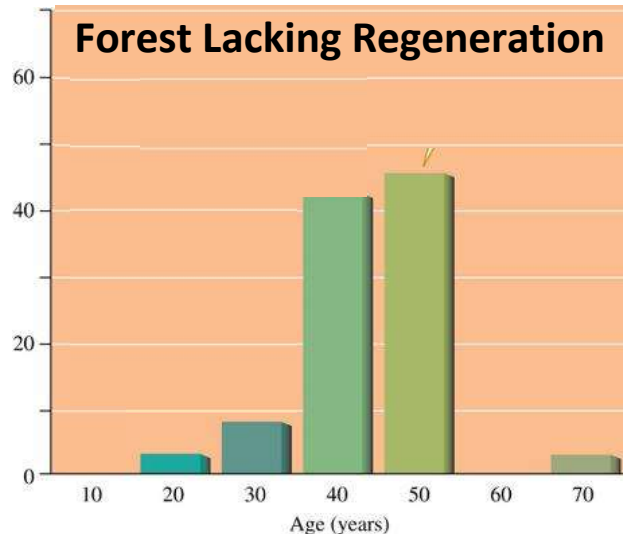
20.6 km shrub/liana data



# Trees – Size/Age Class Structure Patterns and Regeneration



Study Area - 1940s-50s



Study Area: 2014-2015

## Size Class Categories

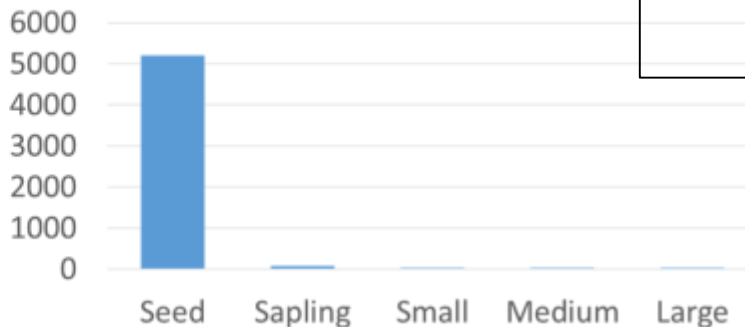
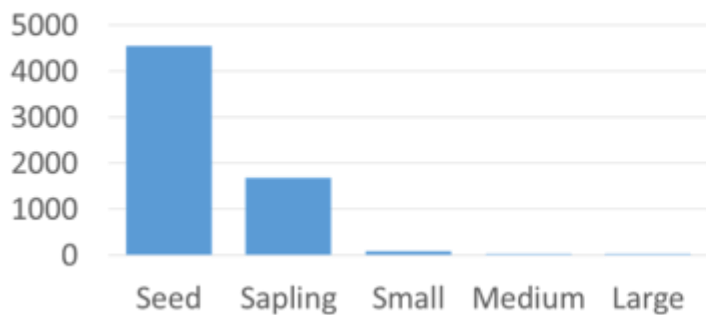
Seedlings: <1' height  
<1" diameter

