Impacts of Deer and Invasive Plant Species on Central New Jersey Forests: *Strategies for Restoration*

RARITAN VALLEY COMMUNITY COLLEGE

SENCER
SCIENCE EDUCATION FOR NEW CIVIC ENGAGEMENTS AND RESPONSIBILITIES

Raritan Headwaters Association

March 29, 2018

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Raritan Valley Community College

NEW JERSEY AUDUBON SOCIETY

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

exotic species = 39% of state flora!!!

Ecological Impacts:

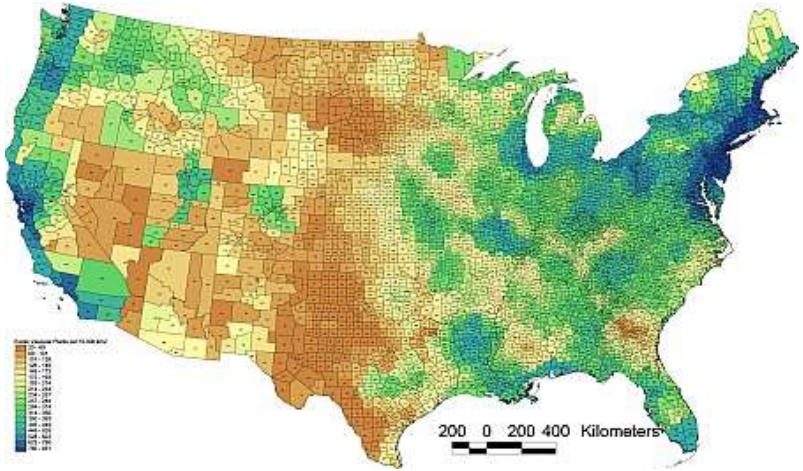
Compete with native species; Threat to endangered species; Disrupt ecosystem processes (nutrient cycling, pollination/dispersal, trophic interactions)

(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)



Density of Exotic Species - #/10,000 km²

(BONAP 2011)

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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

>10 deer/mi²
Impact preferred browse species

>20 deer/mi²
Prevent forest regeneration

>100 deer/mi²
Without deer management

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

Historic: **8-11 deer/mi²**

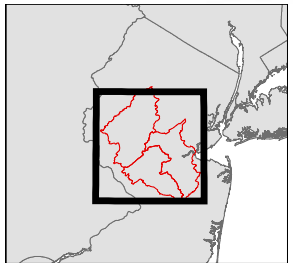
Healthy forest with dense understory vegetation and native plant species.

Current: **13-76 deer/mi²**

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

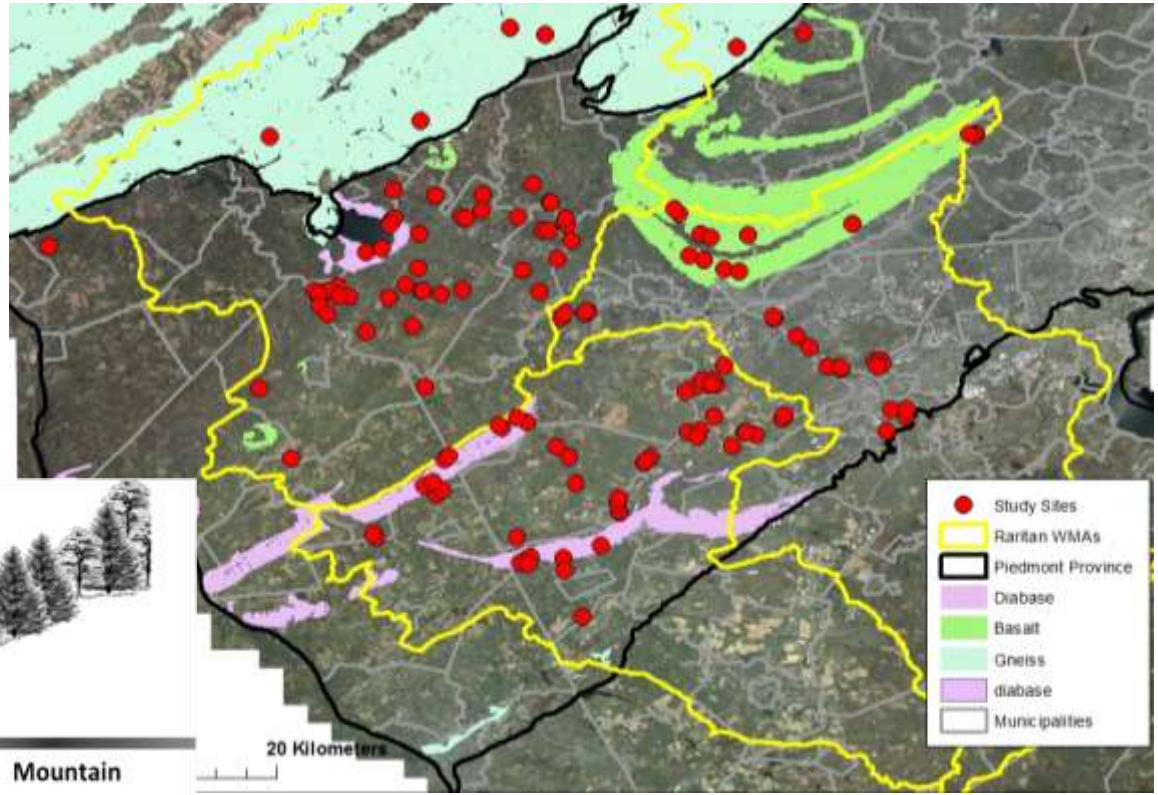
Overbrowsed forest with invasive barberry shrubs at Peter's Tract in Bernardsville (2016)

Study Area and Design

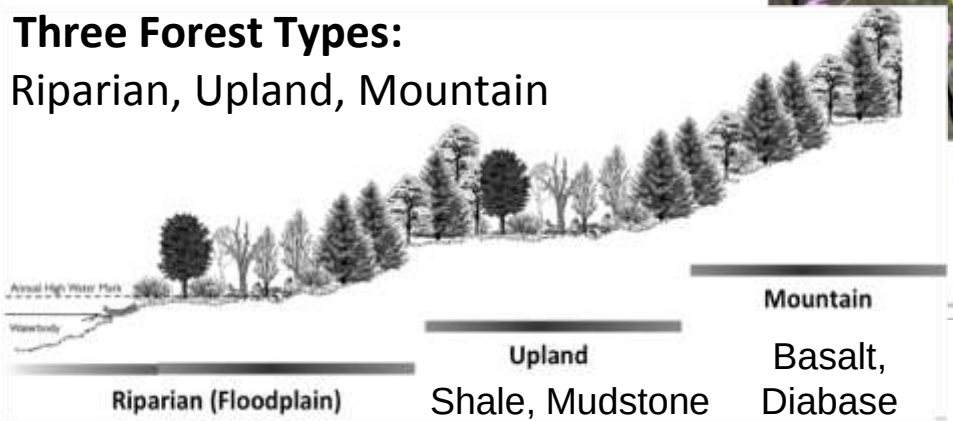


- *Raritan Watershed*
- *Piedmont Province*

135 Study Sites



Three Forest Types:
Riparian, Upland, Mountain

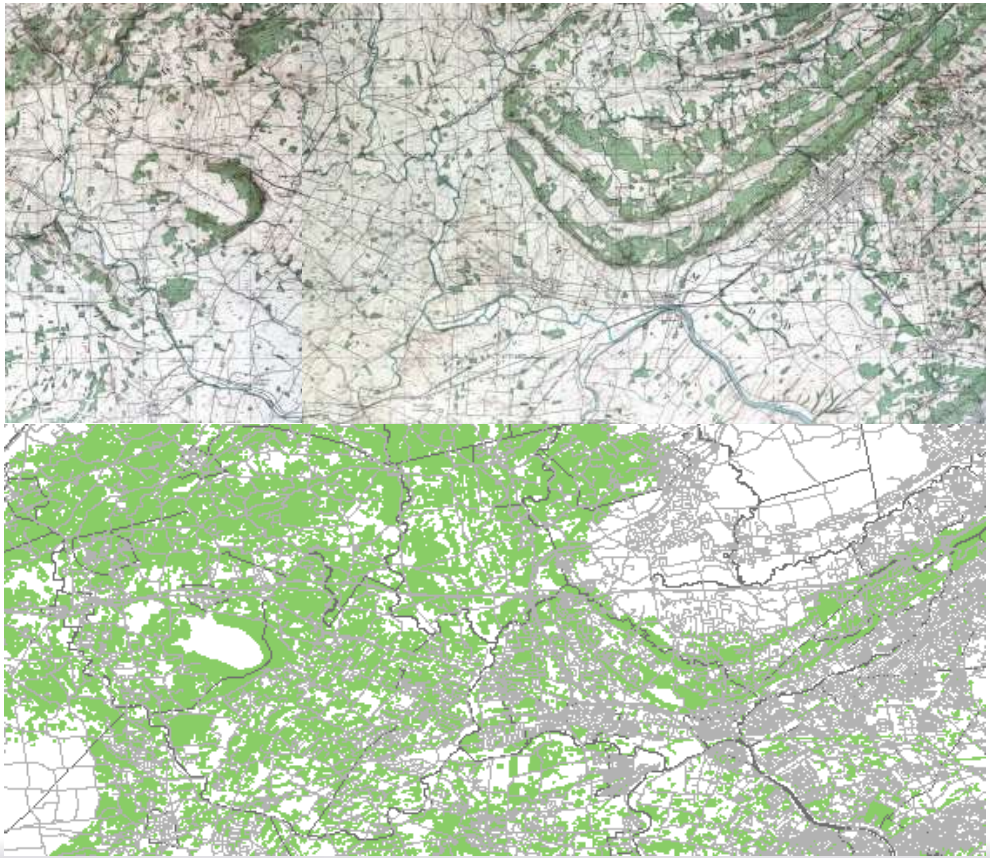


	Riparian (Floodplain)	Upland	Mountain
Soils =	Alluvial	Shale, Mudstone & Sandstone	Basalt, Diabase & Gneiss

Forest Age

"Old" and "Young" (before or after 1930)

