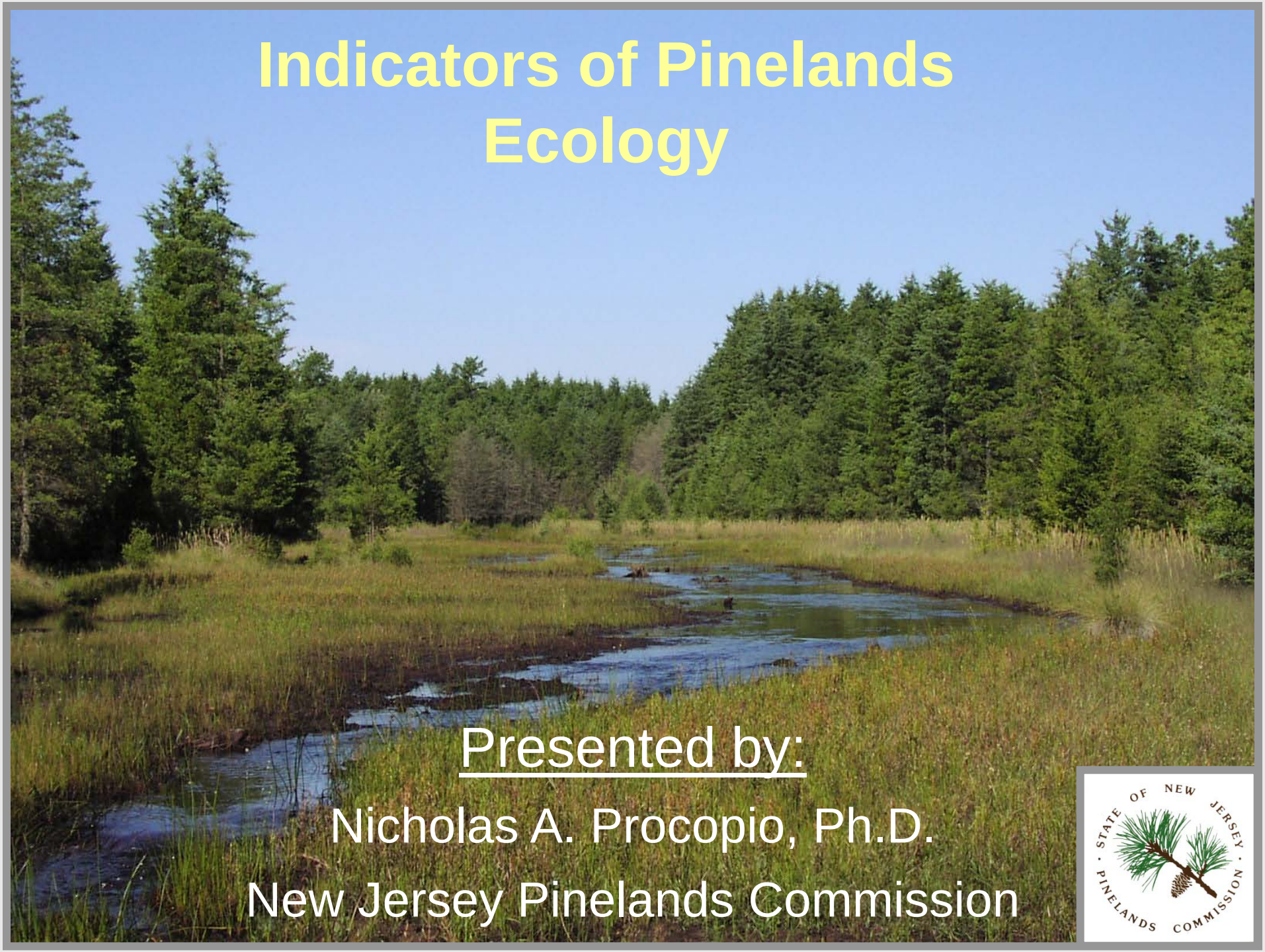
Indicators of Pinelands Ecology



Presented by:

Nicholas A. Procopio, Ph.D.

New Jersey Pinelands Commission

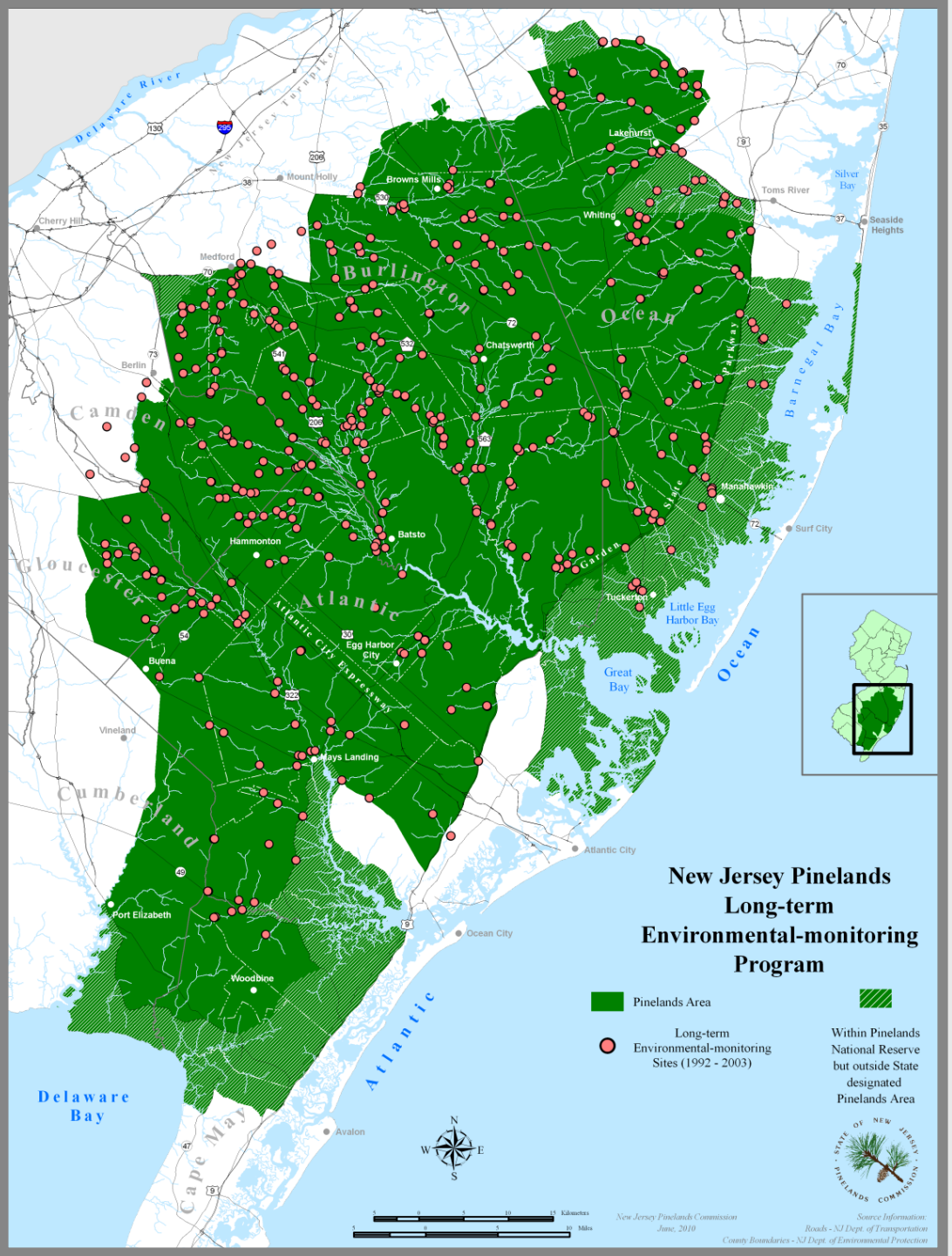
Land-use Activities

Water-quality Degradation

Nutrient enrichment
Increase in dissolved solids
Elevated pH

Altered Biological Communities

Presence of nonnative and loss of native plant species
Presence of nonnative and loss of native fish species
Presence of nonnative and loss of native frog species

