Land-use Patterns and Aquatic and Wetland Resources in the New Jersey Pinelands

Presented by:

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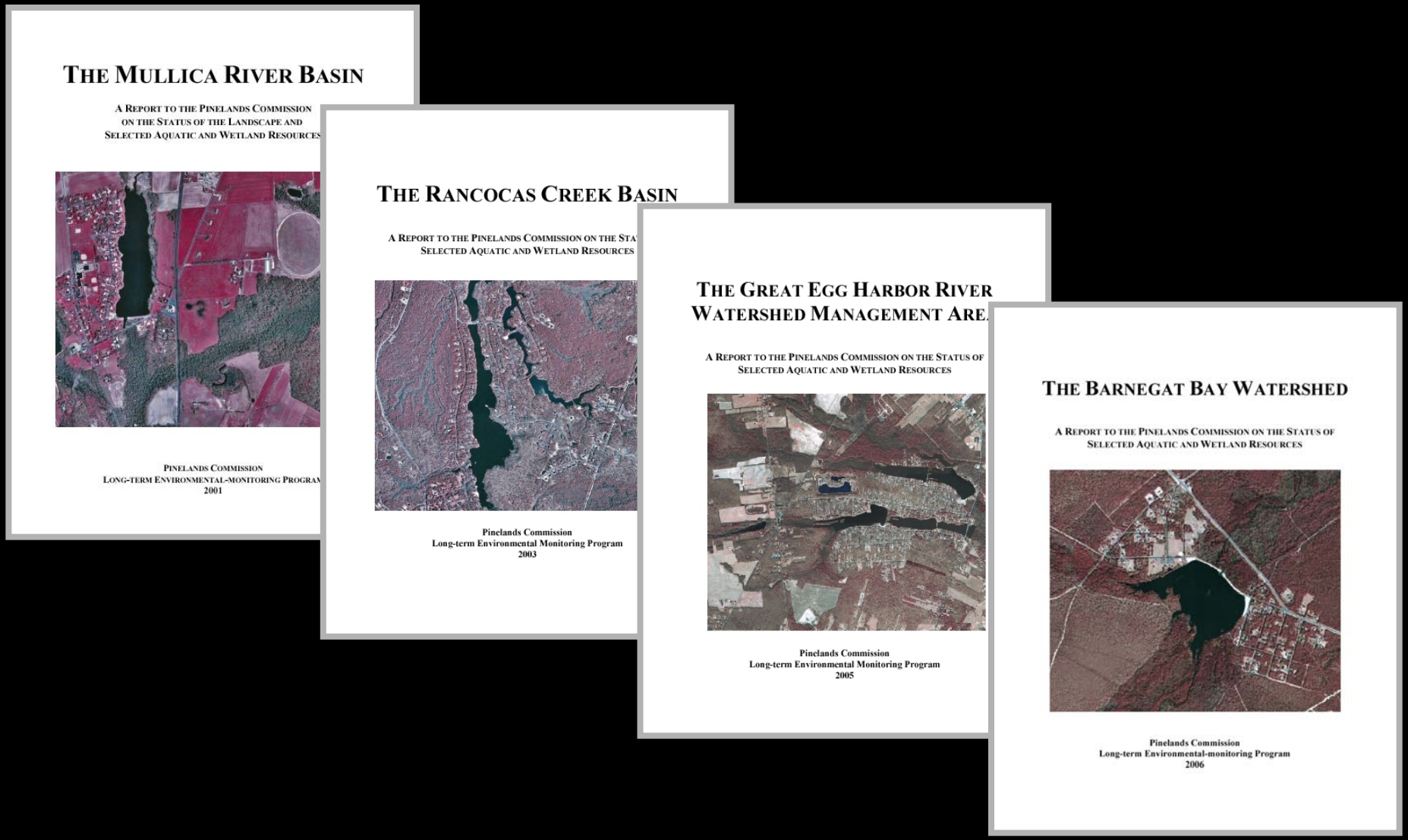
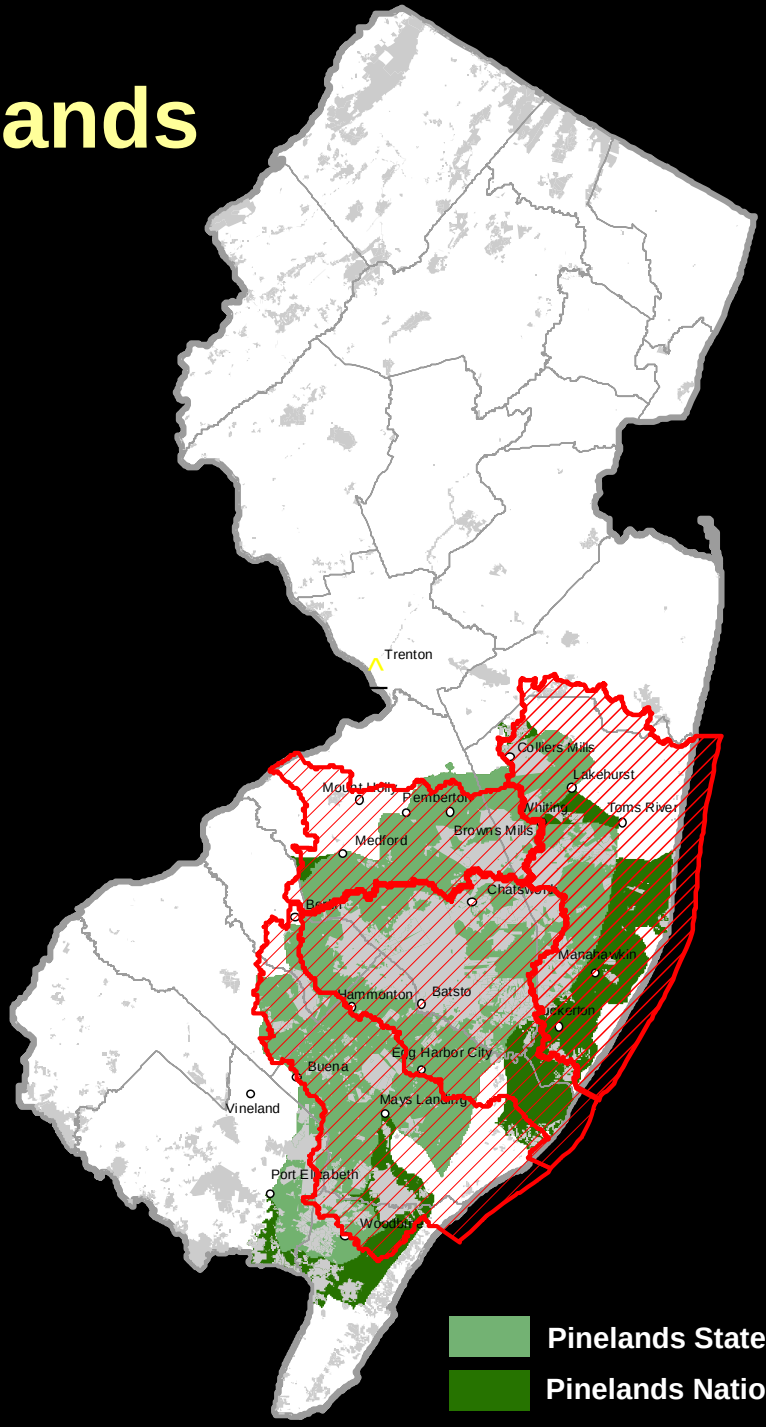
New Jersey Pinelands Commission