Forest Development in Central NJ – late 1800's to 2012



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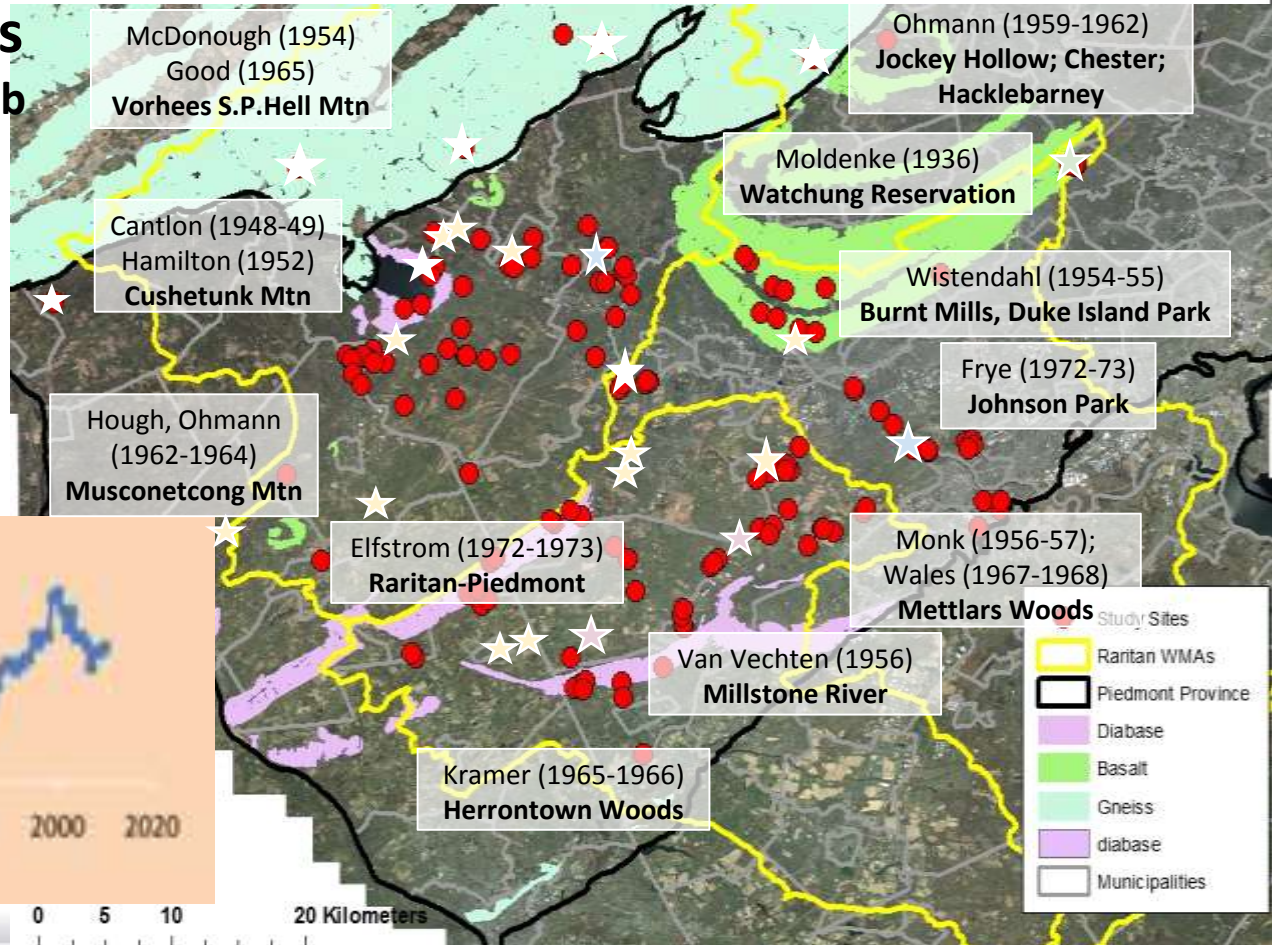
Historical Comparisons

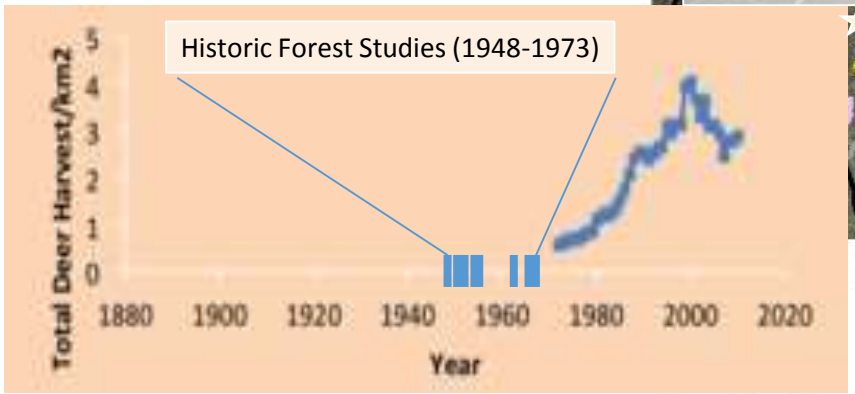
Murray Buell Plant Ecology Lab
Rutgers University
(1948-1973)

22 Studies

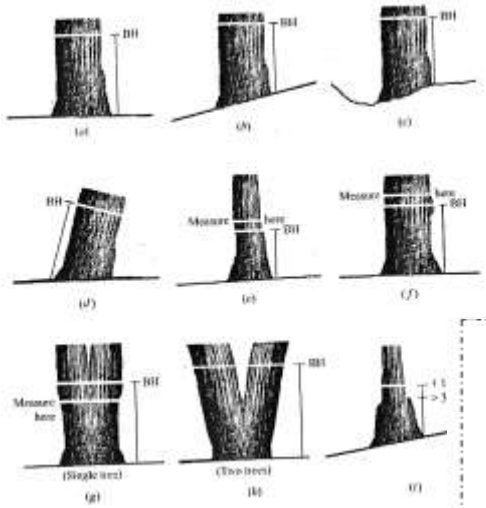
137 Locations; 216 Stands

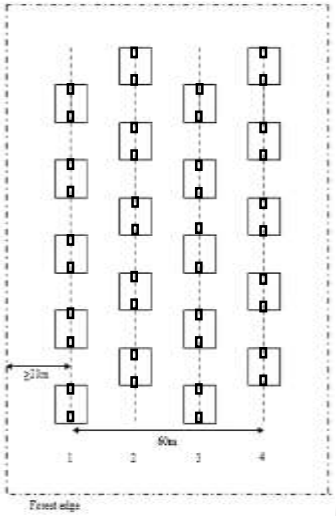


NJ Deer Population Trends



Forest Study Methodology





Four 100 m Transects (20 m apart)

Twenty 100 m^2 plots (~0.5 acres)

Forty 1 m^2 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

2014-2017 Vegetation Studies: Forest Ecology Interns

Counted / Measured:

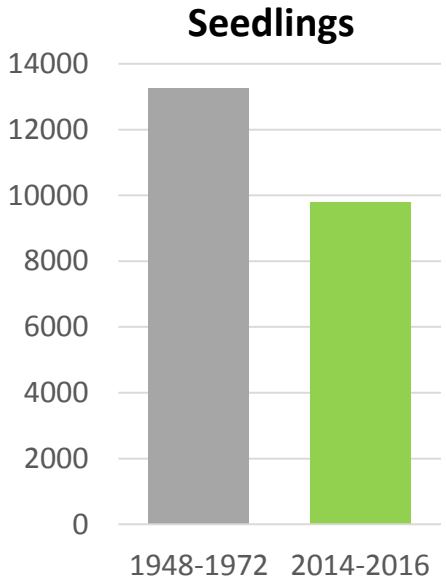
>50,000 trees

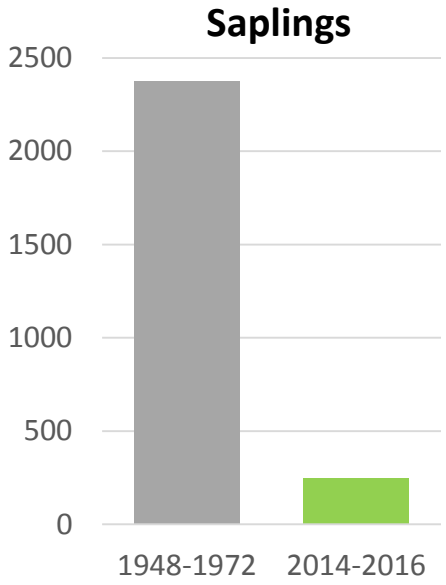
>550,000 seedlings

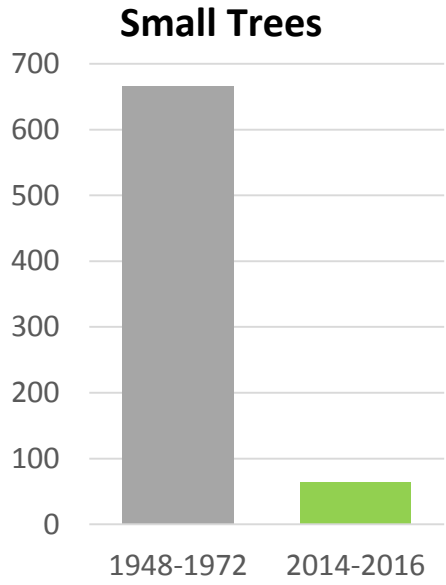
>4,000 herb plots

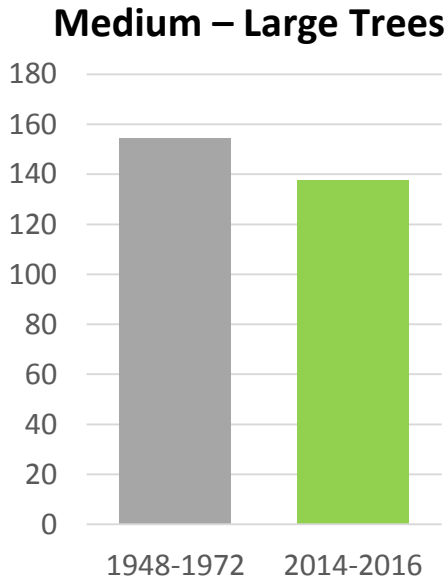
>22 km shrub/liana data

Comparison of Past and Present Forest Size Class Structure







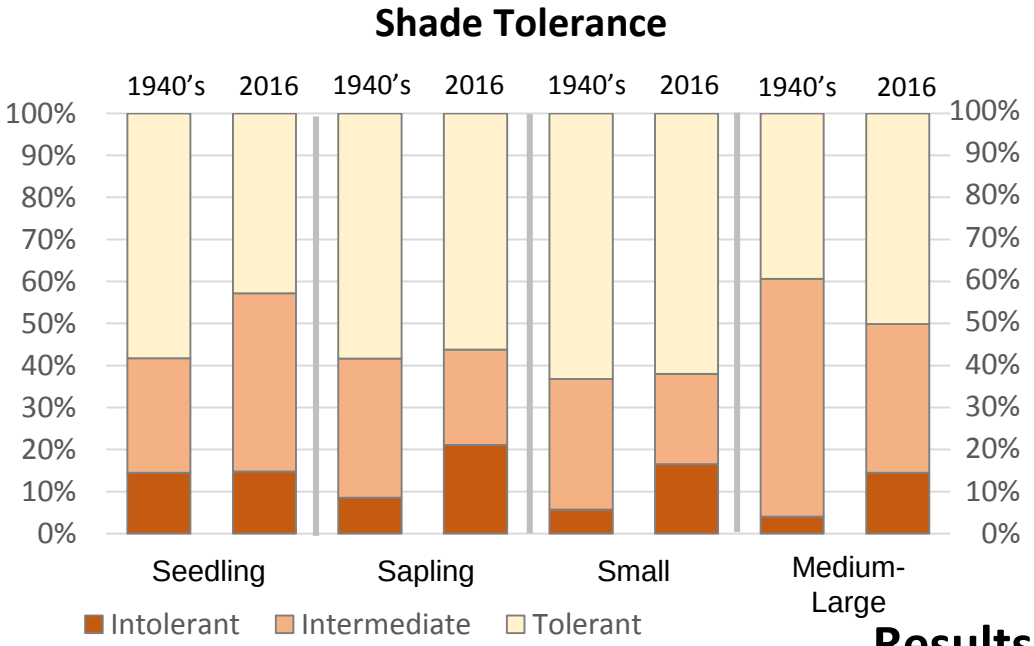


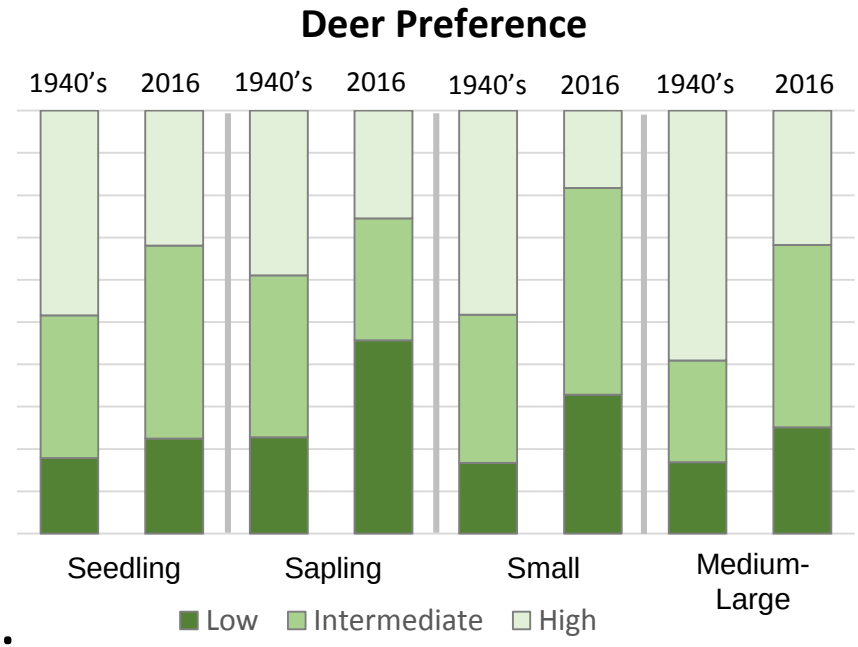
% Change from Past (1948-73) to Present (2014-17)

Seedlings	Saplings	Small	Medium - Large
-26%	-90%	-90%	-11%

Why the lack of regeneration? *Shade vs. Deer*

% Composition of Forest Size Classes





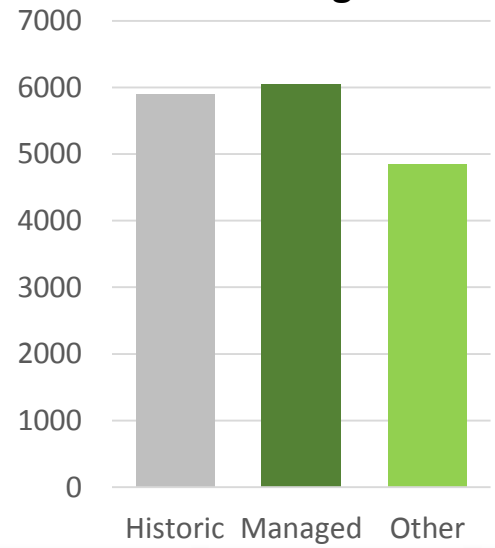
Results:

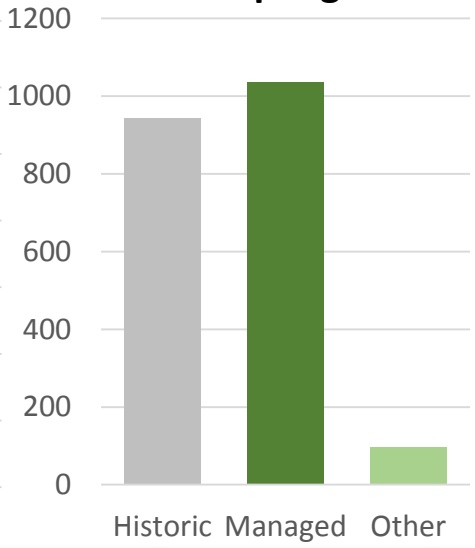
Increases in *Shade Intolerant* species (i.e., more light than in past)

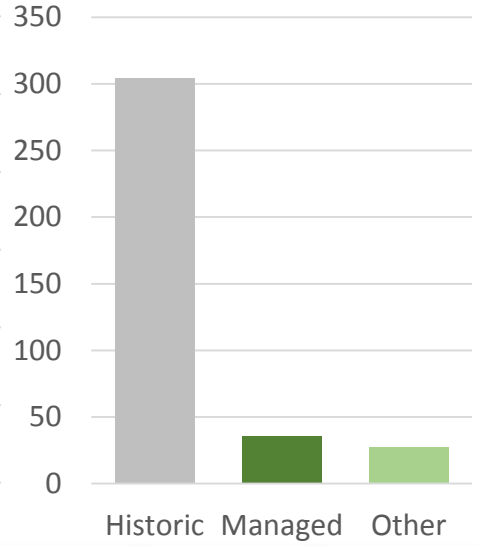
Increases in *Deer Resistant* species (i.e., more deer pressure than in past)