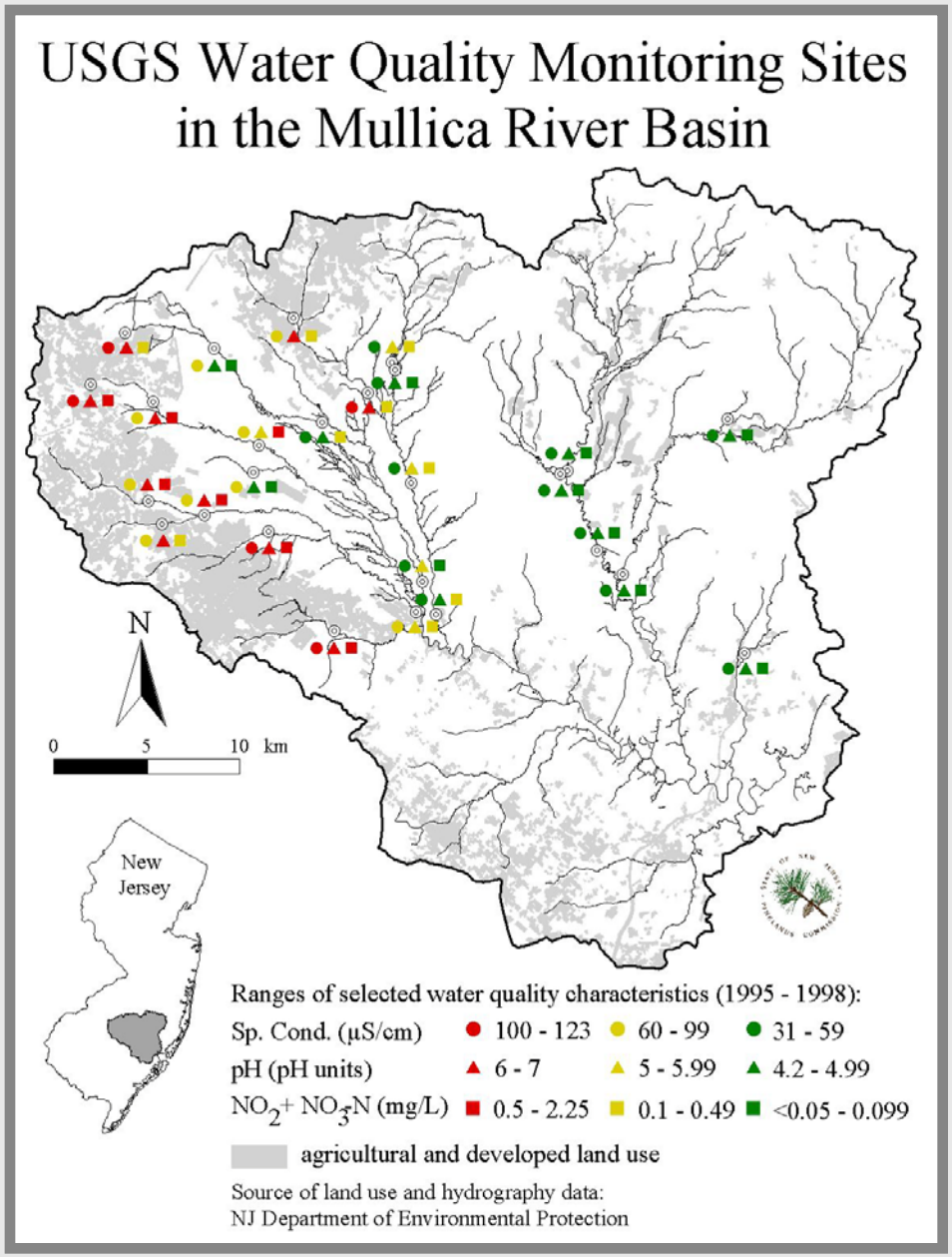


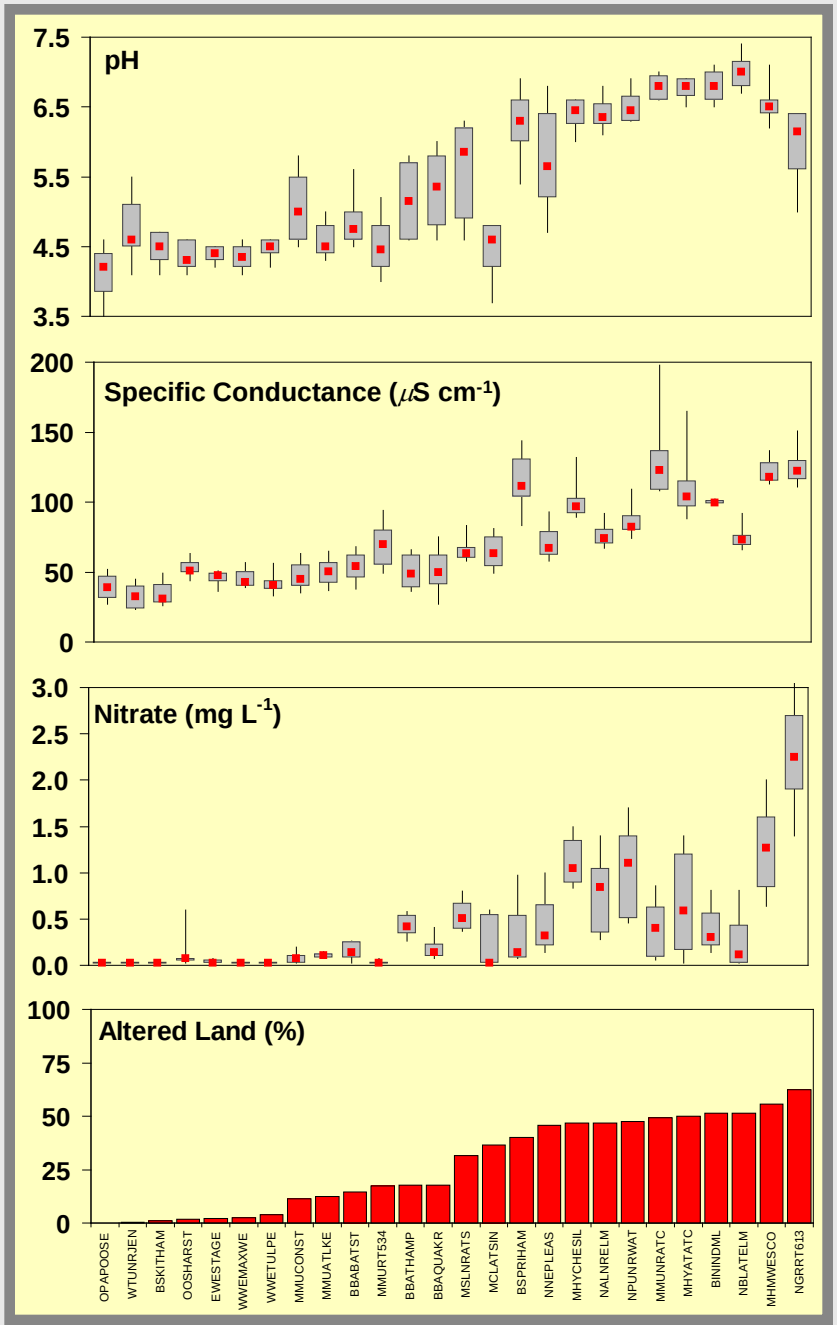
Watershed Assessments

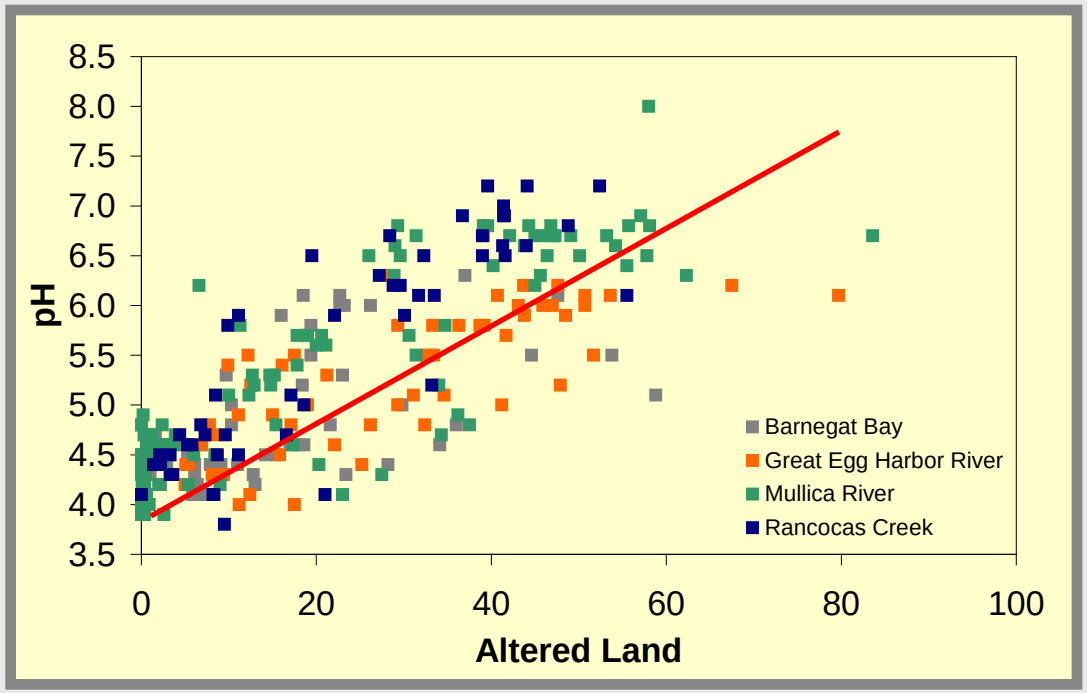
1999 - 2003

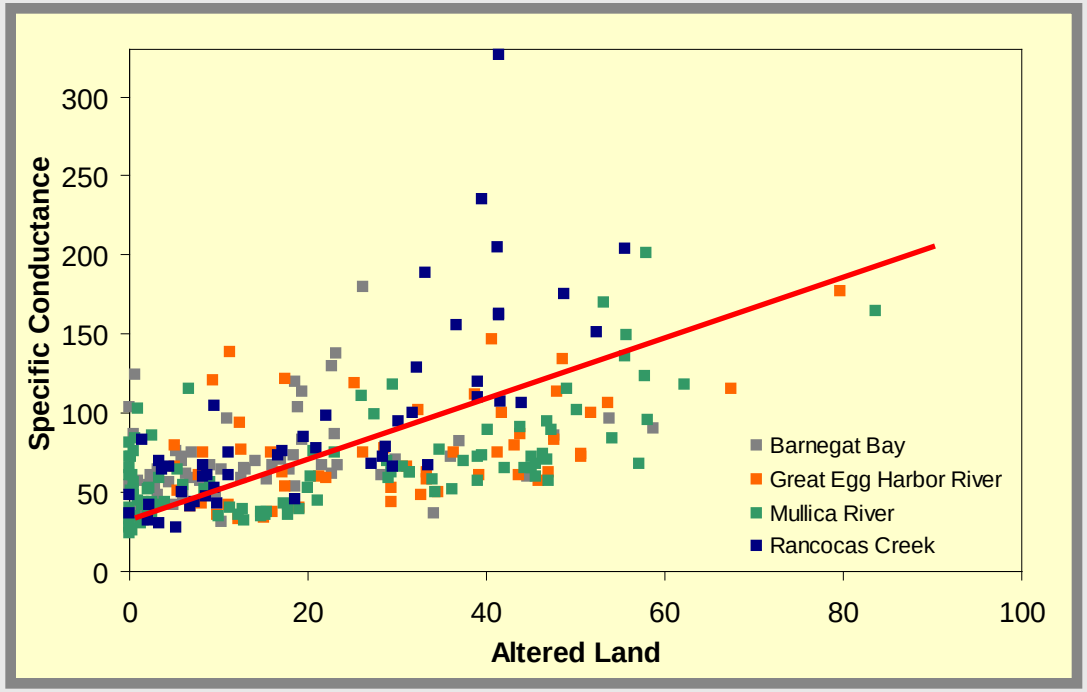
- 273 Water-quality sites
- 202 stream-vegetation sites
- 253 fish sites
  - 72 Impoundments
  - 181 streams
- 194 anuran sites

Water-quality Gradients









General water-quality gradient is associated with an increase in altered land throughout the Pinelands

Comparison of Four Major Pinelands Watersheds

pH and Specific Conductance

Table 1. Spearman rank correlation coefficients (r) relating pH and specific conductance to the percentage of altered land associated with monitoring sites (n) in the four major Pinelands watersheds. Altered land represents the combined percentage of developed land and upland agriculture in a drainage basin. For all correlations, $p < 0.001$.