Saplings: >1' height  
<1" diameter

Small trees: 1 - 3.9" dbh

Med. trees: 4 - 9.9" dbh

Large trees: > 10.0" dbh

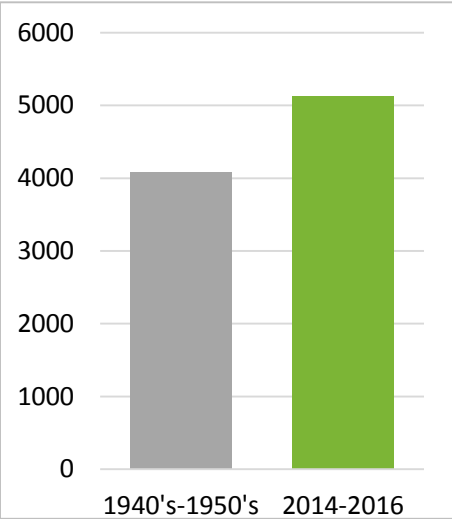




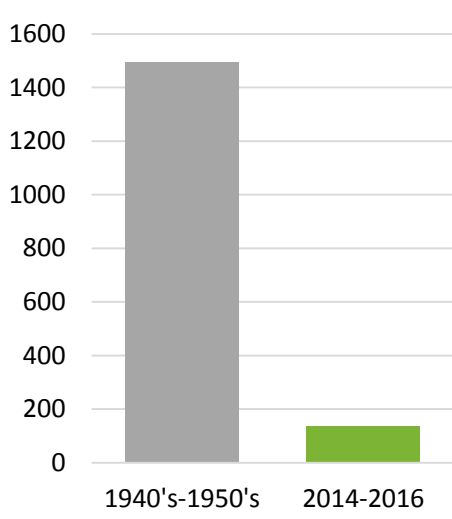


# Comparison of Past and Present Forest Size Class Structure

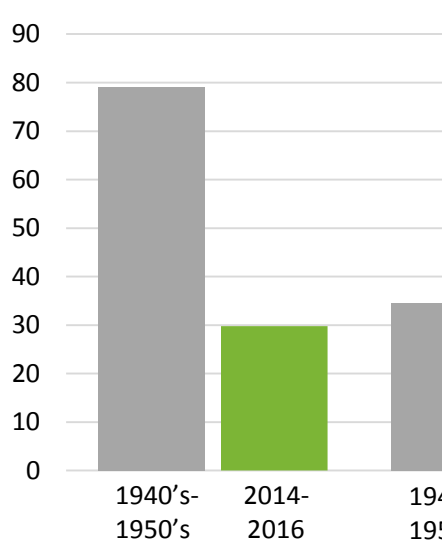
### Seedlings



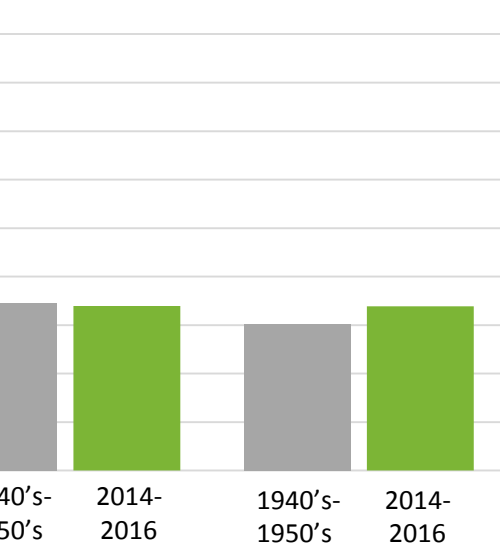
### Saplings



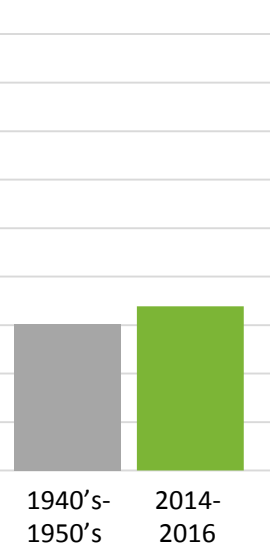
### Small



### Medium



### Large

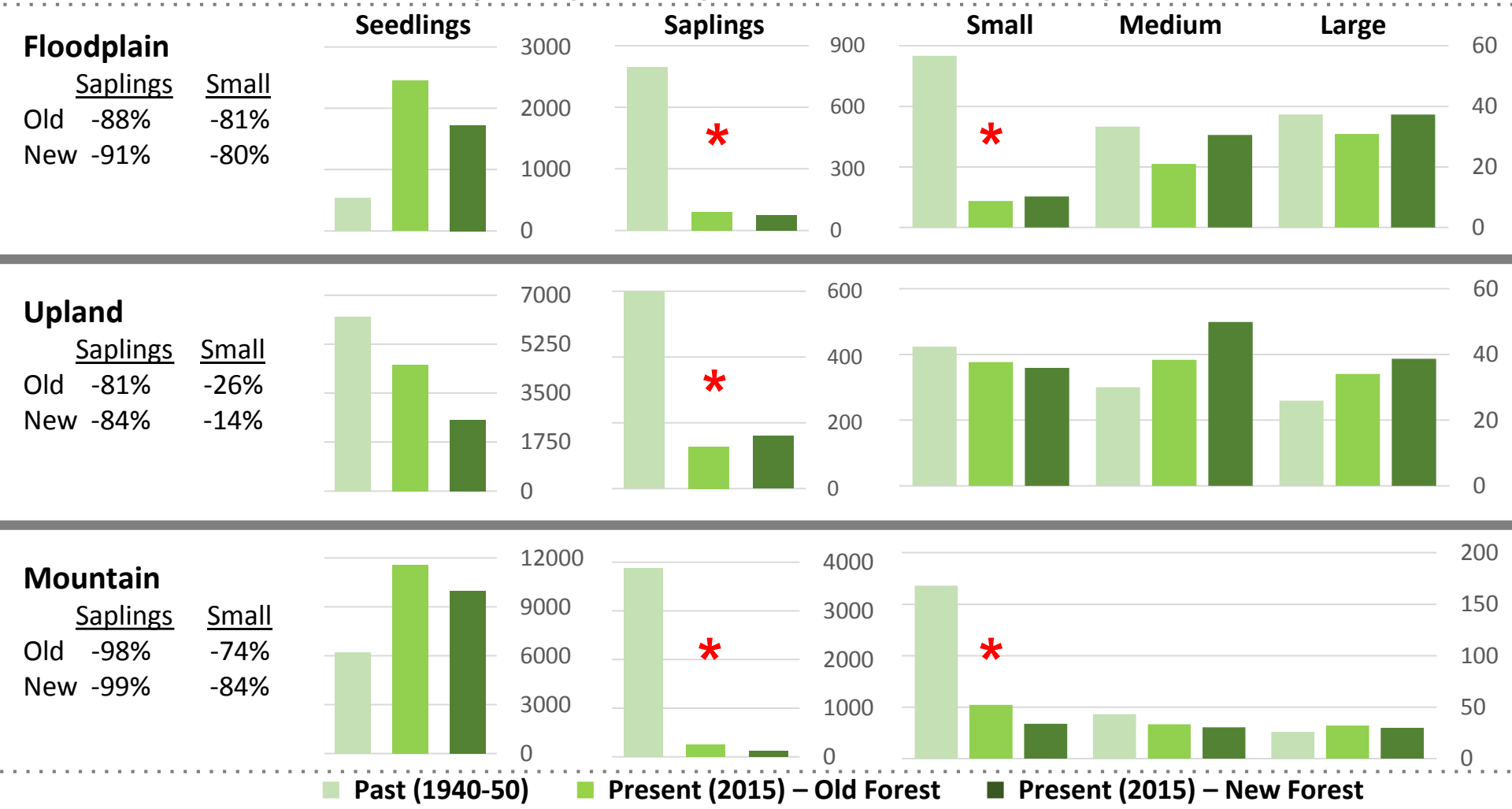


## % Change from Past (1940-50) to Present (2014-16)

Age	Seedlings	Saplings	Small	Medium	Large
"New"	25%	<b>-91%</b>	<b>-62%</b>	-2%	12%

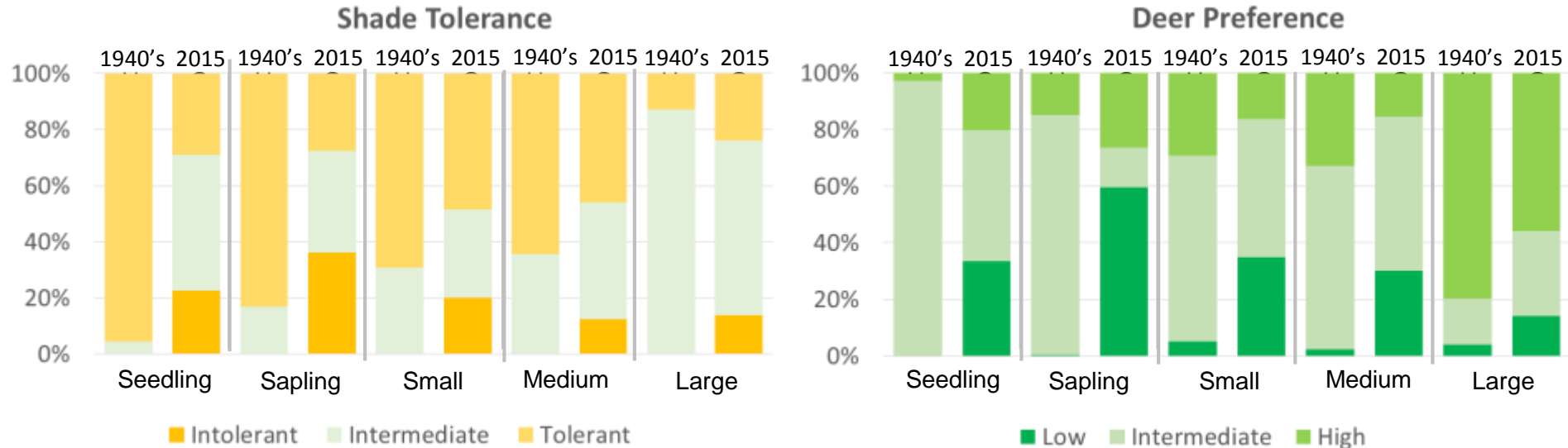


# % Decline in tree size class from past to present in old and new forests





# Why the lack of regeneration? *Shade Intolerance vs. Deer* *% Composition of Forest Size Classes*



## Results:

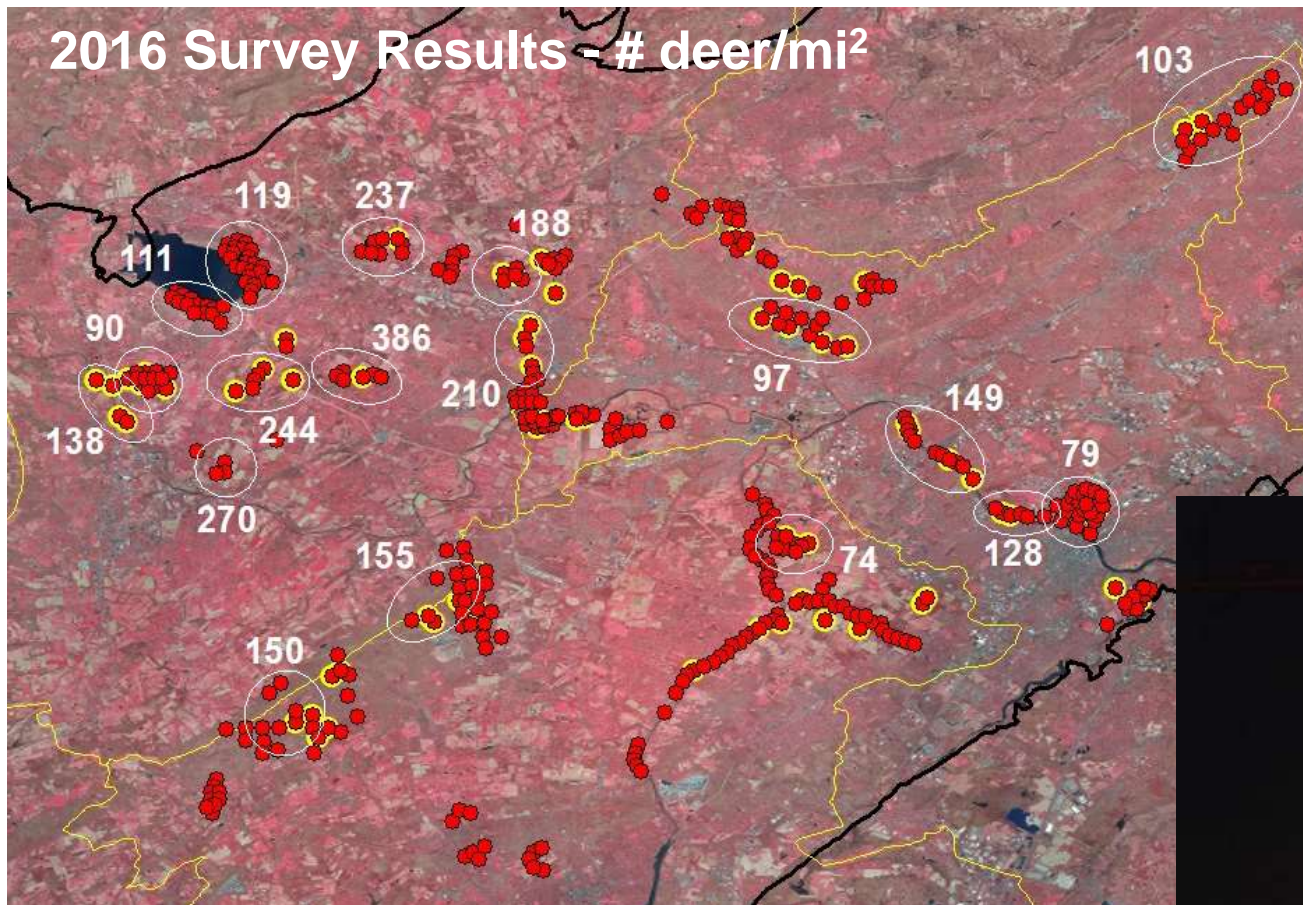
Increases in *Shade Intolerant* species (i.e., more canopy gaps than in past)