Long-term Environmental-monitoring Program



http://www.nj.gov/pinelands/science/

The New Jersey Pinelands



Land-use Activities

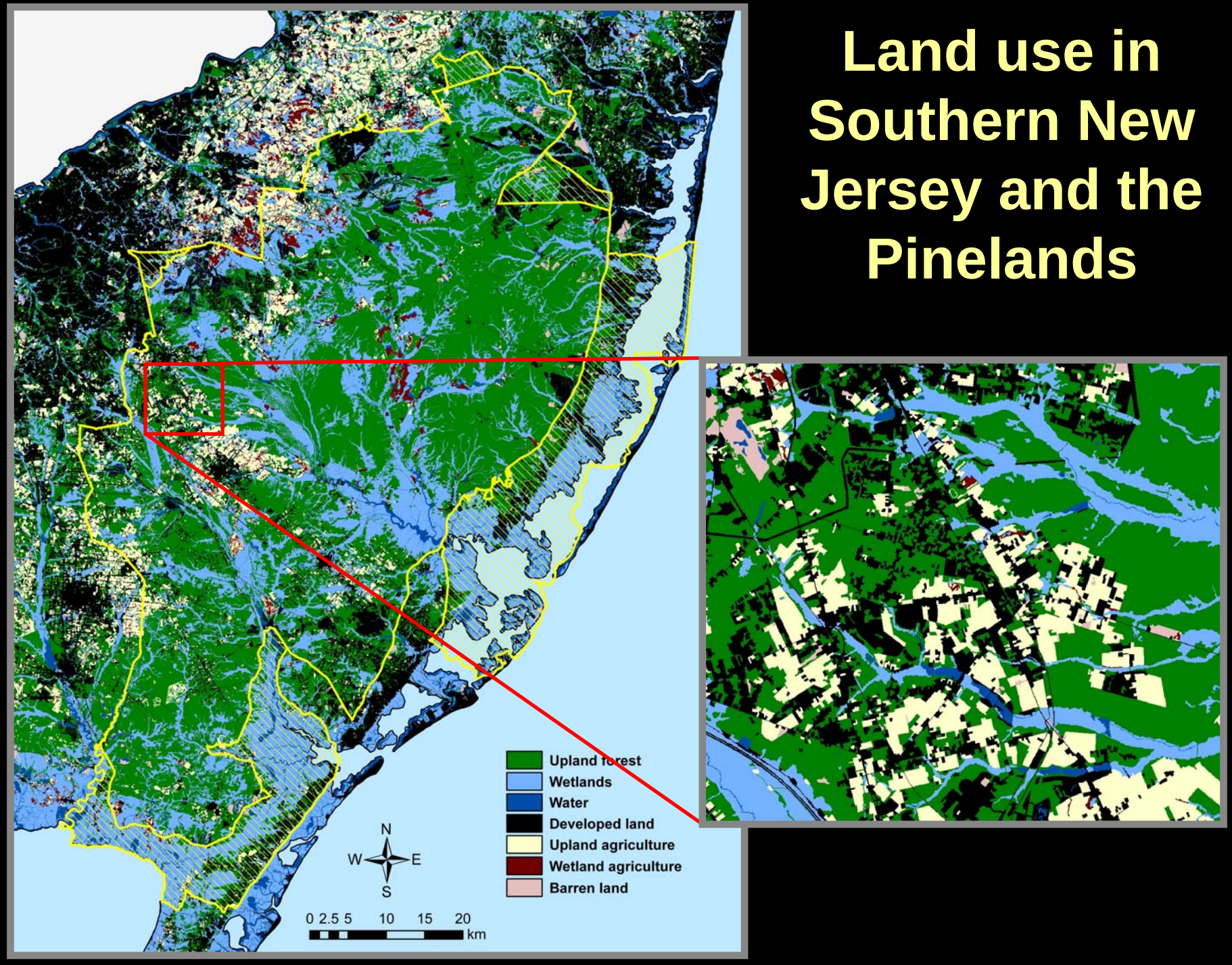
Water-quality Degradation

Nutrient enrichment
Increase in dissolved solids
Elevated pH

Altered Biological Communities

Presence of nonnative plant species
Loss of native plant species
Presence of nonnative fish species
Presence of nonnative frog species
Loss of native frog species

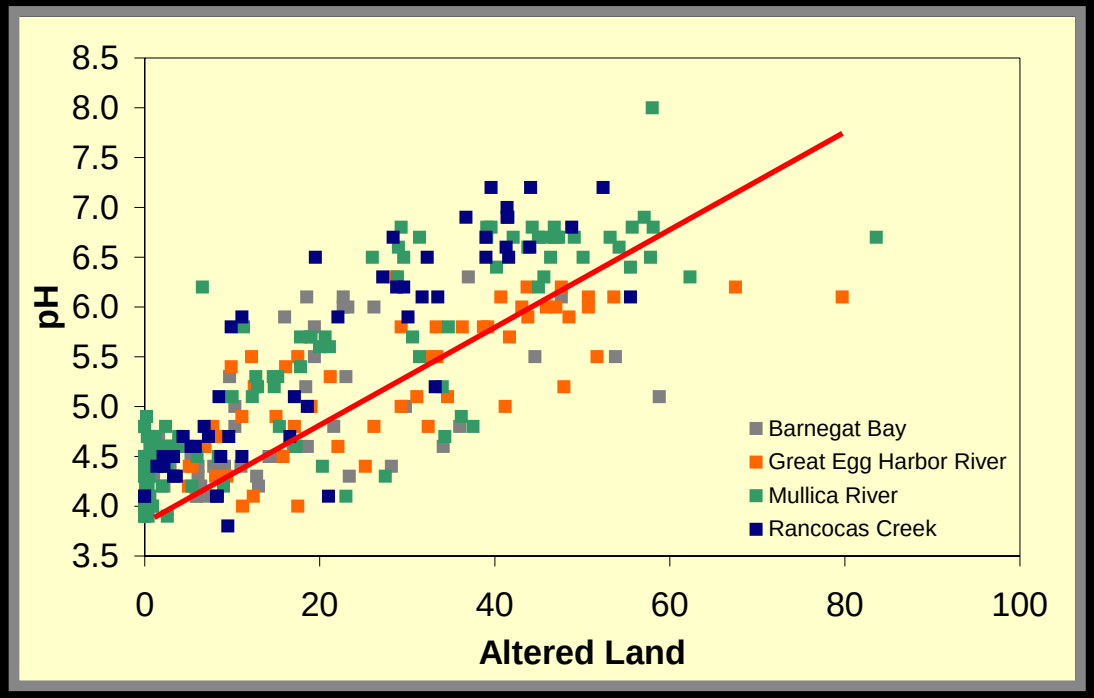
Land use in Southern New Jersey and the Pinelands