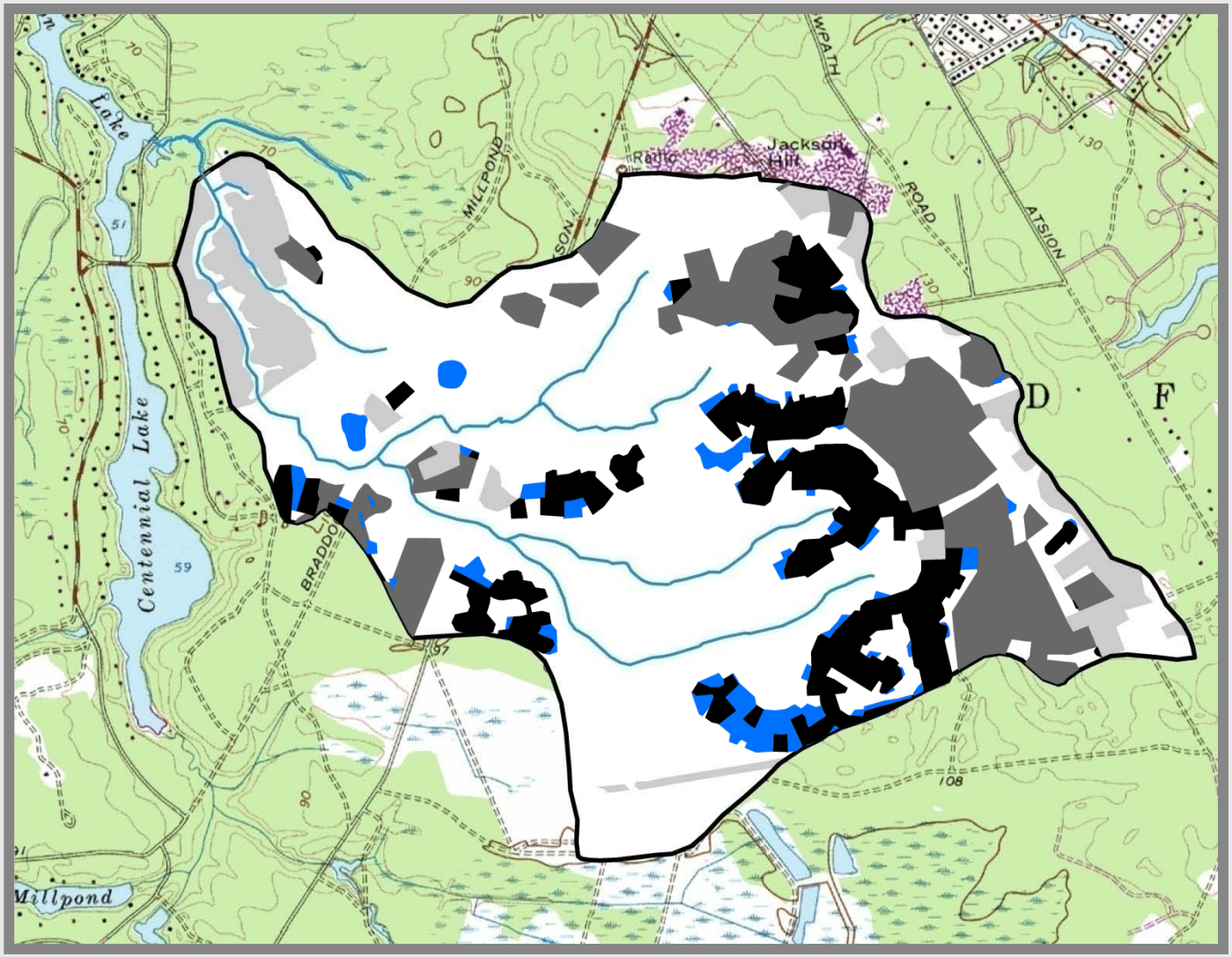
Watershed	n	pH	Specific conductance
Mullica River	103	0.83	0.59
Rancocas Creek	49	0.86	0.84
Great Egg Harbor River	49	0.79	0.55
Barnegat Bay	58	0.60	0.57

Nutrients

Table 2. Spearman rank correlation coefficients (r) relating altered land to median nitrite plus nitrate as nitrogen (NO_x), ammonia as nitrogen, and total phosphorus as phosphorus (Total P) concentrations at monitoring sites (n) in the four major Pinelands watersheds. Altered land represents the combined percentage of developed land and upland agriculture in a drainage basin. Median total-phosphorus concentrations at all Great Egg Harbor River sites were below the 0.05 mg L^{-1} detection limit.

Watershed	Nutrient	n	r	*p*
Mullica River				
	NO_x	25	0.77	<0.001
	Ammonia	25	-0.07	0.746
	Total P	25	0.05	0.822
Rancocas Creek				
	NO_x	51	0.50	<0.001
	Ammonia	51	0.37	0.008
	Total P	51	0.01	0.969
Great Egg Harbor River				
	NO_x	12	0.77	0.003
	Ammonia	12	0.45	0.144
	Total P	12	--	--
Barnegat Bay				
	NO_x	20	0.78	<0.001
	Ammonia	20	0.14	0.552
	Total P	20	0.29	0.222