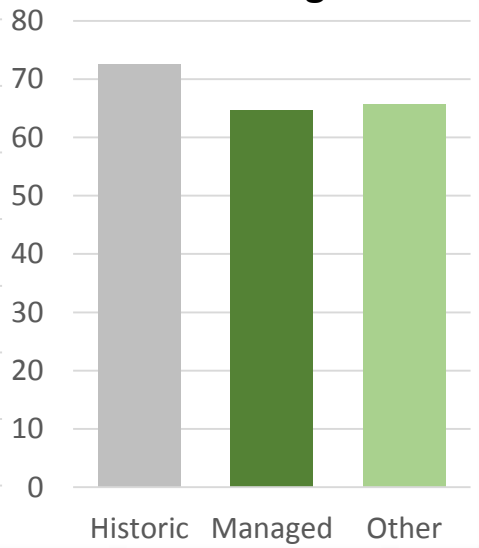
Effects of Deer – Experimental Evidence

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

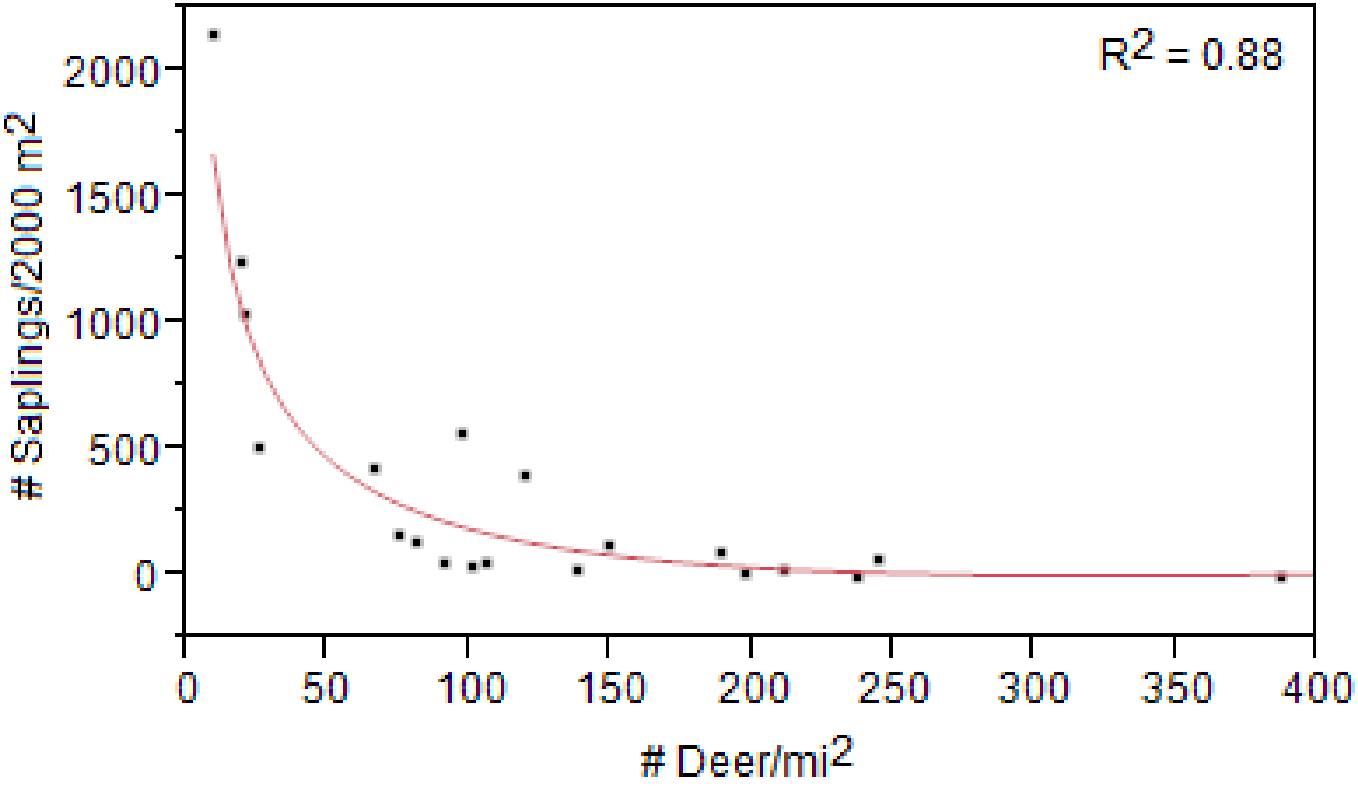




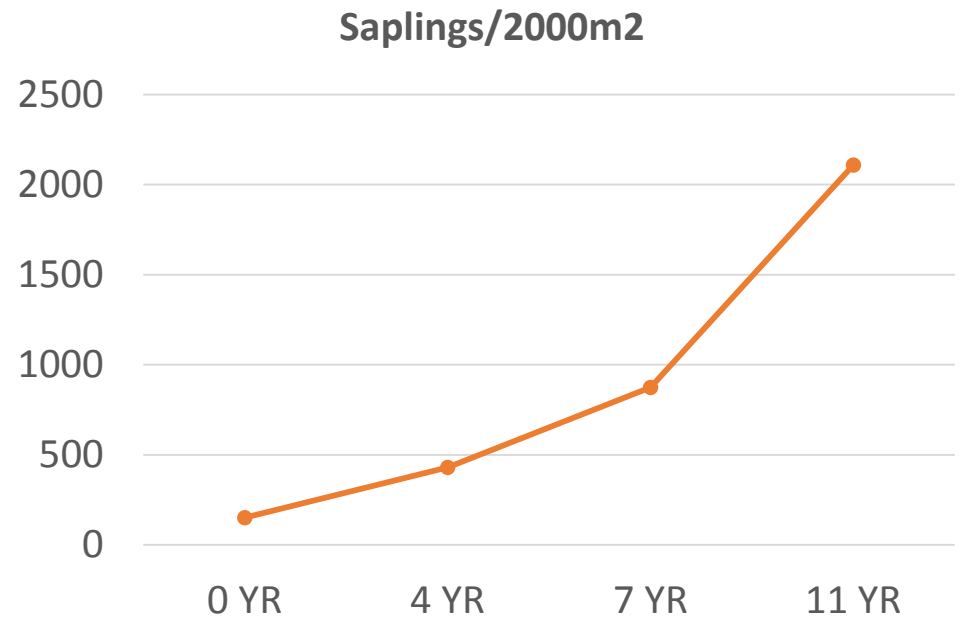


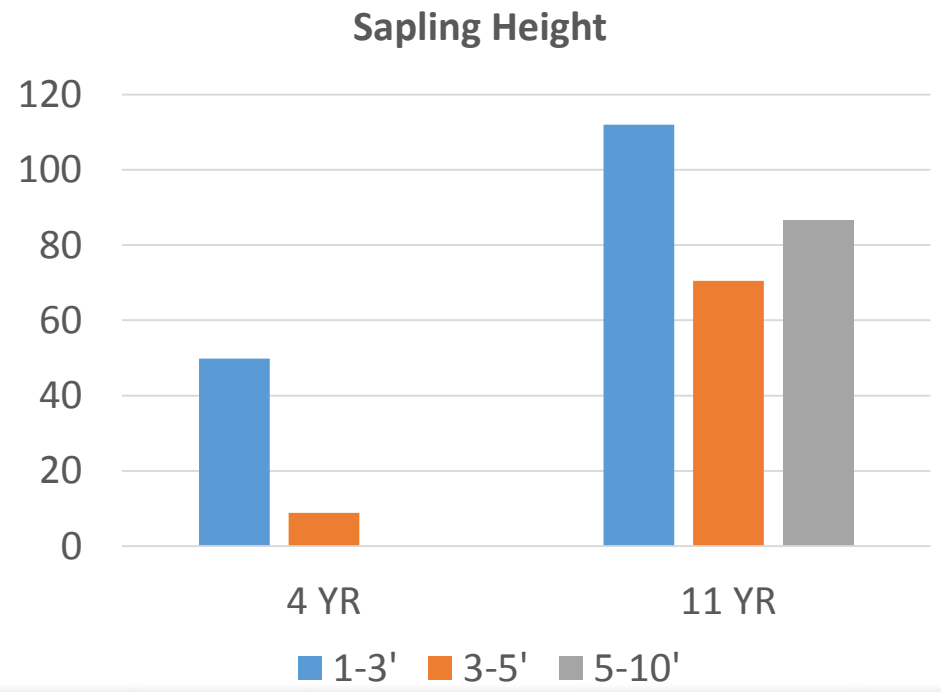


Relationship of # Saplings to Deer Densities



Increasing Number and Size of Saplings in Deer Exclosures Over Time

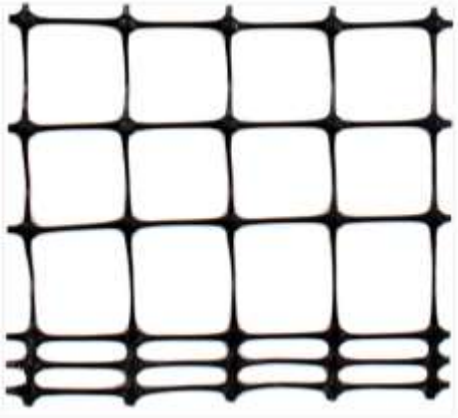




Possible Solutions for Forest Restoration: Deer Fencing

Costs Depend on Materials Selected:

Plastic = $1-2/ft. ***Metal (Fixed Knot) = $3-5/ft.***



Prices obtained from Deer Busters (www.deerbusters.com)

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***

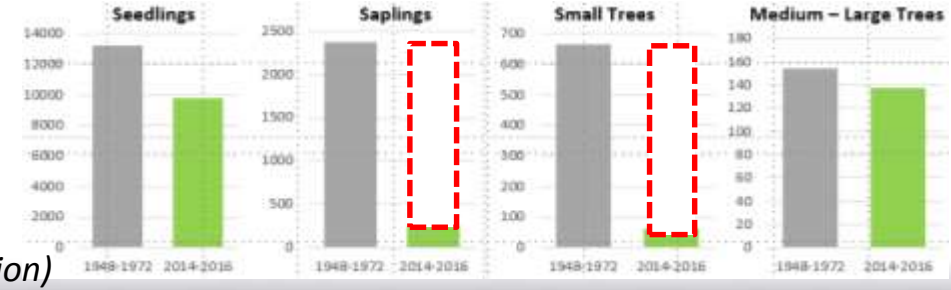
Material	Quantity	Cost (Per Item)	Total Cost
Wooden Posts (8')	2,827	$7.50	$21,203
Wire Fencing	28,269 ft.	$4.00 - 4.50/ft.	$120,143
or *Plastic Fencing*		*$0.91/ft.*	*$25,699*
Gate	1	$250.00	$250.00
		TOTAL: $28,449 - $144,096	

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			
Plantings	**Approximate Quantity**	**Average Cost (Per Tree) [1,2]**	**Total Cost [3]**
Saplings	232,408	$2.29	$532,214
Small Trees	8,968	$3.99	$35,782
		Total	**$567,996**



[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

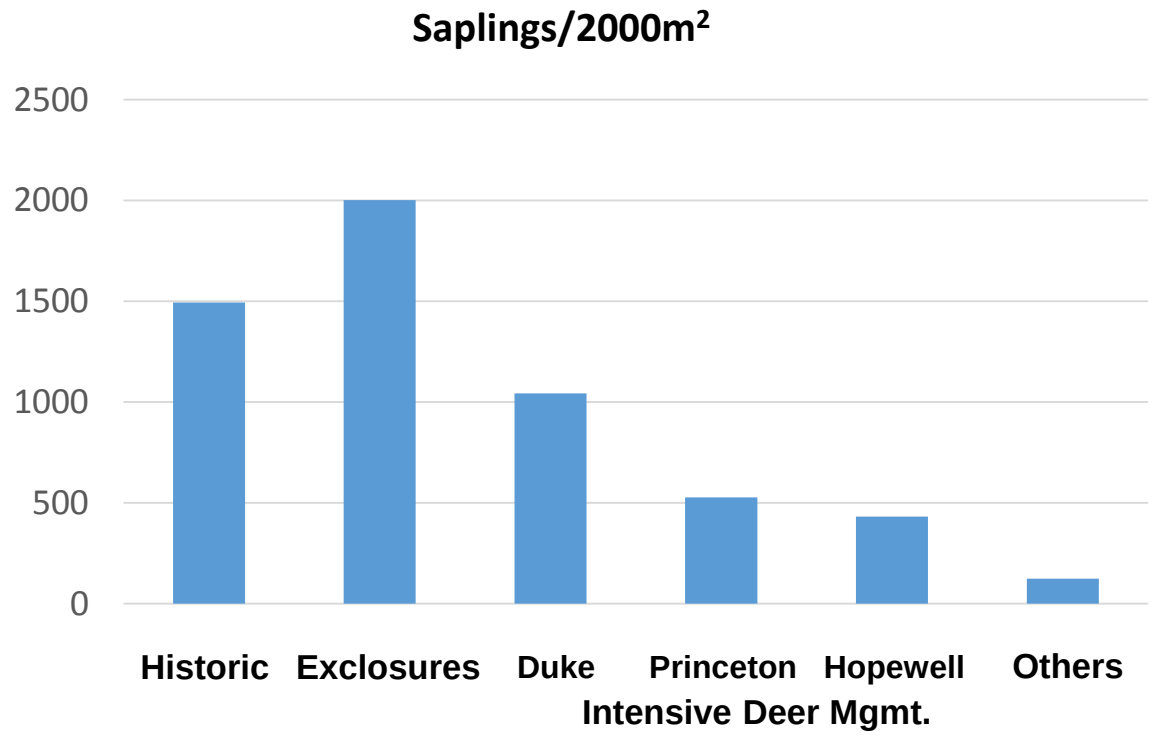
Ecological Deer Management – Duke Farms, HLT, FoHVOS, some County Pks

Low cost and very 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 Sapling Numbers