Increases in *Deer Resistant* species (i.e., more deer pressure than in past)





# 2016 Survey Results - # deer/mi<sup>2</sup>

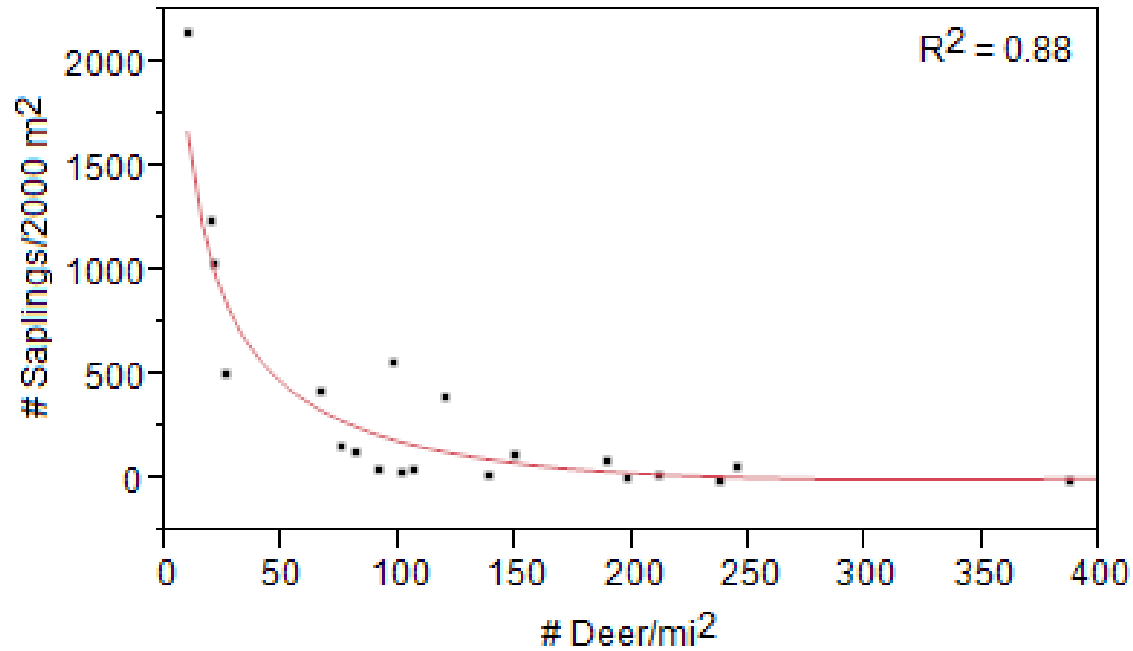


## Deer Densities *Spotlight Surveys*





## Relationship of # Saplings to Deer Densities



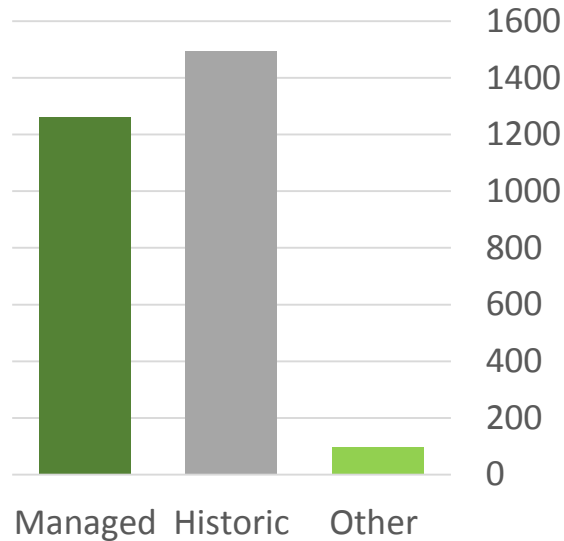


# Experimental Evidence for Effects of Deer: *Exclosures and Other Ecological Deer Management*

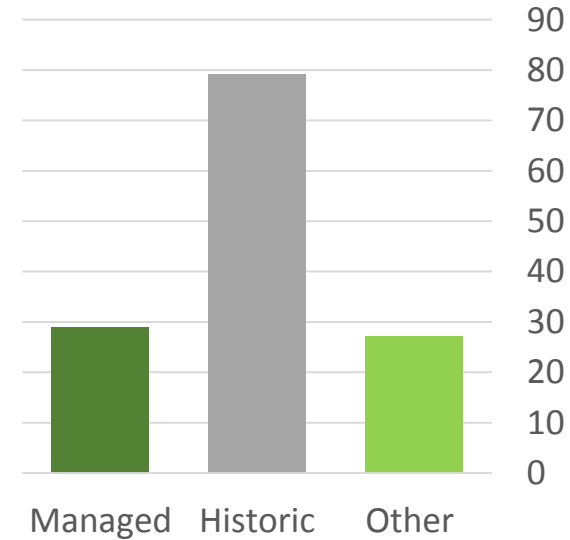
### Seedlings



### Saplings



### Small Trees

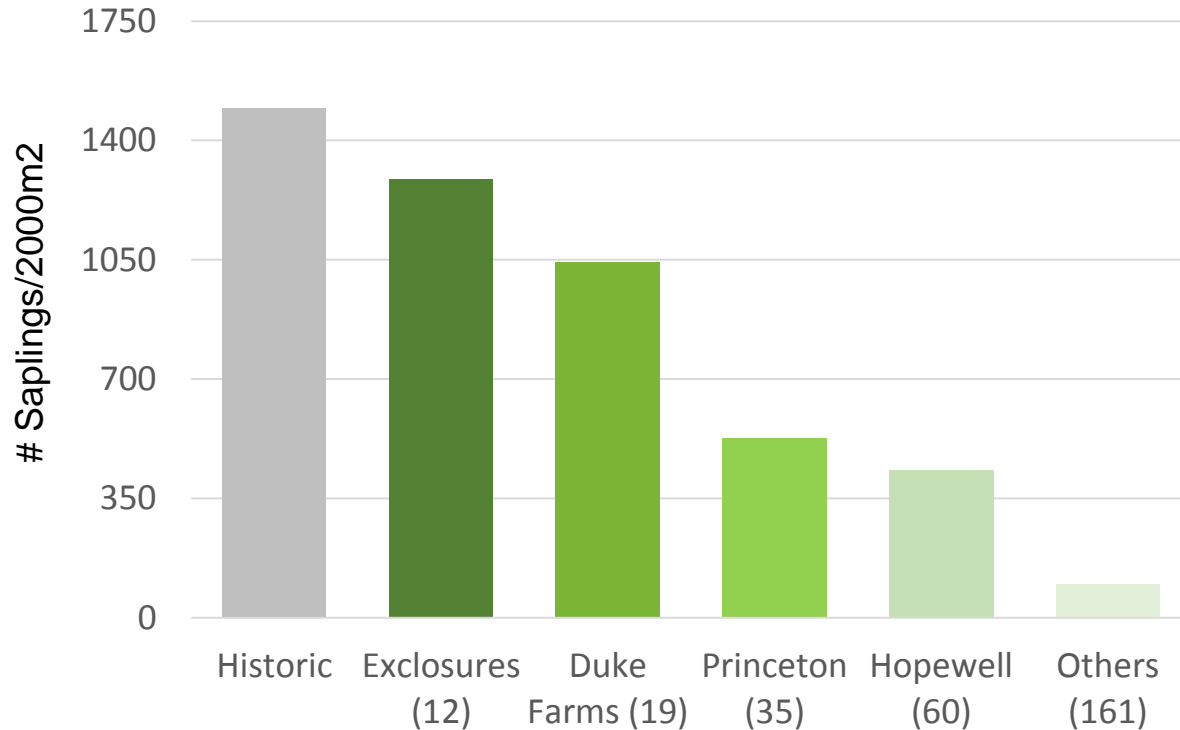






# Experimental Evidence for Effects of Deer:

## *Effects of Ecological Deer Management on # Saplings*





# Deer Overabundance

**>10 deer/mi<sup>2</sup>**

Impact preferred  
browse species

**>20 deer/mi<sup>2</sup>**

Prevent forest  
regeneration

**>100 deer/mi<sup>2</sup>**

Without Deer Mgmt.