Landscape Pattern Changes: Mimosa Lakes



Percentage Altered Land

1986 – 8.8%

1995 – 23%

2002 – 33%

2007 – 35%

1988 – median pH did not exceed **4.8**

2001 & 2009 – median pH exceeded **6.0**

Pinelands Stream Vegetation

Golden club

Tawny cotton-grass

Bayonet rush

Slender bur-reed

Swaying rush

Alga pondweed

Common Disturbance-indicator Plants

Ludwigia palustris
water purslane

Impatiens capensis
jewelweed

Eupatorium dubium
joe-pye weed

Mikania scandens
climbing hempweed

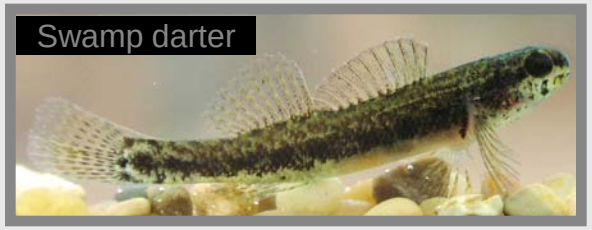
Boehmeria cylindrica
false nettle

Polygonum sagittatum
arrow-leaved tearthumb

Callitriche heterophylla
water-starwort

Fish Species

Restricted Species



Widespread Species

Non-native Species

Anuran Species

Widespread Species

Fowler's toad

Southern leopard frog

Green frog

Restricted Species

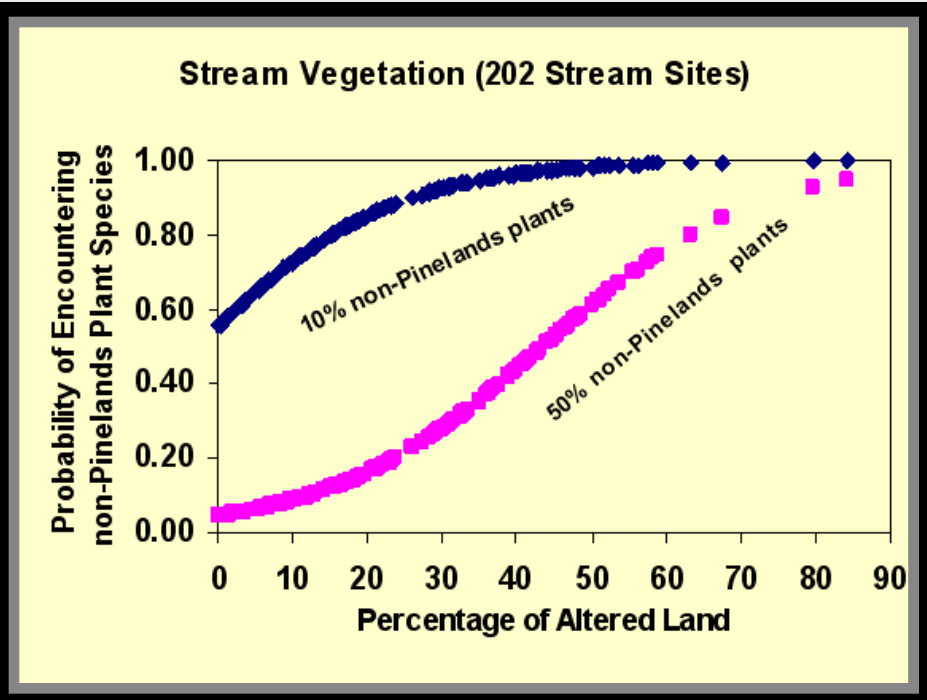
Pine Barrens treefrog

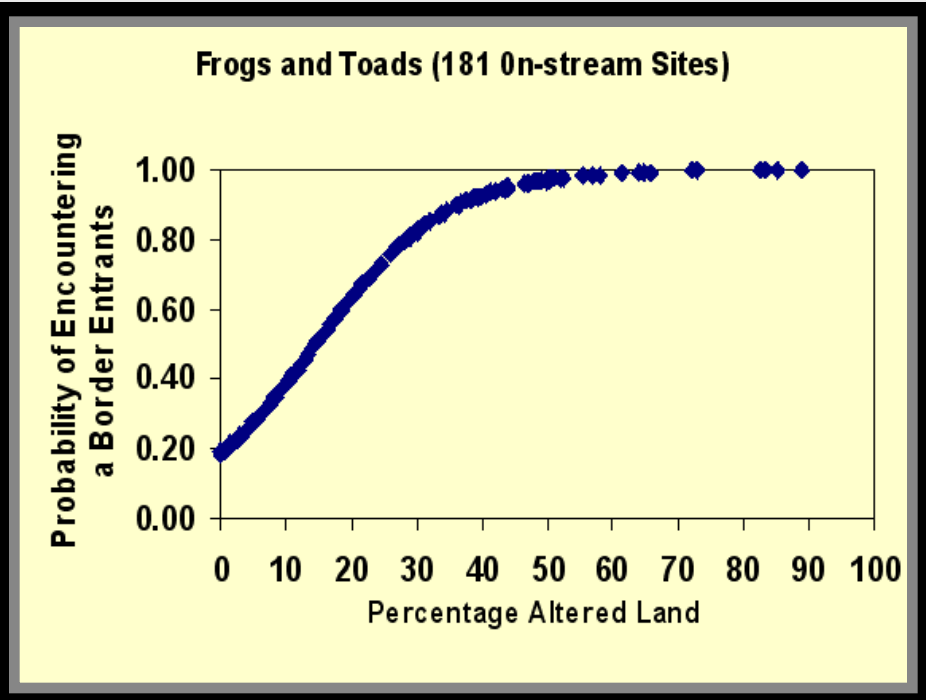