Public Safety - Vehicle Damage from Deer Collisions

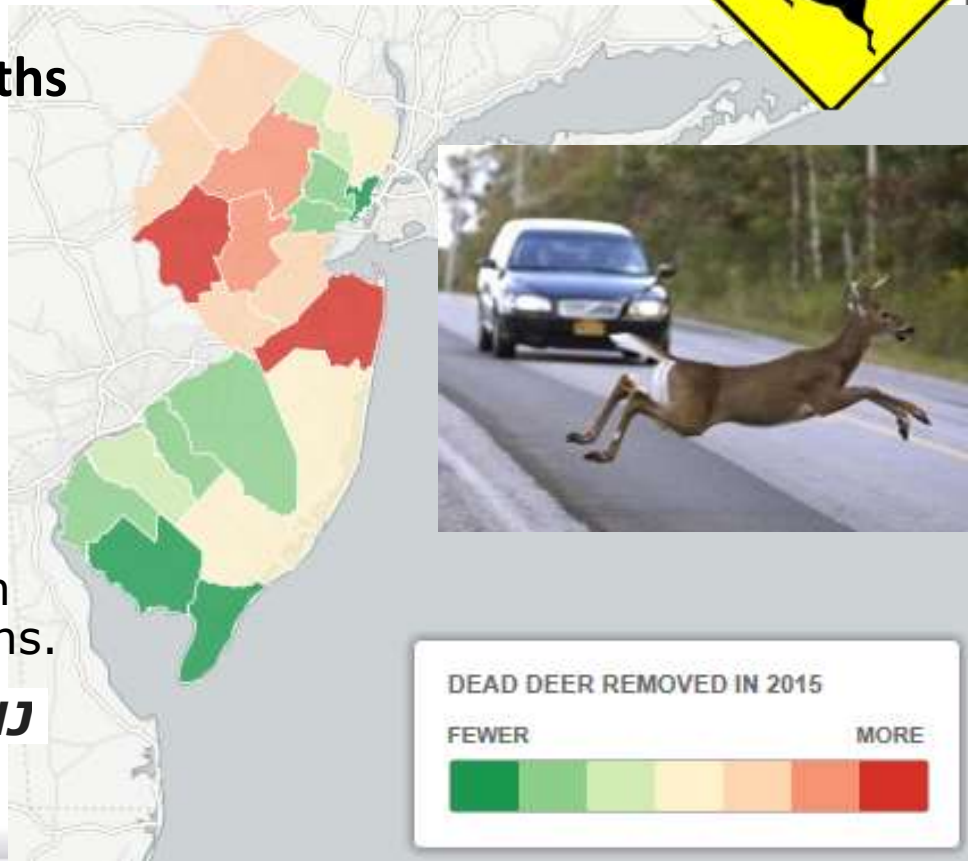
>1,000,000 DVCs/yr in U.S.; >200 deaths

(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 feer from 34/mi^2 to 18/mi^2

Proportionate Reduction in Deer Collisions e.g., 60% Reduction in Princeton

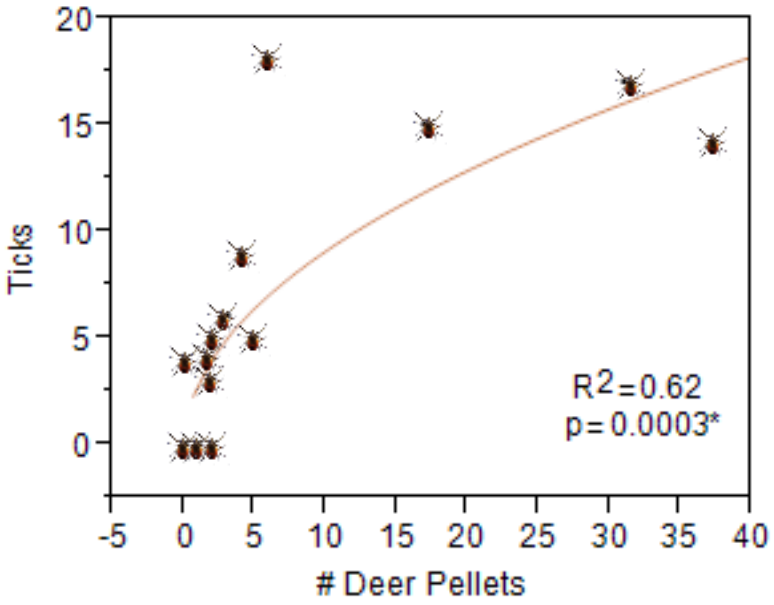
Bernards Twp - Road kill numbers reduced from 289 in 2001 to 49 in 2016 (-83%)

Public Health - *Lyme Disease*

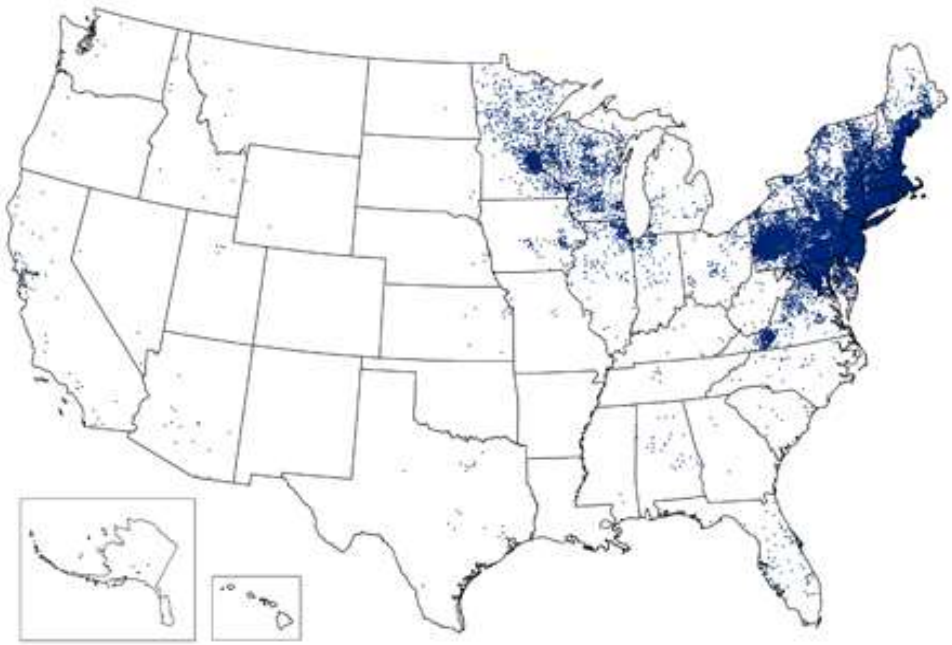
330-640 cases/yr in Morris County since 2000
207-528 cases/yr in Hunterdon County

Center for Disease Control and Prevention (2016)

Effect of Deer on Tick Abundance



Reported Cases of Lyme Disease -- United States, 2014

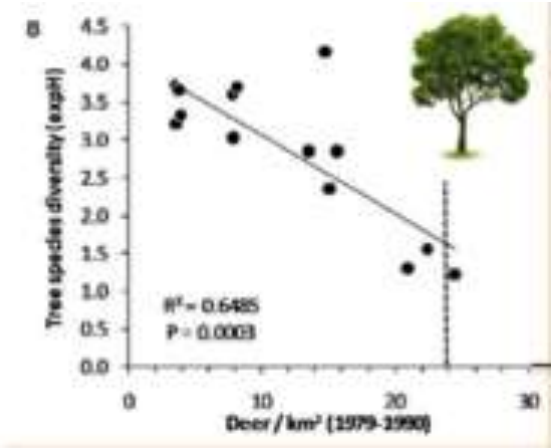


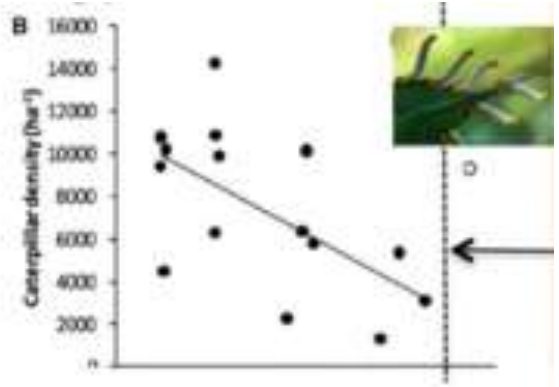
1 dot placed randomly within county of residence for each confirmed case

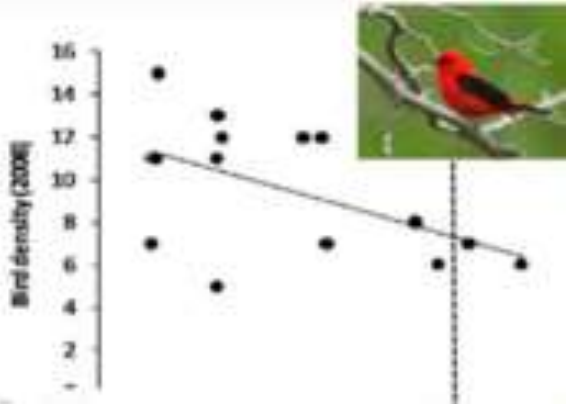
Effects of Deer on the Food Web

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

Effects of Deer on Ground/Shrub Nesting Birds

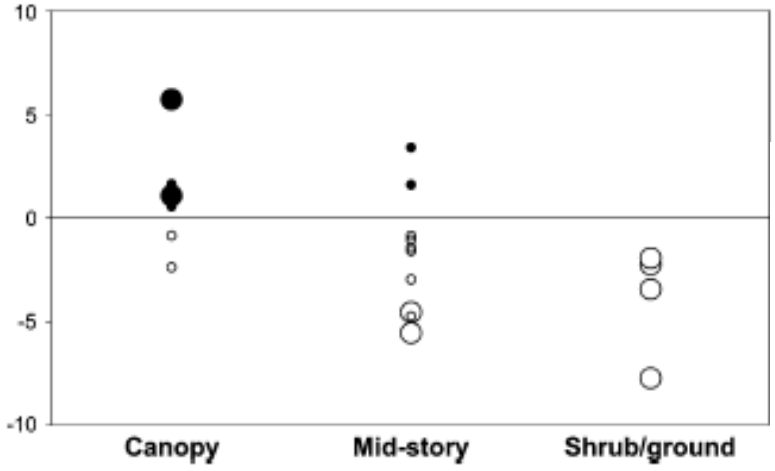


Fig. 1 Time series of photos from Hutcheson Memorial Forest (HMF) in Somerset County, New Jersey. HMF is mixed oak-hickory forest with 26 ha of old growth surrounded by secondary forest, old fields, and farm fields. (a) Shows the forest in 1976 with an intact shrub layer. Overbrowsing by deer and non-native plant invasion have changed the forest understory and midcanopy from native saplings, shrubs and 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

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

Baiser et al (2008)

Public Education and Outreach

Importance of public outreach and evidence-based decision-making
Collect data on deer, forest regeneration, invasives &
monitor effectiveness of management