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

Historic: **8-11 deer/mi<sup>2</sup>**



Healthy forest with dense understory  
vegetation and native plant species.

Current: **13-76 deer/mi<sup>2</sup>**



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

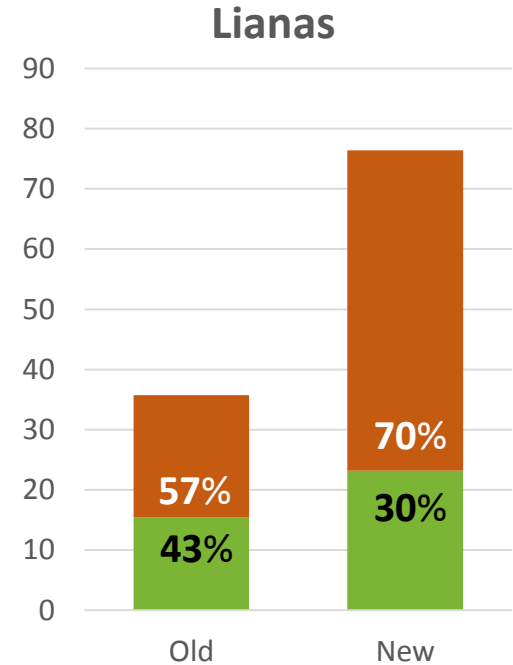
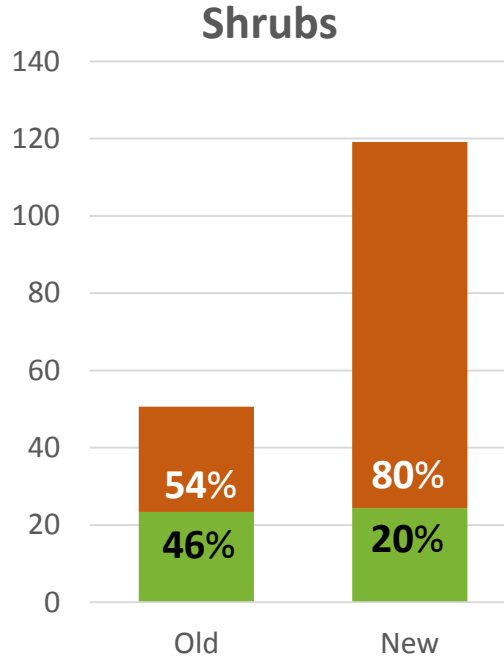
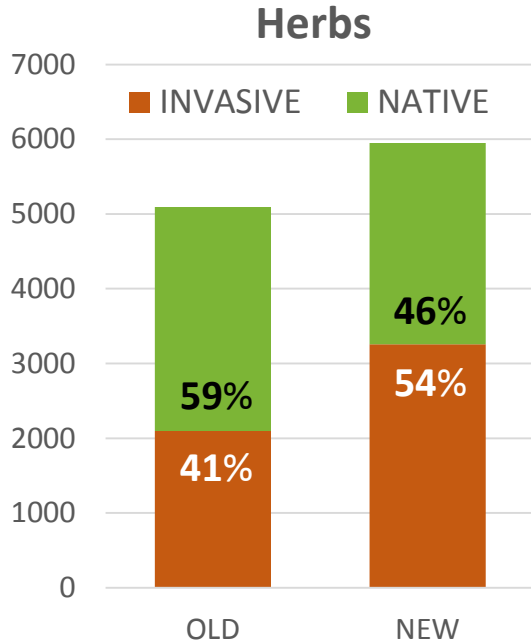


Overbrowsed forest with invasive  
barberry shrubs at Peter's Tract in  
Bernardsville (2016)

# Forest Understory Layers:

## *Relative Cover of Shrubs, Herbs, and Lianas*

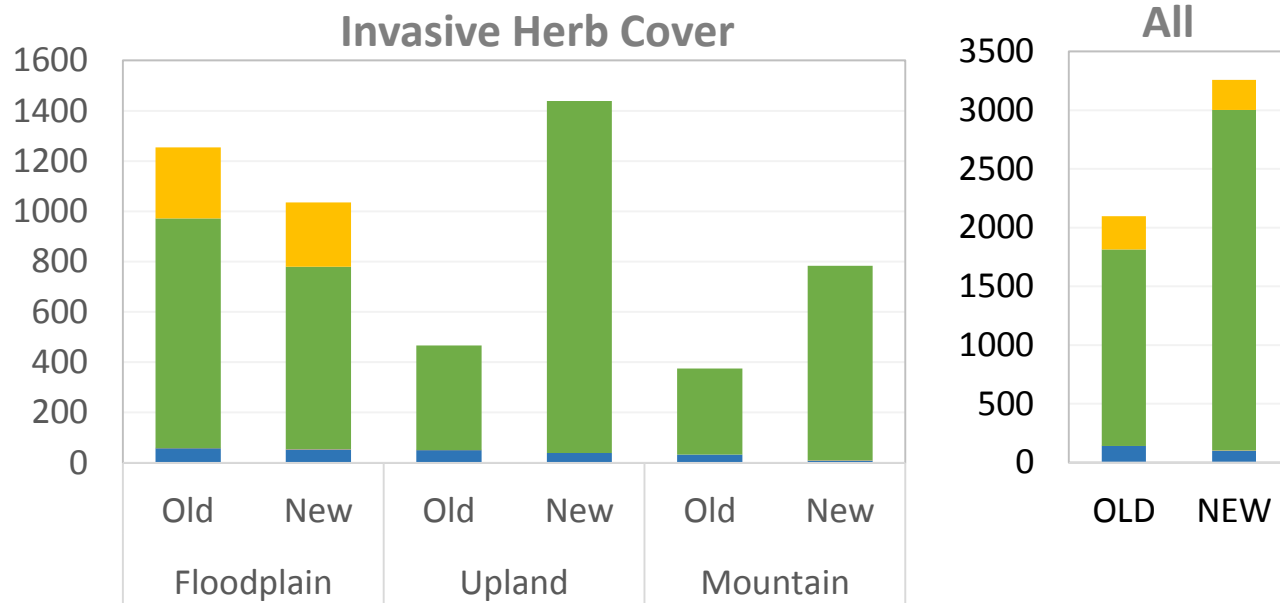
- ◆ More invasive than native
- ◆ Greater proportion of invasives in “Young” forests