Carpenter frog

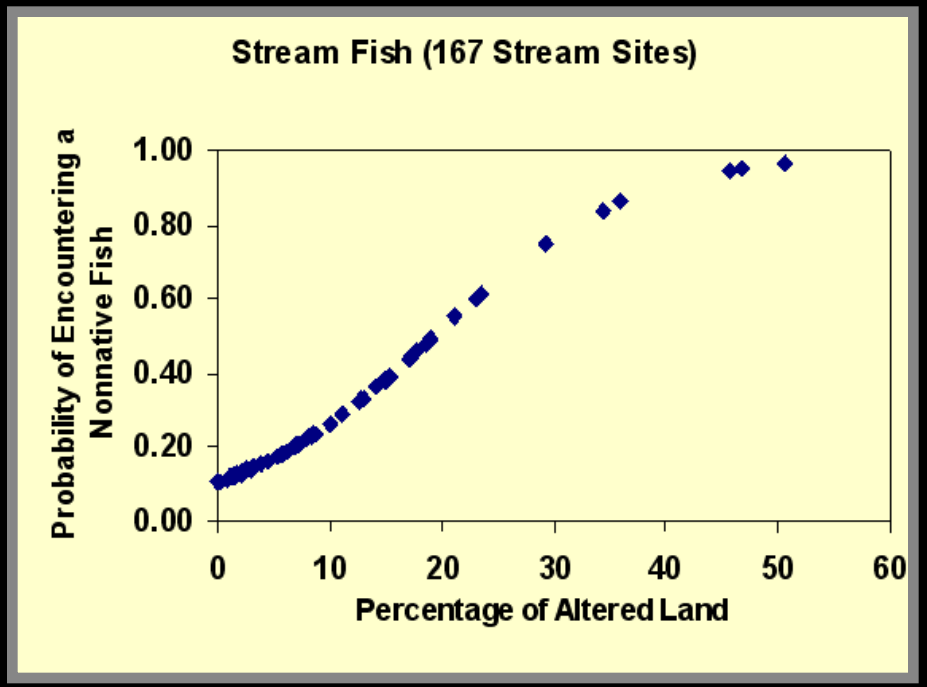
Non-native Species

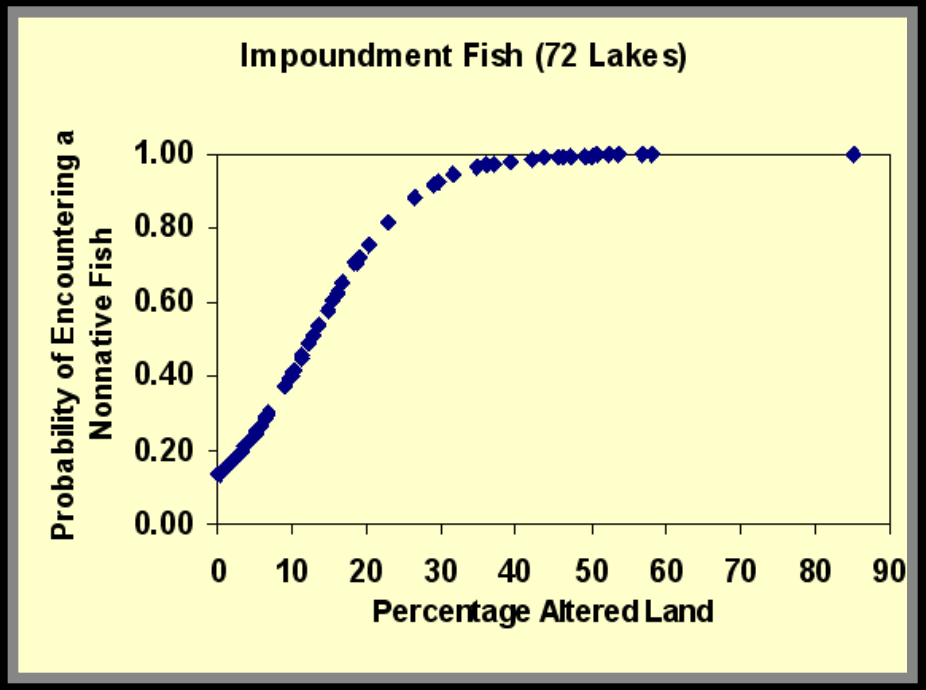
Northern cricket frog

Bullfrog

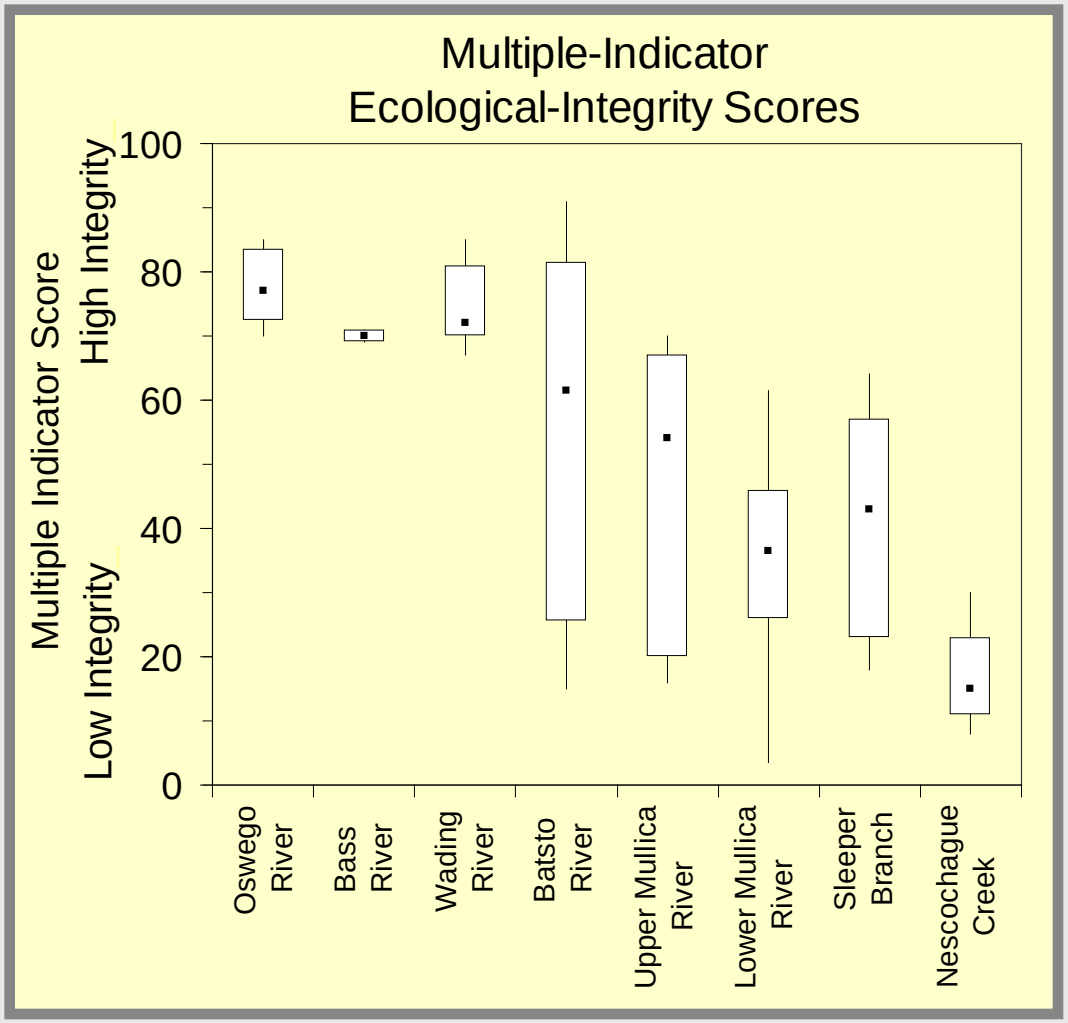

Stream Vegetation (202 Stream Sites)
Probability of Encountering non-Pinelands Plant Species
1.00
0.80
0.60
0.40
0.20
0.00
0
10
20
30
40
50
60
70
80
90
Percentage of Altered Land
10% non-Pinelands plants
50% non-Pinelands plants


Frogs and Toads (181 0n-stream Sites)
Probability of Encountering a Border Entrants
1.00
0.80
0.60
0.40
0.20
0.00
0
10
20
30
40
50
60
70
80
90
100
Percentage Altered Land

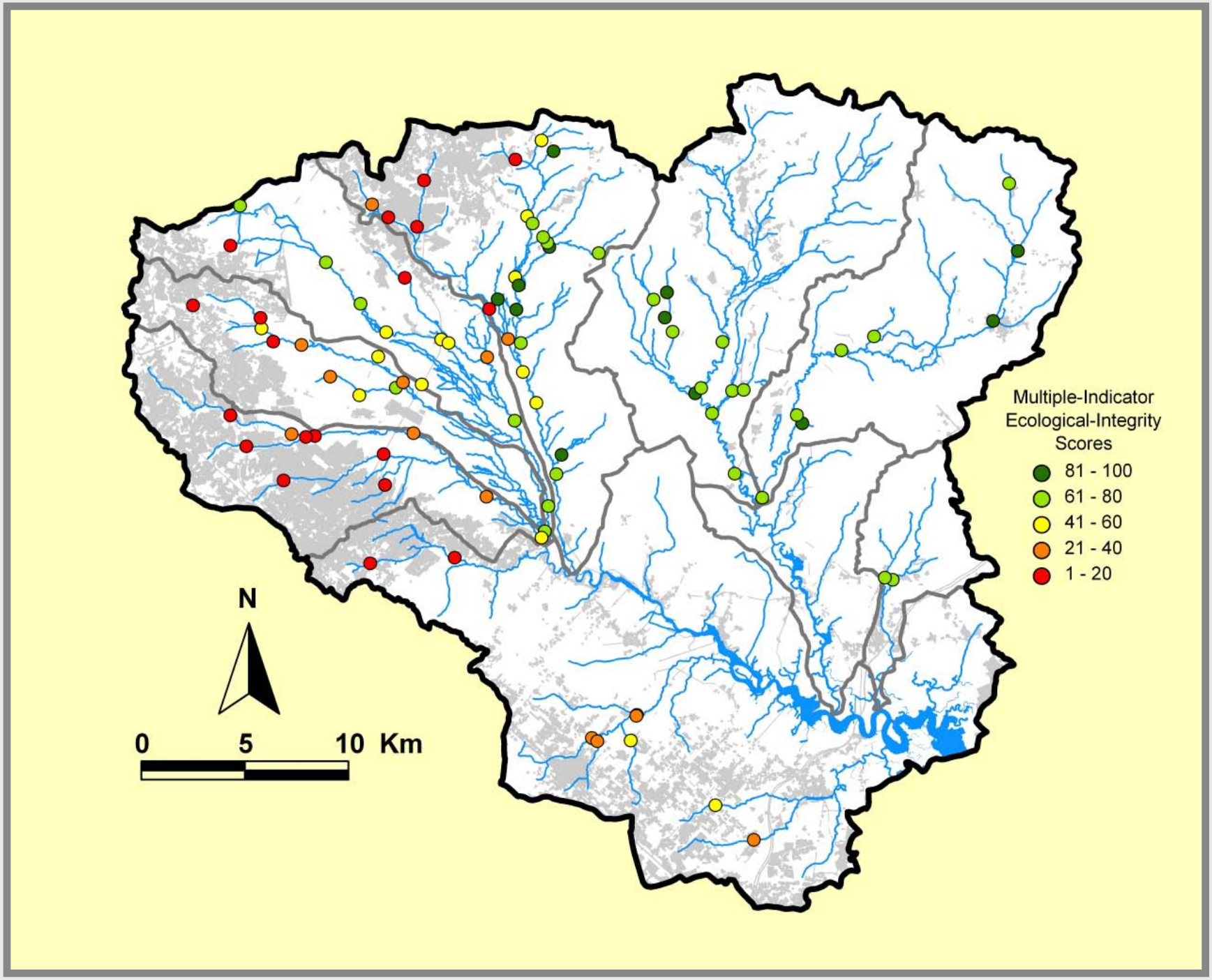

Stream Fish (167 Stream Sites)
Probability of Encountering a Nonnative Fish
1.00
0.80
0.60
0.40
0.20
0.00
0
10
20
30
40
50
60
Percentage of Altered Land


Impoundment Fish (72 Lakes)
Probability of Encountering a Nonnative Fish
1.00
0.80
0.60
0.40
0.20
0.00
0
10
20
30
40
50
60
70
80
90
Percentage Altered Land