Monitoring – Evidence Based Decision-making

Figure 1. Results of Deer Spotlight Surveys in Raritan Township in April 2017

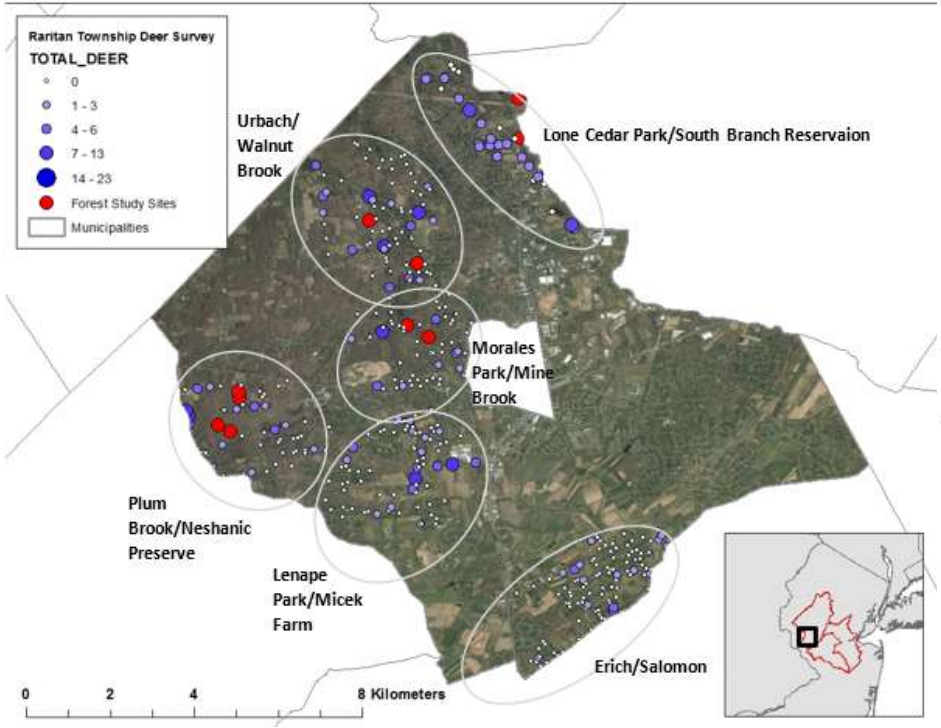
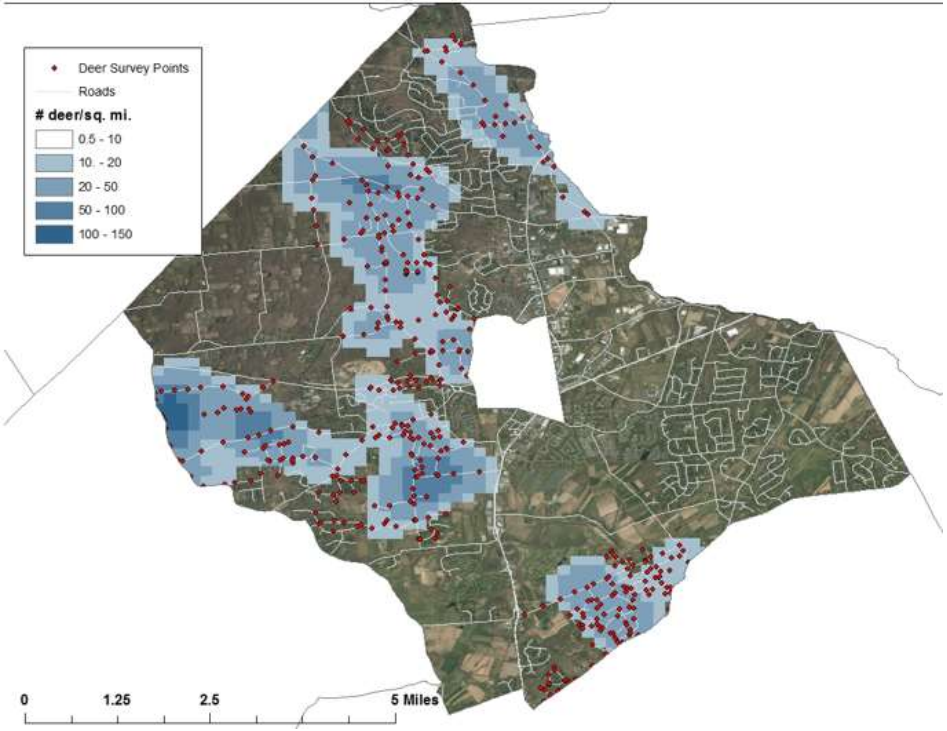


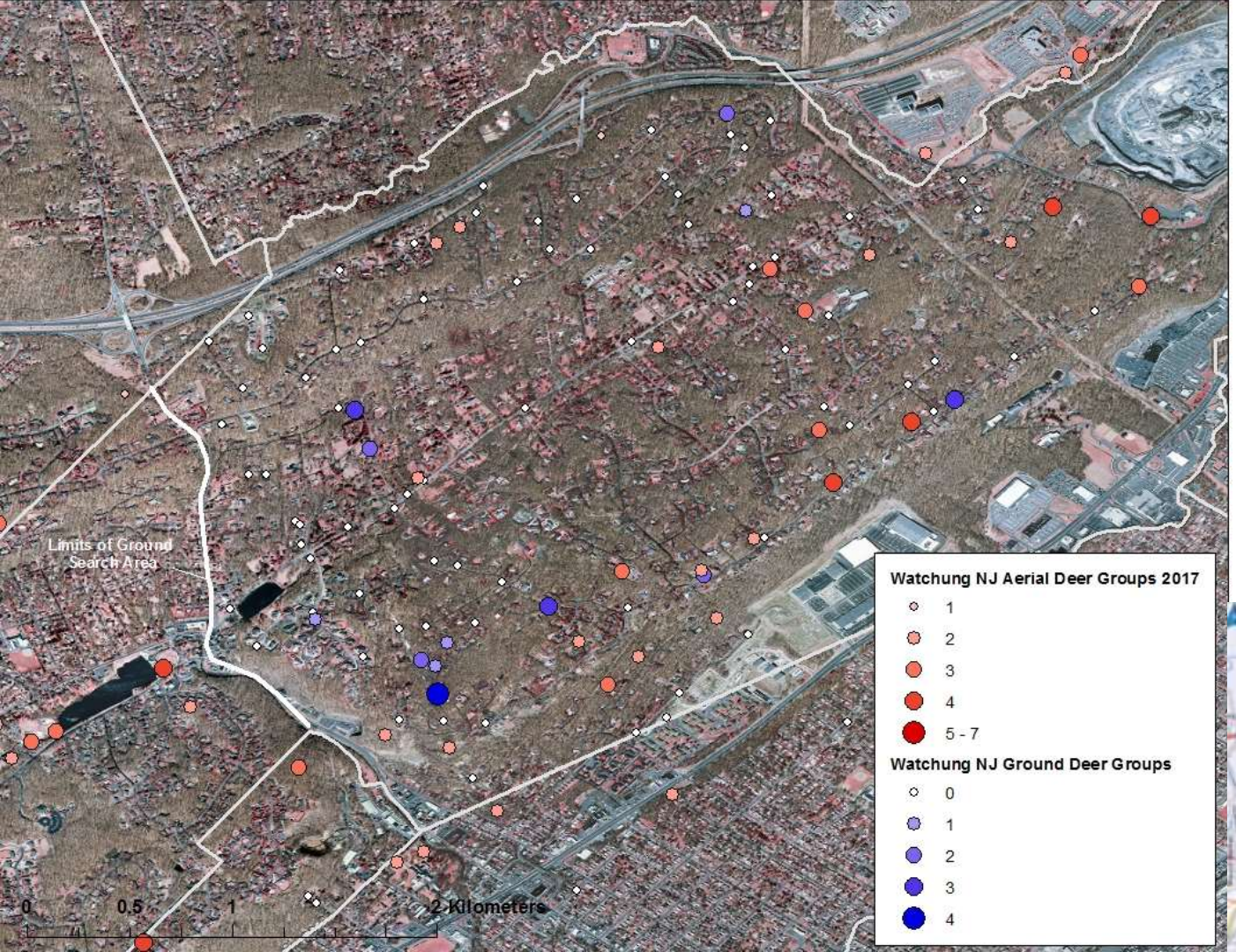
Figure 2. Map of Localized Deer Density Along Survey Routes in Raritan Township in 2017



Aerial vs. Ground Survey Results

Aerial – 21.8/mi^2
(Vision Air Research)
February 2017

Ground – 22.6/mi^2
(RVCC)
April 2017

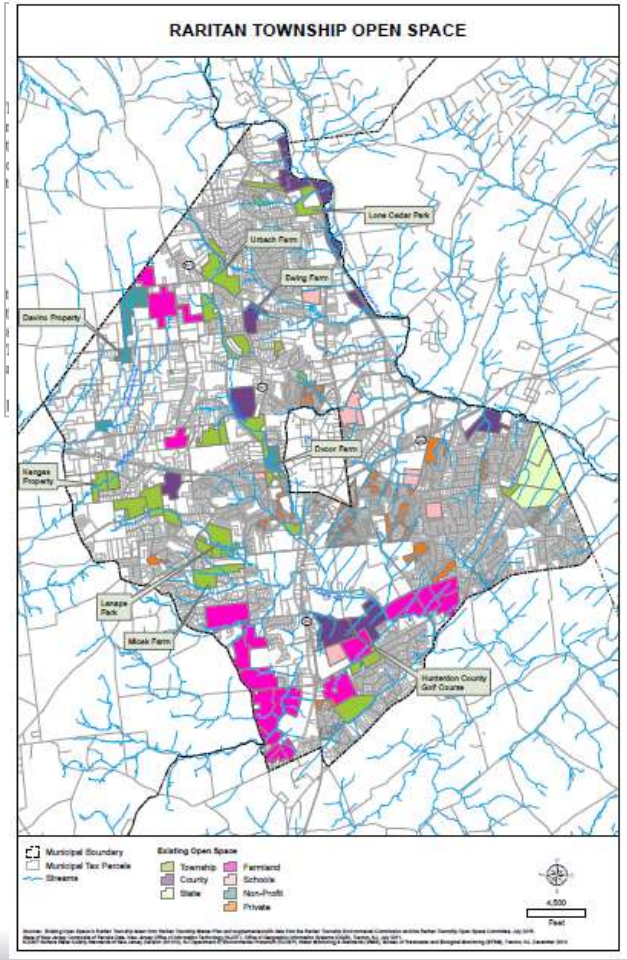


Hunting Options for Deer Management:
Hunting Programs on Preserves/Town Lands

Recommended hunting policies

- Hunter Safety Training and Education
- Increased Take

  3 to 1 “earn a buck”
- Hunting Targets (0.15-0.25 deer/acre)
- Harvest Reports
- Monitoring & Enforcement
- Incentives
- Subsidies
- Stewardship
- Monitoring Deer Population
- Community Based Deer Management (NJDEP)