# Herb Layer - 55% *more* Invasive Herbs in Young vs. Old Forests (237% more in Upland Forests)

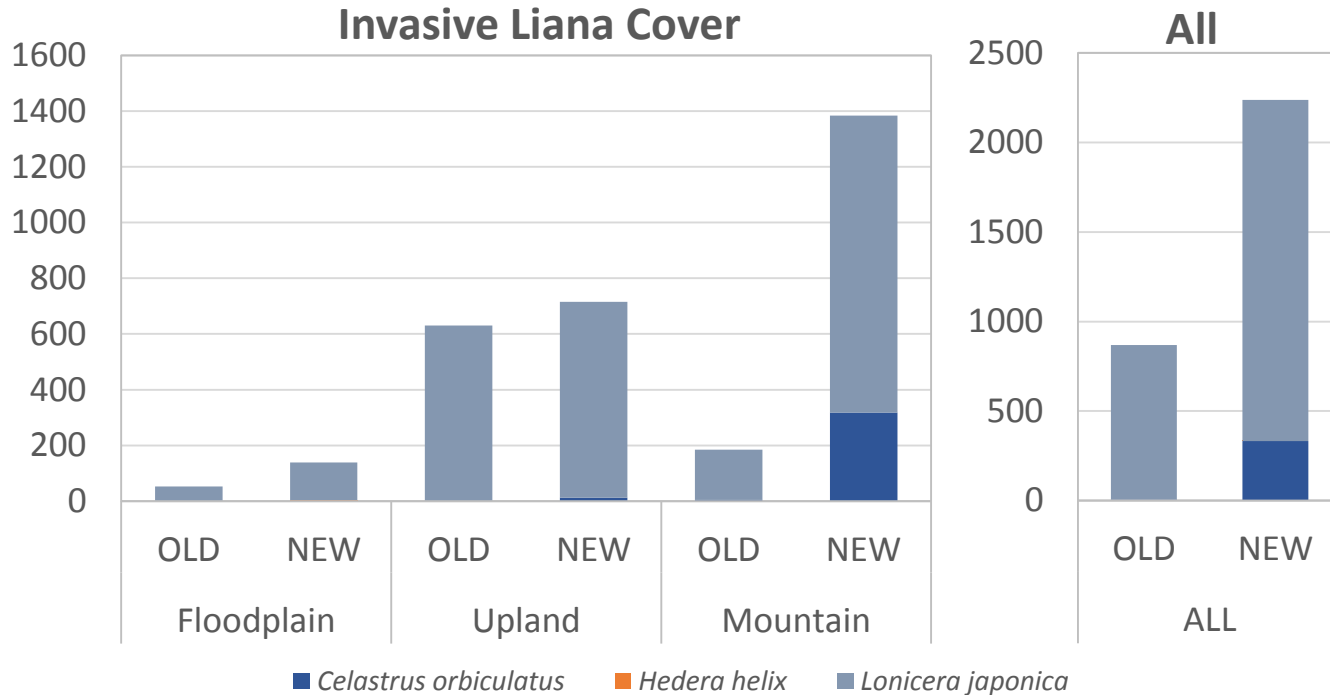


■ *Alliaria petiolata* ■ *Artemisia vulgaris* ■ *Microstegium vimineum* ■ *Lysmachia nummularia*

**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)

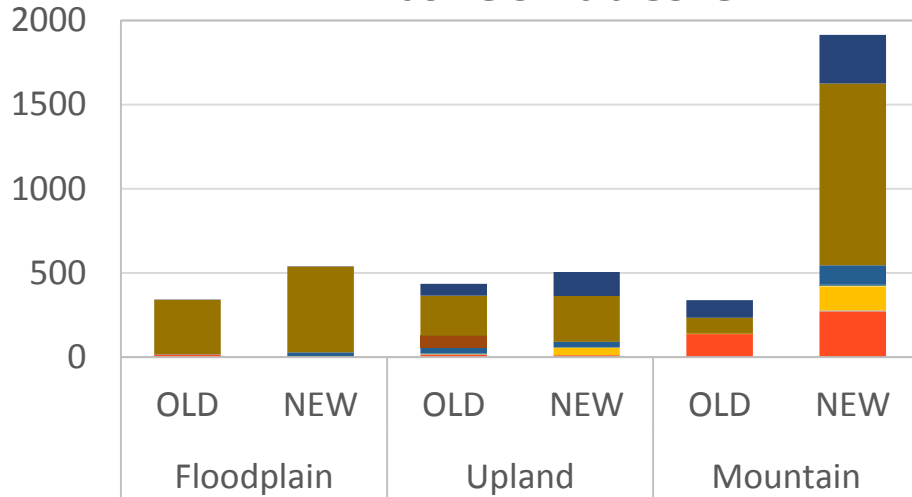


**Dominant Invasive Liana - Japanese Honeysuckle (*Lonicera japonica*)**

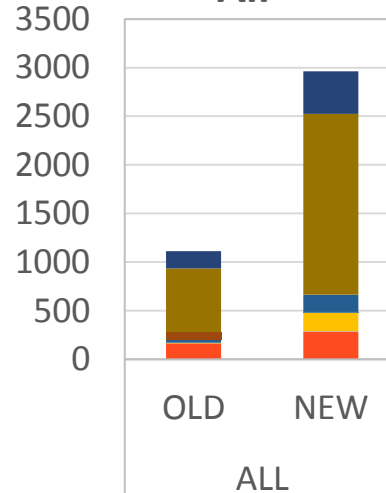
# Shrubs - 166% *more* Invasive Shrubs in Young vs. Old Forests

## 466% more invasive shrubs in New Mountain Forests

Invasive Shrub Cover



All



Japanese Barberry at the NJ Audubon's Scherman-Hoffman Wildlife Sanctuary Bernardsville, NJ (2016)

- *Aralia spinosa*
- *Berberis thunbergii*
- *Elaeagnus angustifolia*
- *Elaeagnus umbellata*
- *Elaeagnus spp.*
- *Euonymus alatus*
- *Ligustrum vulgare*
- *Lonicera maackii*
- *Lonicera sp.*
- *Rosa multiflora*
- *Rubus phoenicolasius*

**Dominant Invasive Shrub - Multiflora Rose (*Rosa multiflora*)**



# Bird Survey Methodology

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

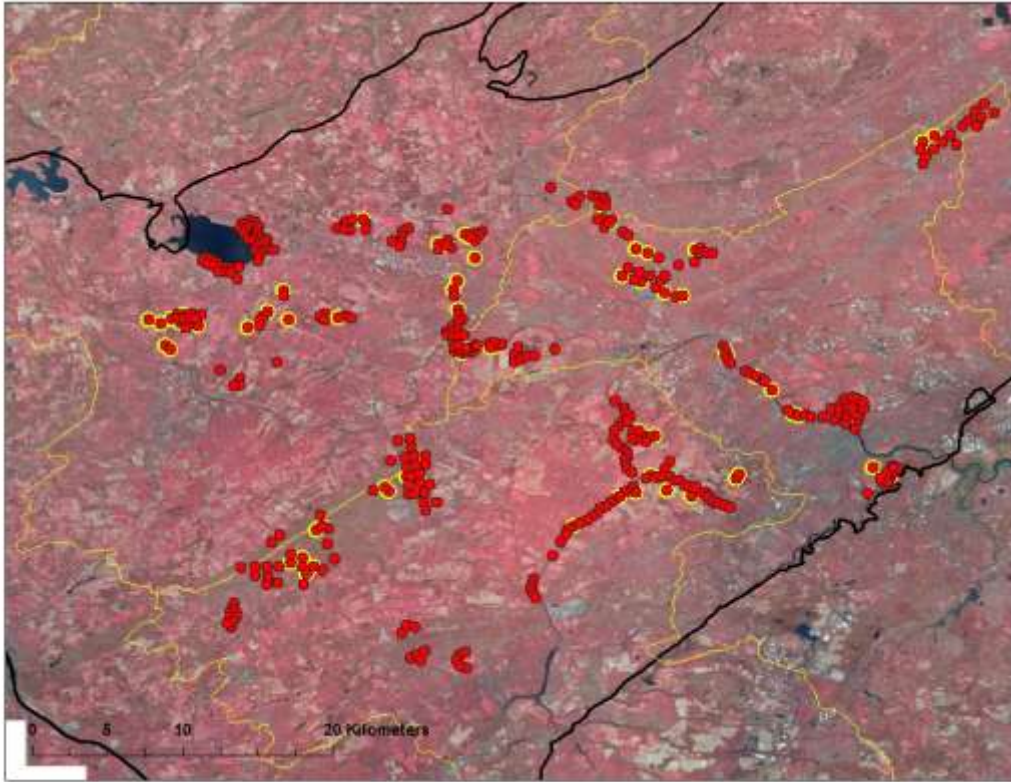
2nd Survey (June 16-30):