Multiple-indicator Ecological-integrity Scores for the Mullica River Basin



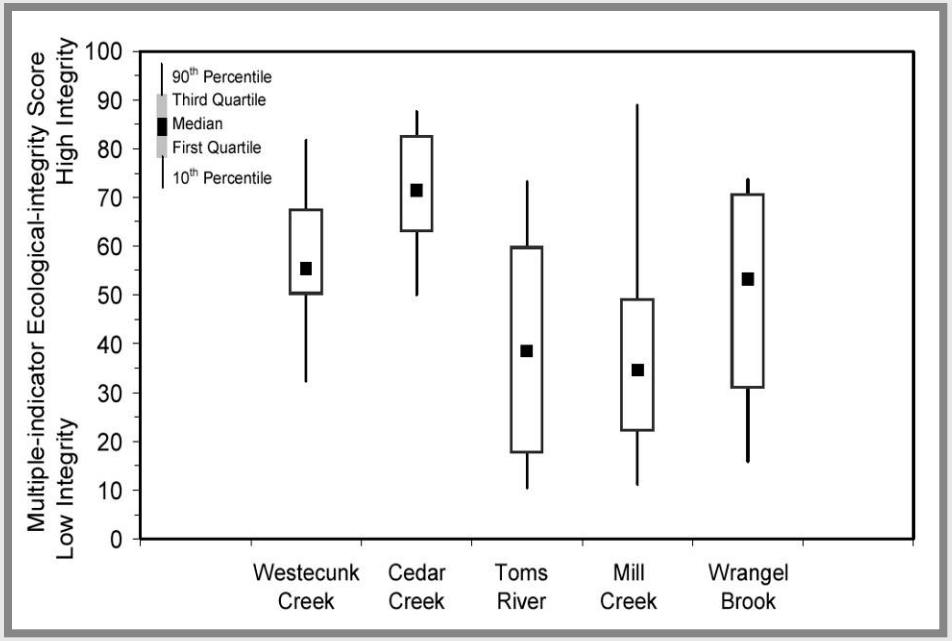
Median value of relativized (0 – 100) and rescaled ranks of each parameter for each site.


Multiple-Indicator
Ecological-Integrity
Scores
81 - 100
61 - 80
41 - 60
21 - 40
1 - 20
N
0
5
10 Km

Multiple-indicator Ecological-integrity Scores for the Barnegat Bay Basins

Table 5. Spearman rank correlations between altered land and ranked and rescaled water-quality scores, community-ordination scores, and multiple-indicator ecological-integrity scores. Ranking and rescaling sites from 0 (low ecological integrity) to 100 (high ecological integrity) to develop the multiple-indicator scores produced correlations with signs opposite of those obtained using the original water-quality data and ordination scores.

Variable	n	r	*p*
pH	58	-0.60	<0.001
Specific conductance	58	-0.57	<0.001
Stream vegetation	47	-0.59	<0.001
Anurans	16	-0.24	0.364
Stream fish	39	-0.54	<0.001
Impoundment fish	14	-0.67	0.008
Ecological-integrity score	57	-0.71	<0.001



Watershed Assessments

Second Round of Surveys

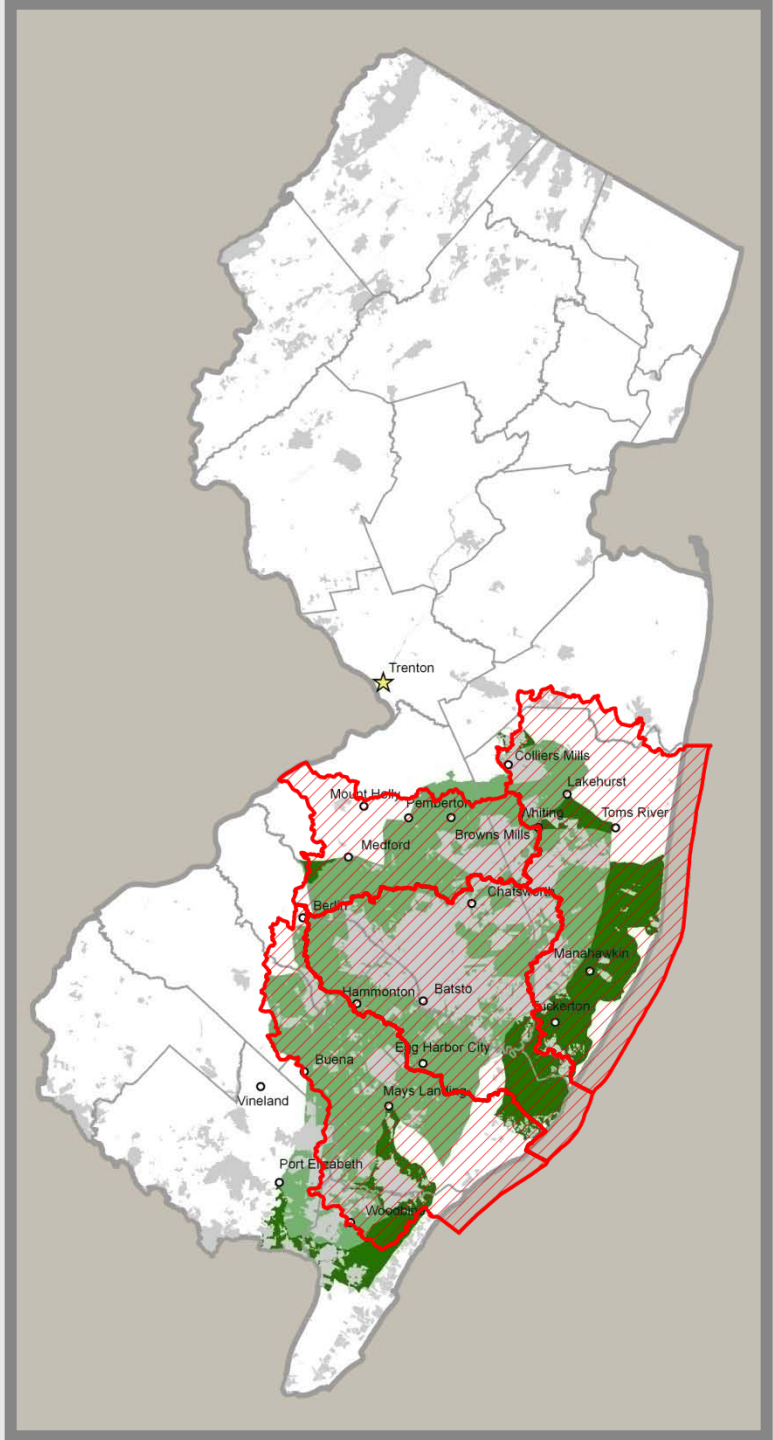
- Water-quality monitoring
- Fish surveys
- Vegetation surveys
- Frog and toad surveys