Hunters Helping the Hungry

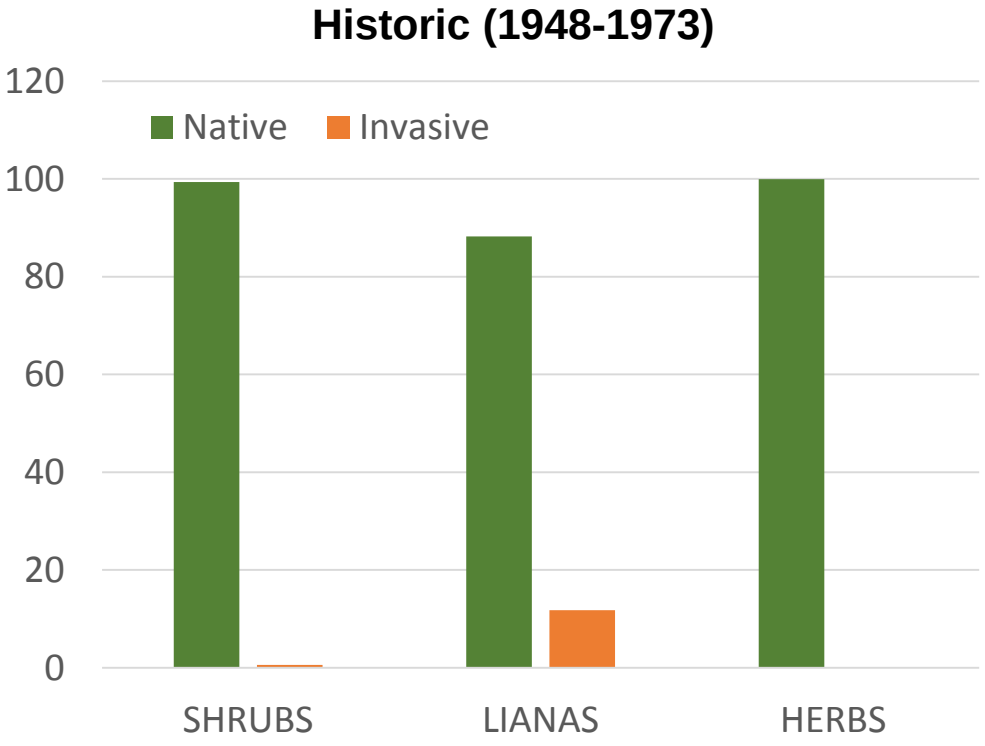
Since the program's inception [1997], hunters have donated over 430,000 pounds of venison to the *HHH* providing approximately 1.7 million meals to those in need (Les Giese 2017)

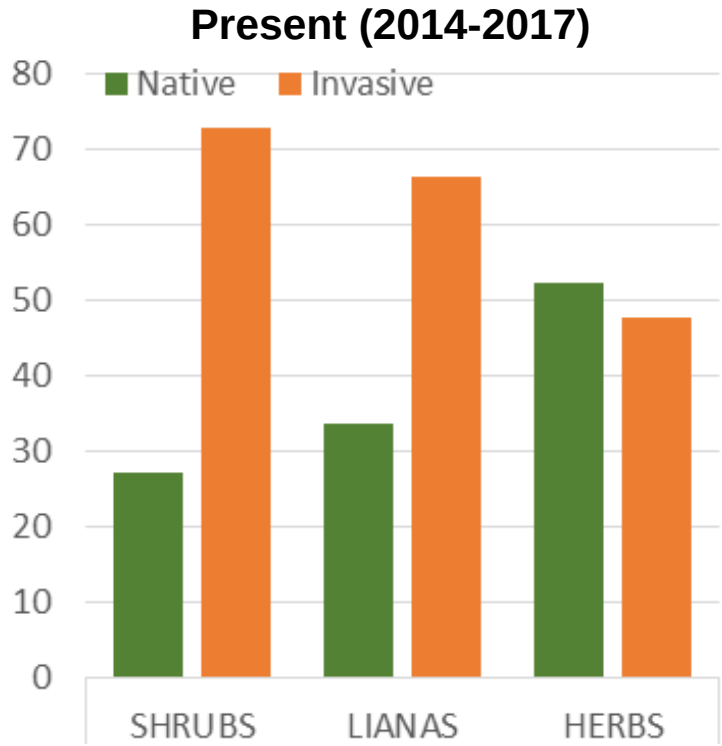
Donation Policy

- Deer <50 lbs costs $30/deer to process
- Deer <50 lbs costs $10/deer to process
- In Pennsylvania, cost is $0

Invasive Plant Species in Forest Understories – *Past to Present*

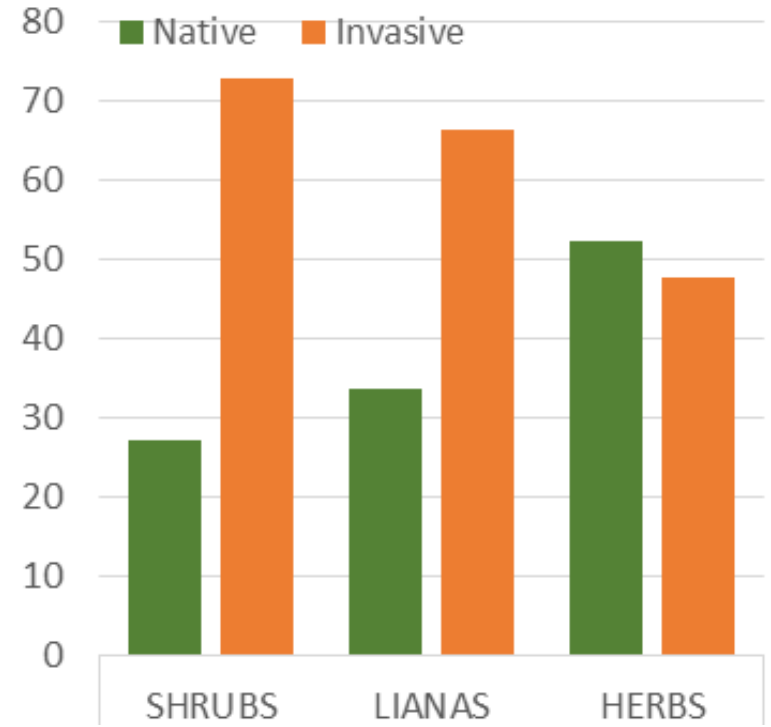
- **Dramatic Increase in Invasive Understory Vegetation from Historic to Present**
- **Present Forest Understories are More Invasive Than Native**





Invasive Plant Species in Forest Understories – *Dominant Species*

- More invasive than native on average



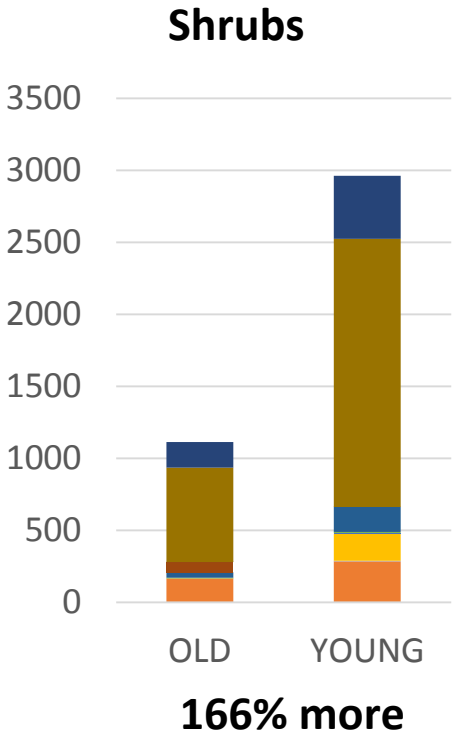
Japanese Stiltgrass – 87%

Multiflora Rose – 62%

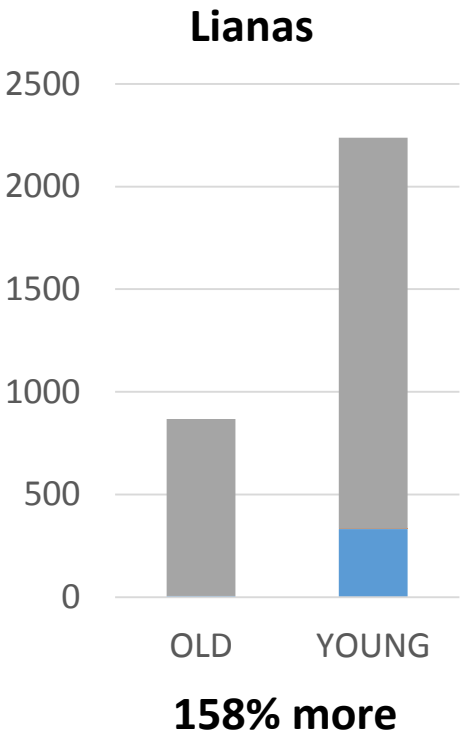
Japanese Honeysuckle
89%

Invasive Plant Species in Forest Understories – *Young vs. Old Forests*

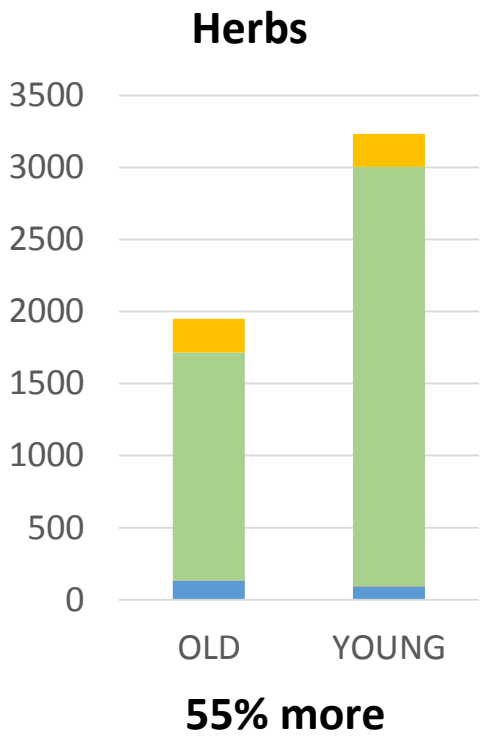
- **More Invasives in Young Forests Than Old**