Bird point count, habitat assessment

Citizen Scientists are assigned to 5-10 points



# 2014-2015 Field Research: *Citizen Science Results*



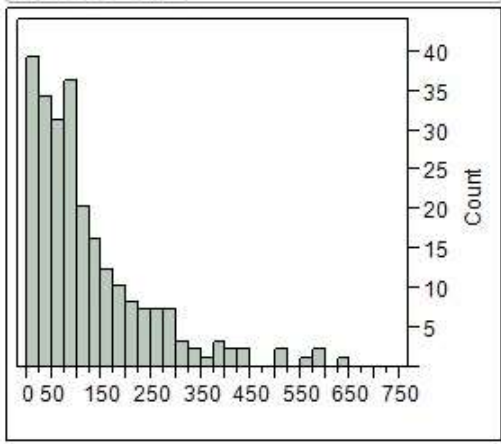
**~300 points surveyed  
at 25 sites**

**~7500 birds counted!  
94 Species**

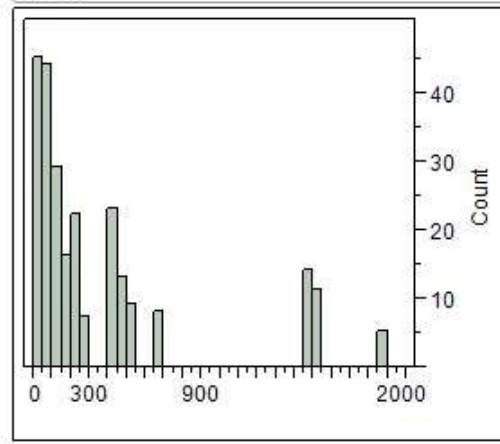


# Edge and Area Effects: *Forest Interior and Ground Nesting Birds*

Closest Edge



Area



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

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 specie is both a forest interior and ground nester. (Rittenhouse et al. 2010)

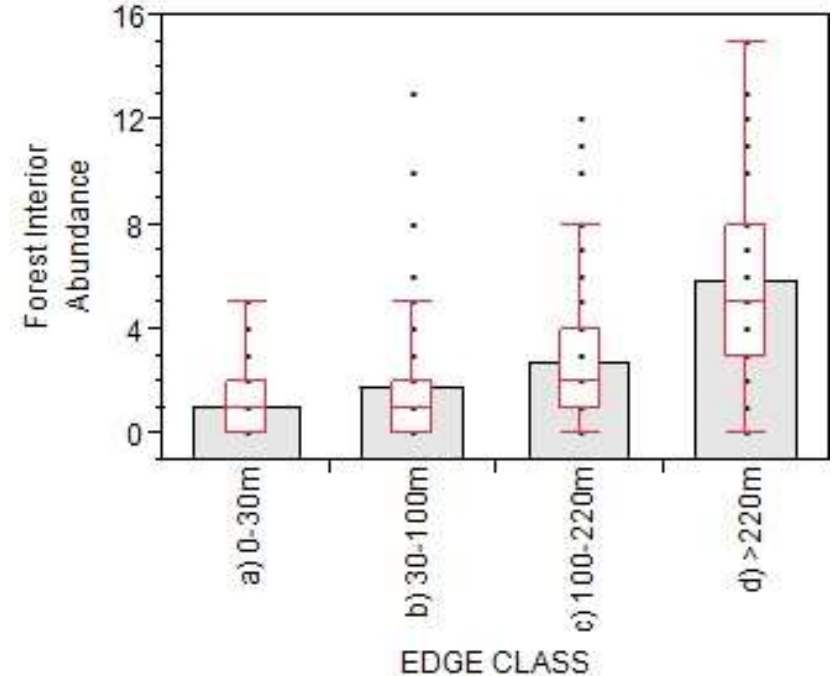
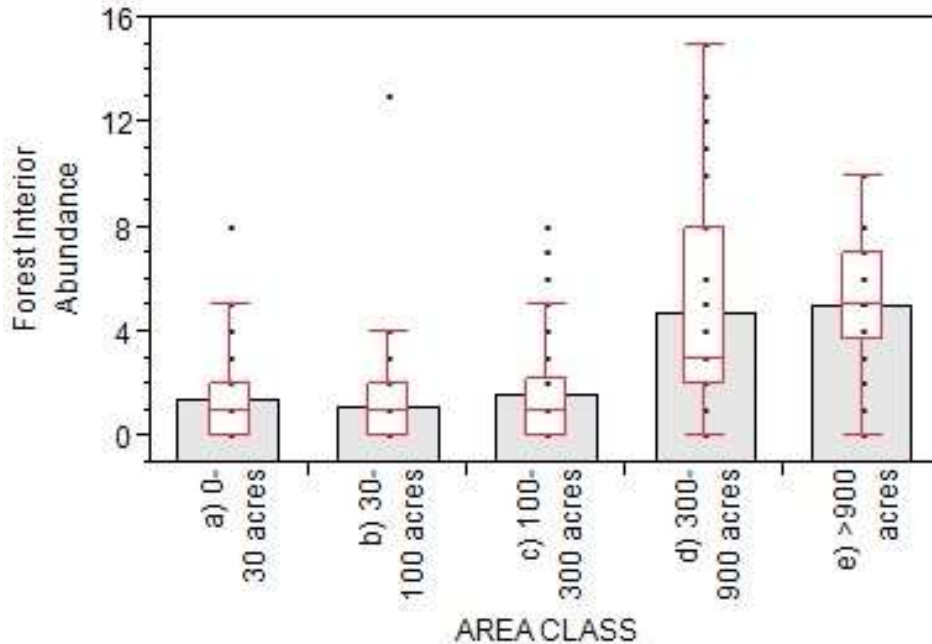
## Forest-Interior Birds (n = 13) and Ground Nesters (n = 11)







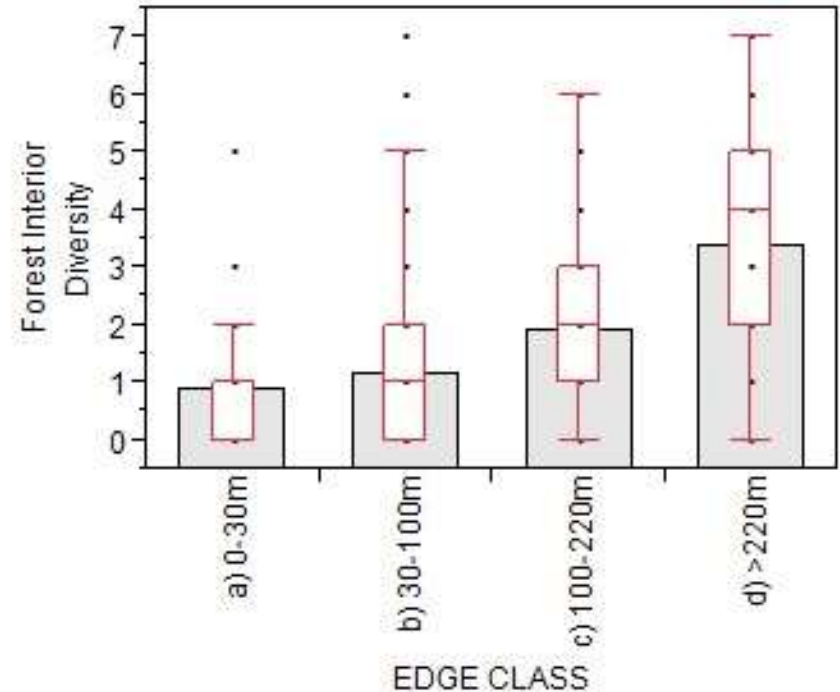
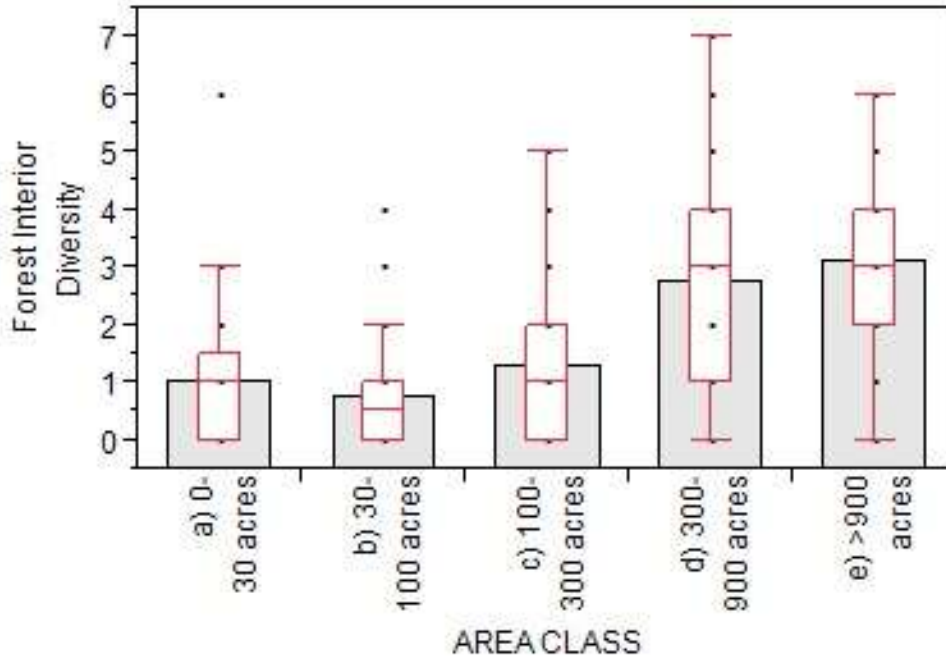
## Edge and Area Effects: *Forest Interior Bird Abundance*