Mullica River Watershed in 2007-2008

Rancocas Creek Watershed in 2009

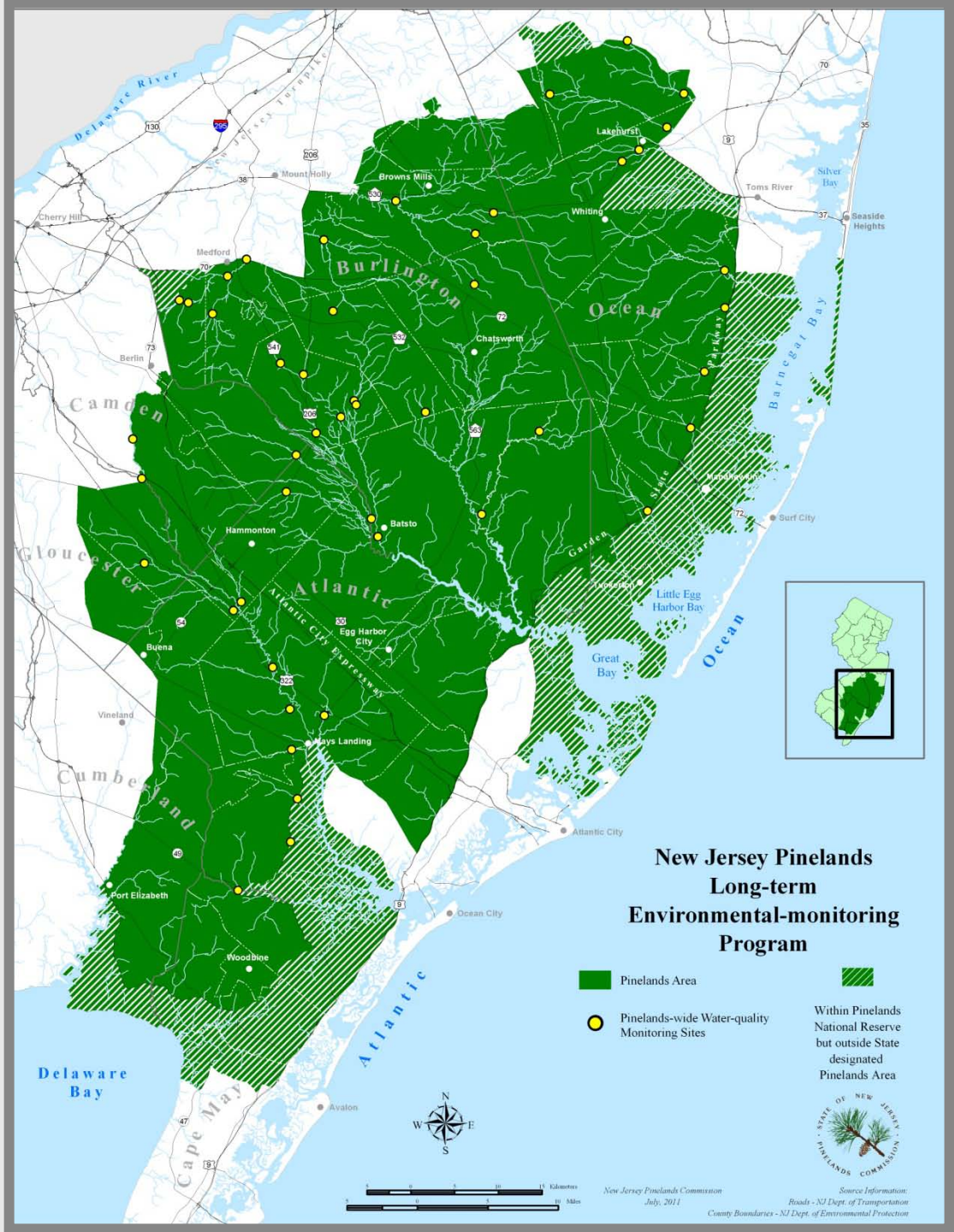
Great Egg Harbor River Watershed in 2010

Barnegat Bay Watershed in 2011



Pinelands-wide Water Quality

- 47 benchmark sites monitored during the growing season of each year since 2005.
- Covering the gradient of water-quality and land-use conditions in the Pinelands.
- Distributed throughout the four Pinelands watersheds.



Conclusions

- Clear relationship between WQ variables & biological community gradients and upstream land-use patterns.

- Clear relationship between WQ parameters and biological community gradients.

- There are several *good* indicators but a **multiple-indicator** approach *better* characterizes a monitoring site.

Policy Implementation

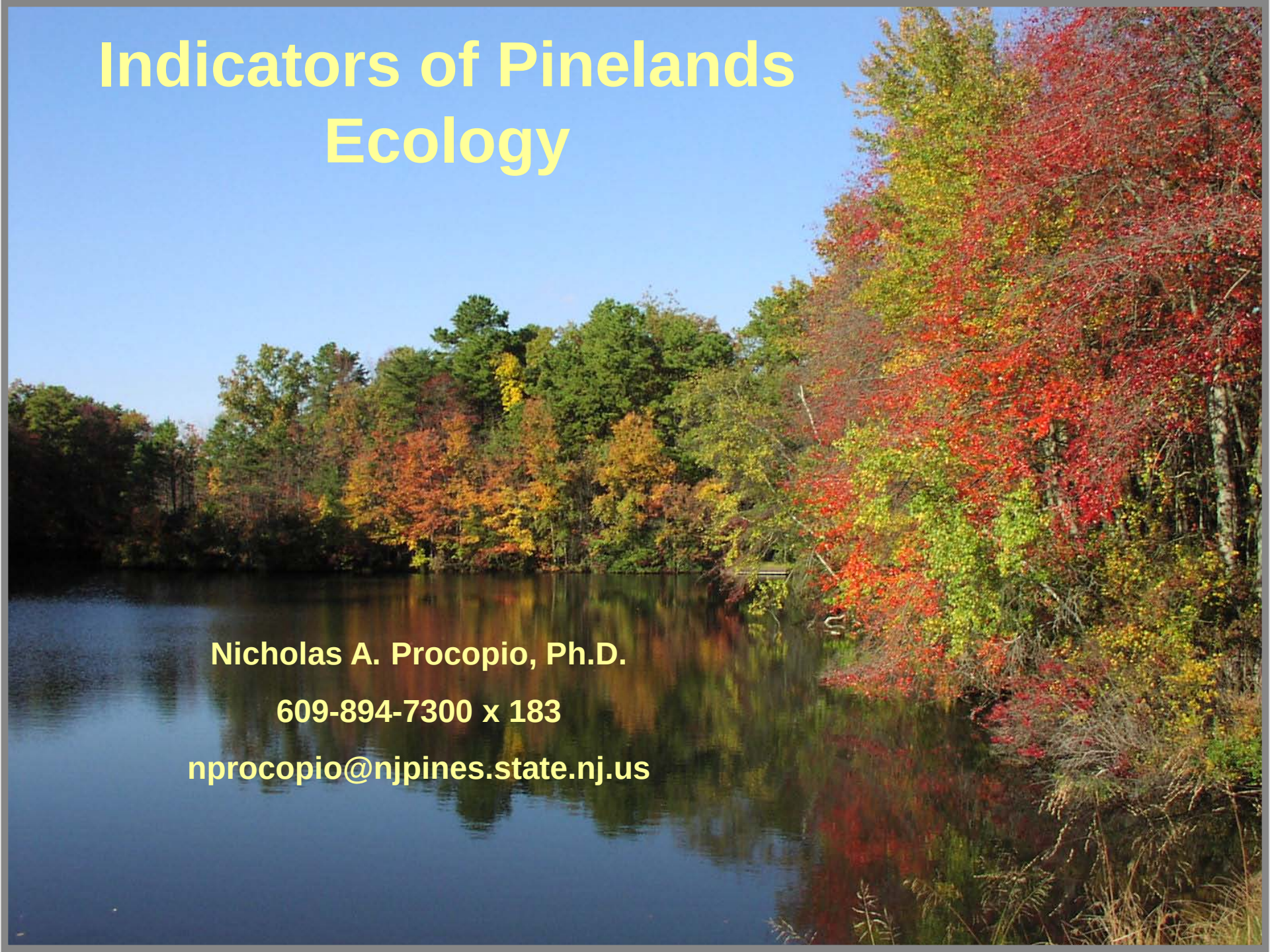
Commission Science data has been used to:

- Develop a regional natural resource protection plan for the Toms River Corridor area,
- Reevaluate the management area designations in the Oyster Creek Watershed,
- Develop a sub-regional resource protection plan for southern Medford and Evesham Townships, and
- Evaluate the ecological-integrity of the New Jersey Pinelands.

…and…

- Water-quality data is used as an input into Commission's buffer model.
- Results from the Kirkwood-Cohansey study will be used to develop updated water-supply policies.
- Added to WQDE – 11,349 data points

Indicators of Pinelands Ecology



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