166% more



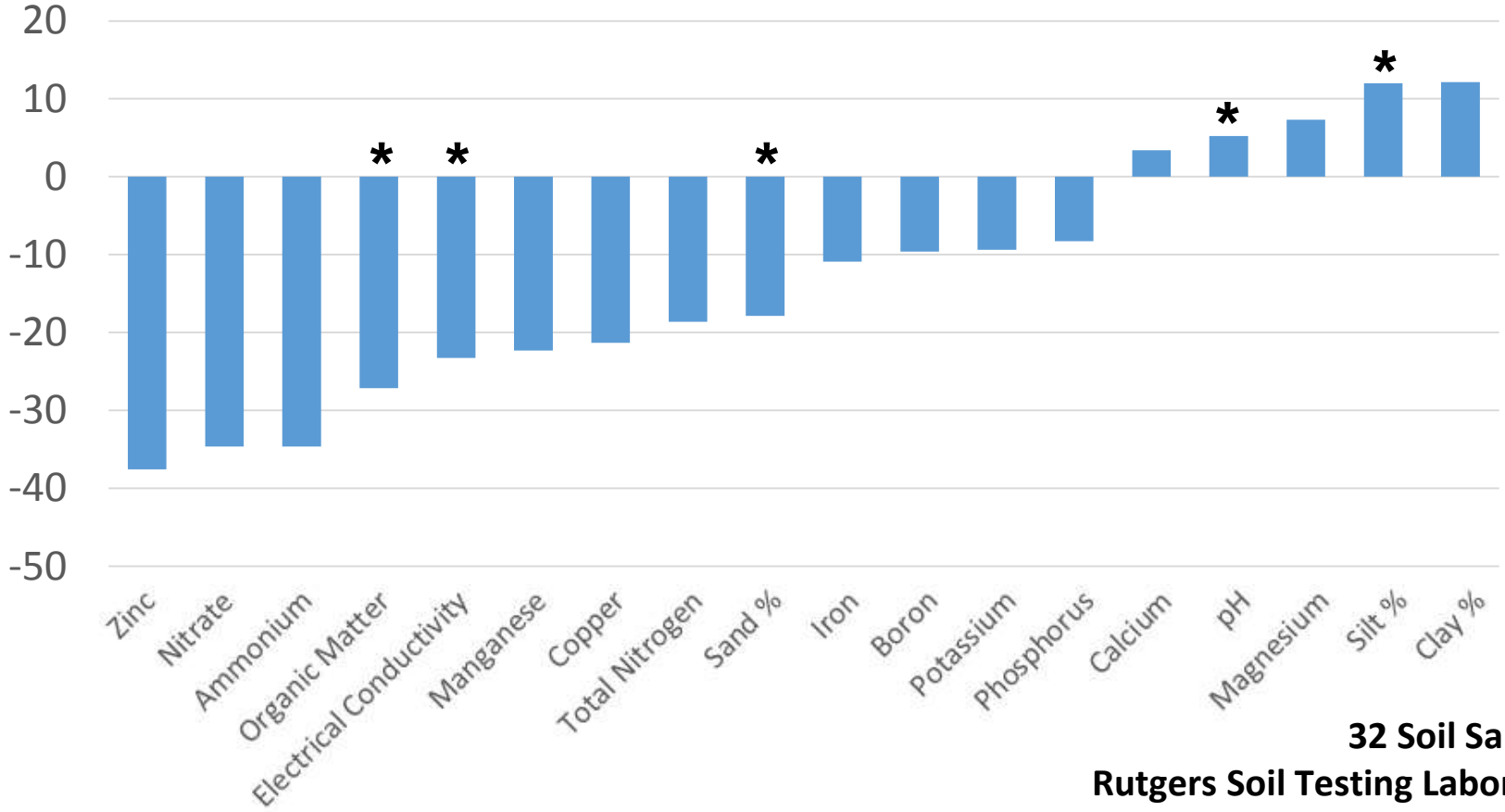
158% more



55% more


Old
Young

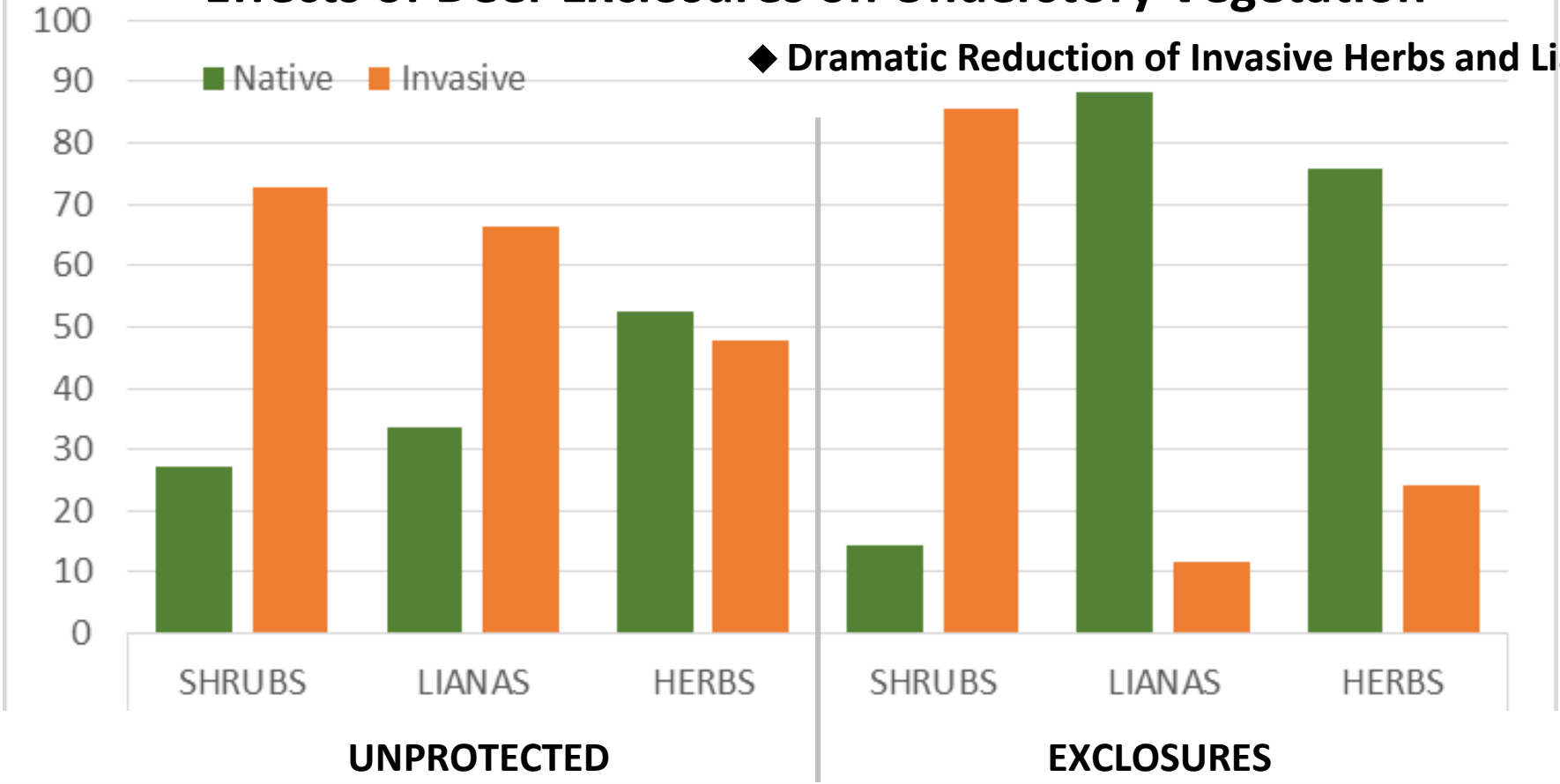
% Difference of Soil Variables (Young vs. Old Forests)



32 Soil Samples
Rutgers Soil Testing Laboratory

Effects of Deer Exclosures on Understory Vegetation

◆ **Dramatic Reduction of Invasive Herbs and Lianas**



Restoration Priorities – *Old Forests!*

Conservation Blueprint (www.njmap2.com)

Bing Maps

1930's Aerials

1899 Forest Map

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 Effects on Food Web

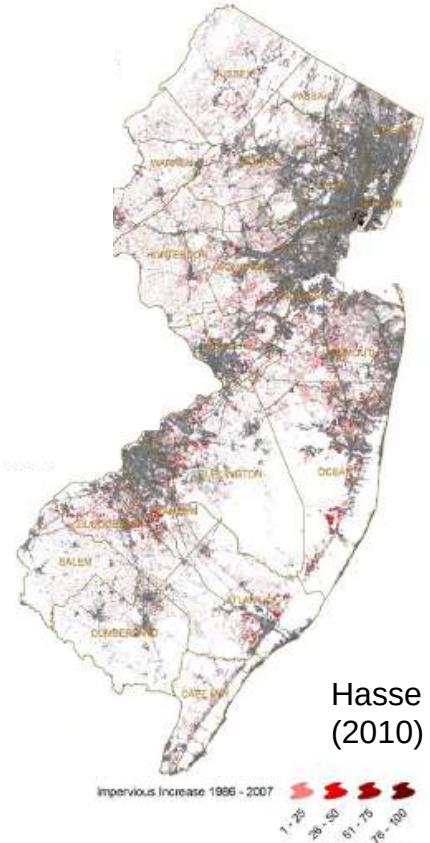
HOSTING CAPACITY OF ALIEN PLANTS INTRODUCED TO NORTH AMERICA

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

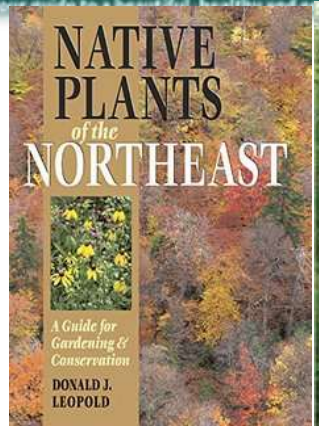
(Tallamy 2009)

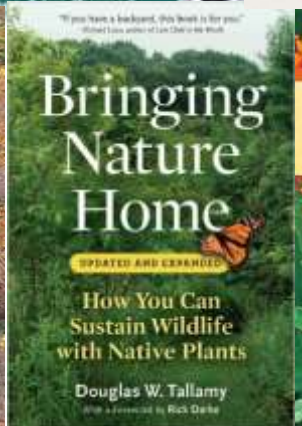
An Ounce of Prevention

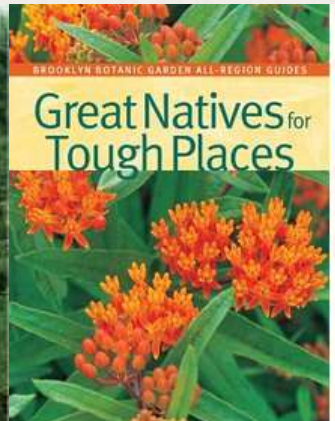
Planting Natives Instead of Exotic Invasives

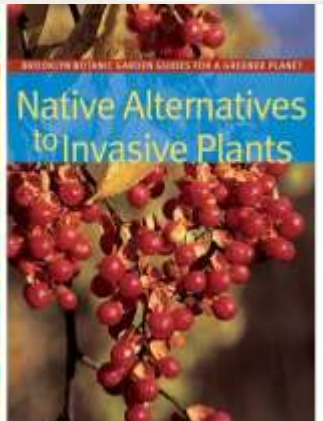


Hasse and Lathrop (2010)









https://bhwp.org/grow/native-plant-nursery/

http://wildridgeplants.com/ http://www.toadshade.com/

https://www.nycgovparks.org/greening/greenbelt-native-plant-center

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