**Significantly greater Abundance of Forest-Interior Birds in**  
**a) Large Forests (>300 acres) and b) Far From Edges (>220 m) ( $p < 0.0001^*$ )**



## Edge and Area Effects: *Forest Interior Bird Diversity*



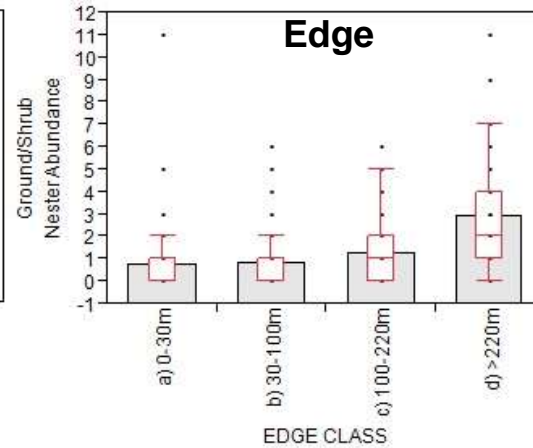
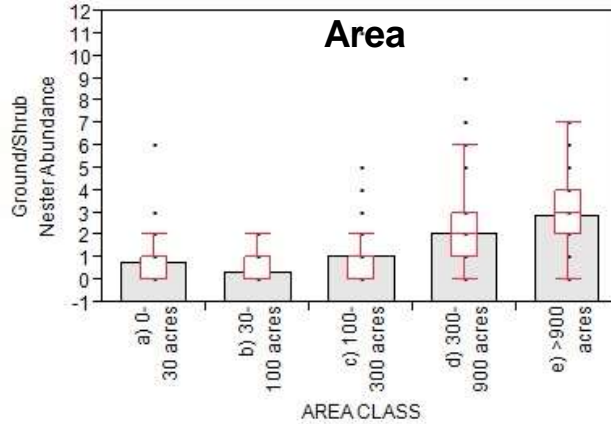
**Significantly greater Diversity of Forest-Interior Birds in**

**a) Large Forests (>300 acres) and b) Far From Edges (>220 m) ( $p < 0.0001^*$ )**

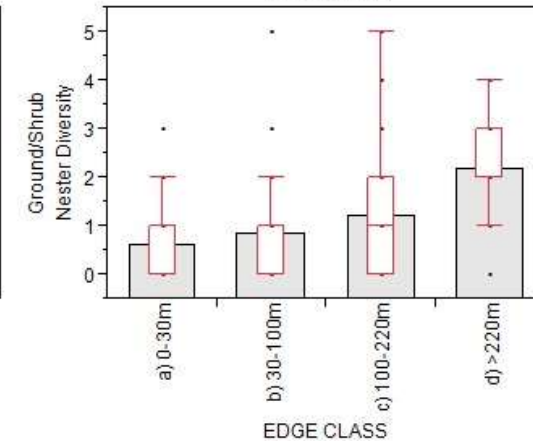
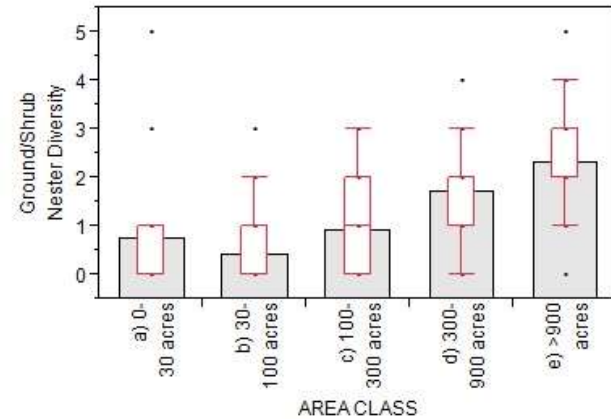


# Edge and Area Effects: *Ground Nesters*

Abundance



Diversity

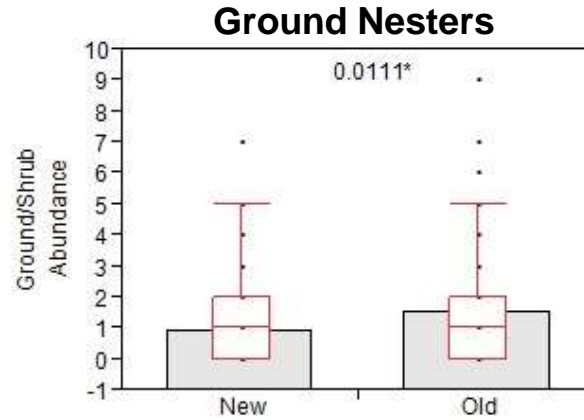
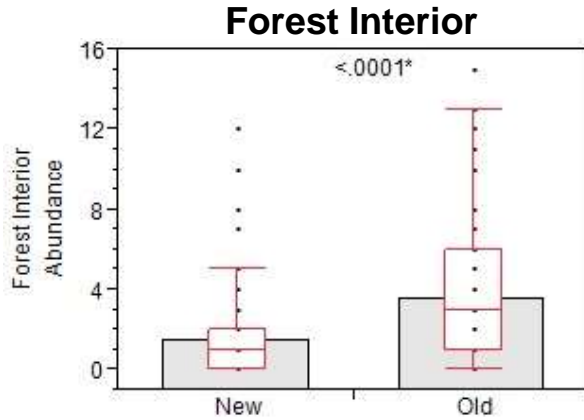




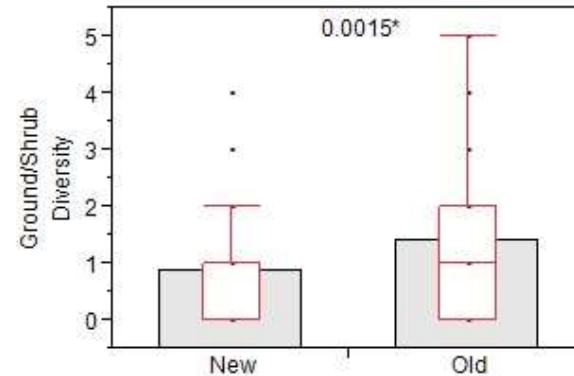
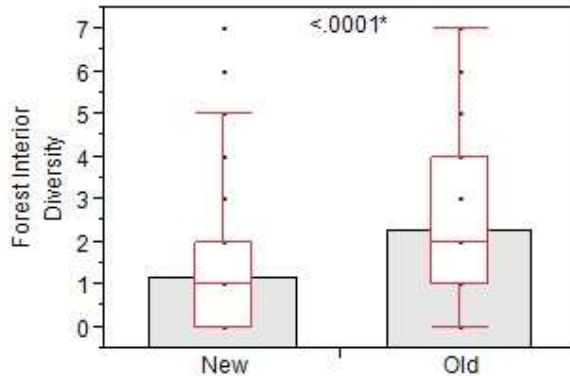


# Effects of Forest Age: *Forest Interior and Ground Nesters*

Abundance



Diversity





# ***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





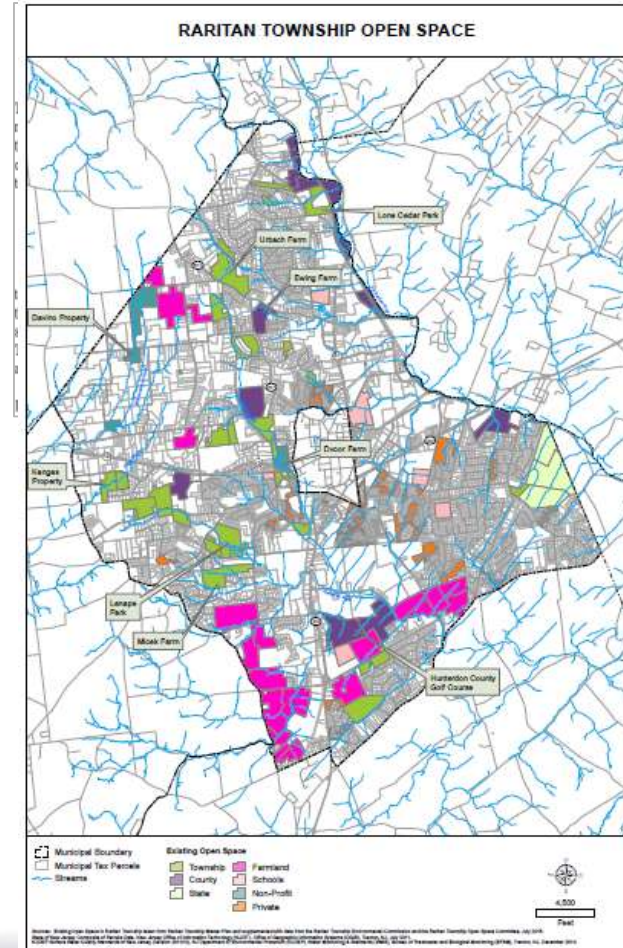
# Hunting Options for Deer Management: *Hunting Lease Agreements on Town Lands*

## 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/mi<sup>2</sup> to 12/mi<sup>2</sup>
- ◆ Princeton Twp – down from 43/mi<sup>2</sup> to 17/mi<sup>2</sup>
- ◆ Bernards Twp – down from 34/mi<sup>2</sup> to 18/mi<sup>2</sup>







## Cost Analysis: Deer Fencing

Approximate Cost for Fencing a 10 Acre Area:

Welded Wire & Posts: **\$22,400**

or Plastic Fencing & Trees: **\$4,300**

Material	Quantity	Cost (Per Item)	Total Cost
Wooden Posts (8')	433	\$7.50	\$3,322.50
Wire Fencing	4430 ft.	\$4.00 - 4.50/ft.	\$18,827.20
<i>(or Plastic Fencing</i>		<i>\$0.91/ft.</i>	<i>\$4027.27)</i>
Gate	1	\$250.00	\$250.00
<b>Total</b>			<b>\$22,399.70</b>



Charlotte Hill - Bernardsville Borough

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

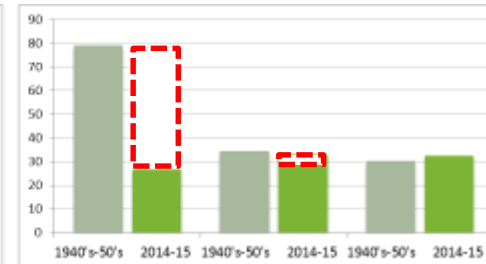
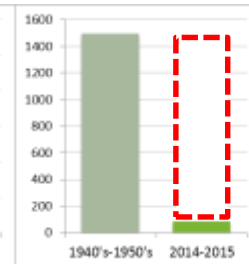
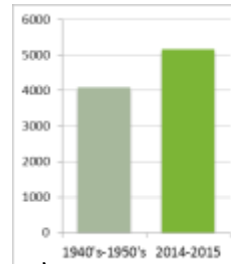


# Cost Analysis: Planting

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

## Replanting Understory Trees on a 10 Acre Plot

Plantings	Approximate Quantity	Average Cost (Per Tree) <sup>1,2</sup>	Total Cost <sup>3</sup>
Saplings	30,580	\$2.29	\$70,028.20
Small Trees	1,180	\$3.99	\$4,708.20
<b>Total</b>			<b>\$74,736.40</b>



<sup>1</sup> Tree prices based off Rutgers Nursery (Rt. 202)

<sup>2</sup> Medium trees not included in total cost

<sup>3</sup> Browse protection (pictured) not included in total cost

(An additional \$2.50 - 3.00 per unit not including installation)



# But Is This Humane?



Underweight

Healthy Weight

## 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:

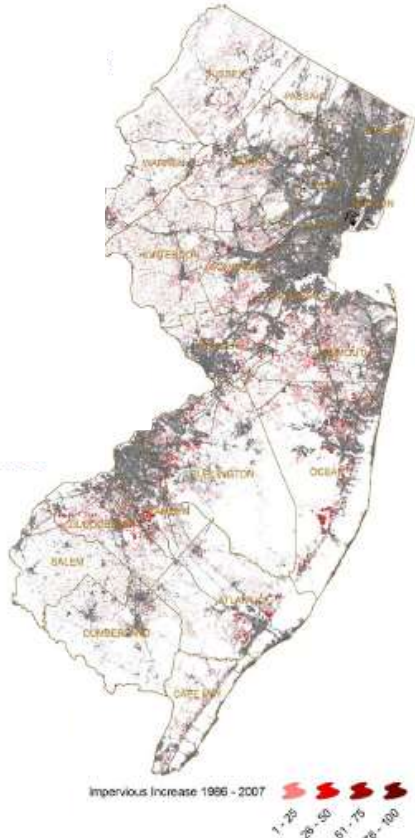
- Since the program's inception [1997], hunters have donated over 234,000 pounds of venison to the *HHH* providing approximately 936,000 servings of protein to those in need





# An Ounce of Prevention

## Planting Natives Instead of Exotic Invasives



**Jersey-Friendly Yards**  
Landscaping for a Healthy Environment

**JerseyYards.org**  
Your guide to a beautiful, healthy and eco-friendly yard.

**THE NATIVE PLANT SOCIETY OF NEW JERSEY**

Home | Native Plants | Events | Get Involved | Become a Member | Contact Us | Search | Shop

It is amazing that ...

There is a plant in New Jersey that is found nowhere else in the world! Read about it [here](#).

Discover Native Plants

The Four Seasons

Welcome

Find out everything there is to know about the native flora of New Jersey, learn from the experts on native plants, get the latest on interesting activities near you, or join one of the many opportunities to participate in the growing national native plant movement — right here in the Garden State.

**NATIVE PLANTS of the NORTHEAST**

A Guide for Gardening & Conservation

DONALD J. LEOPOLD

**PLAN BEFORE YOU PLANT:**  
Native Alternatives to Invasive Ornamentals

Partners: National Invasive Species Council

BROOKLYN BOTANIC GARDEN ALL-REGION GUIDES

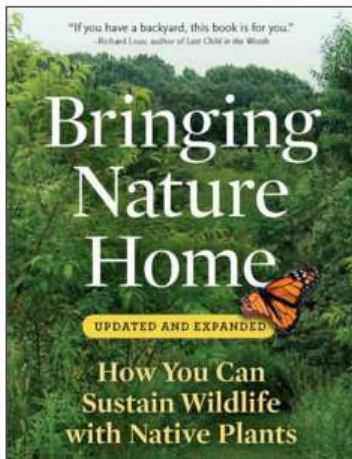
**Great Natives for Tough Places**

BROOKLYN BOTANIC GARDEN SUGGESTS NATIVE PLANTS

**Native Alternatives to Invasive Plants**



# Bringing Nature Home



## 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](http://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.)



# *An Ounce of Prevention*

## Natives Alternatives to Invasives

### 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
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