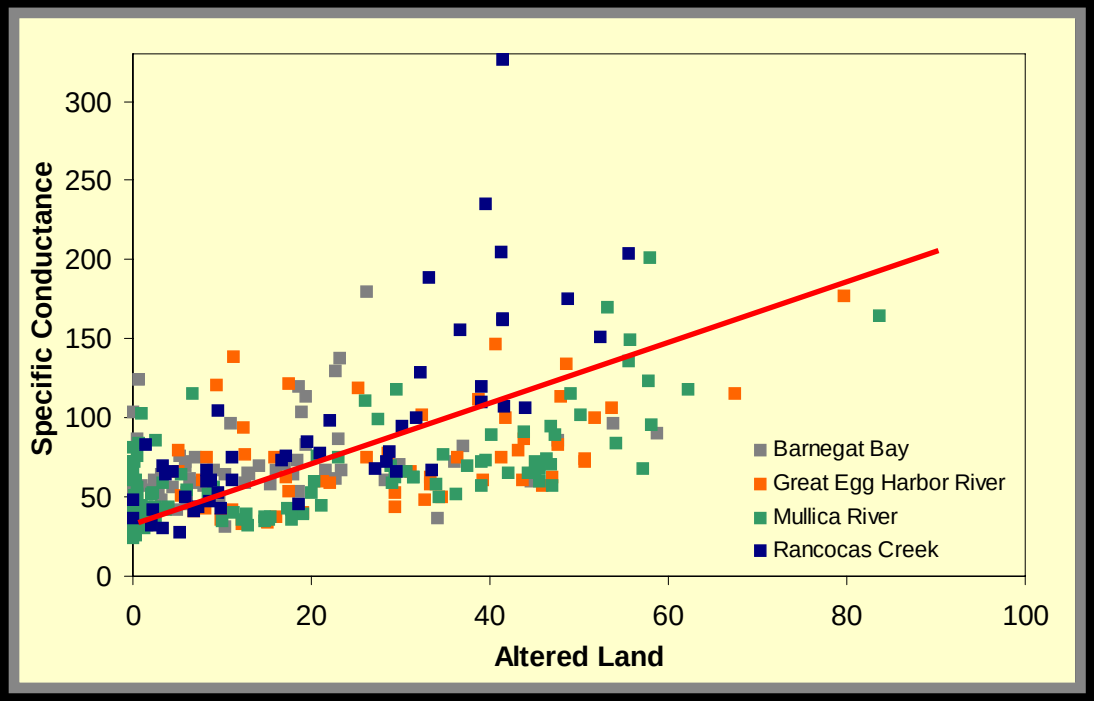


Reference Streams vs. Degraded Streams

Factors	Reference Conditions	Degraded Conditions
Upland agriculture (%)	< 1.0	27.7
Wetland agriculture (%)	< 1.0	< 1.0
Developed land (%)	< 1.0	23.9
Total altered land (%)	2.0	51.7
Calcium, dissolved (mg/L)	0.47	4.9
Magnesium, dissolved (mg/L)	0.30	2.4
Chloride, dissolved (mg/L)	3.3	13
pH (standard units)	4.4	6.8
Specific conductance (µS/cm)	39	104
Sulfate, dissolved (mg/L)	3.6	9.6
Ammonia-N, dissolved (mg/L)	< 0.03	< 0.03
Nitrite + nitrite-N, dis. (mg/L)	< 0.05	0.40
Total phosphorus (mg/L)	<0.01	<0.01

Comparison of Four Major Pinelands Watersheds





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, $p < 0.001$.

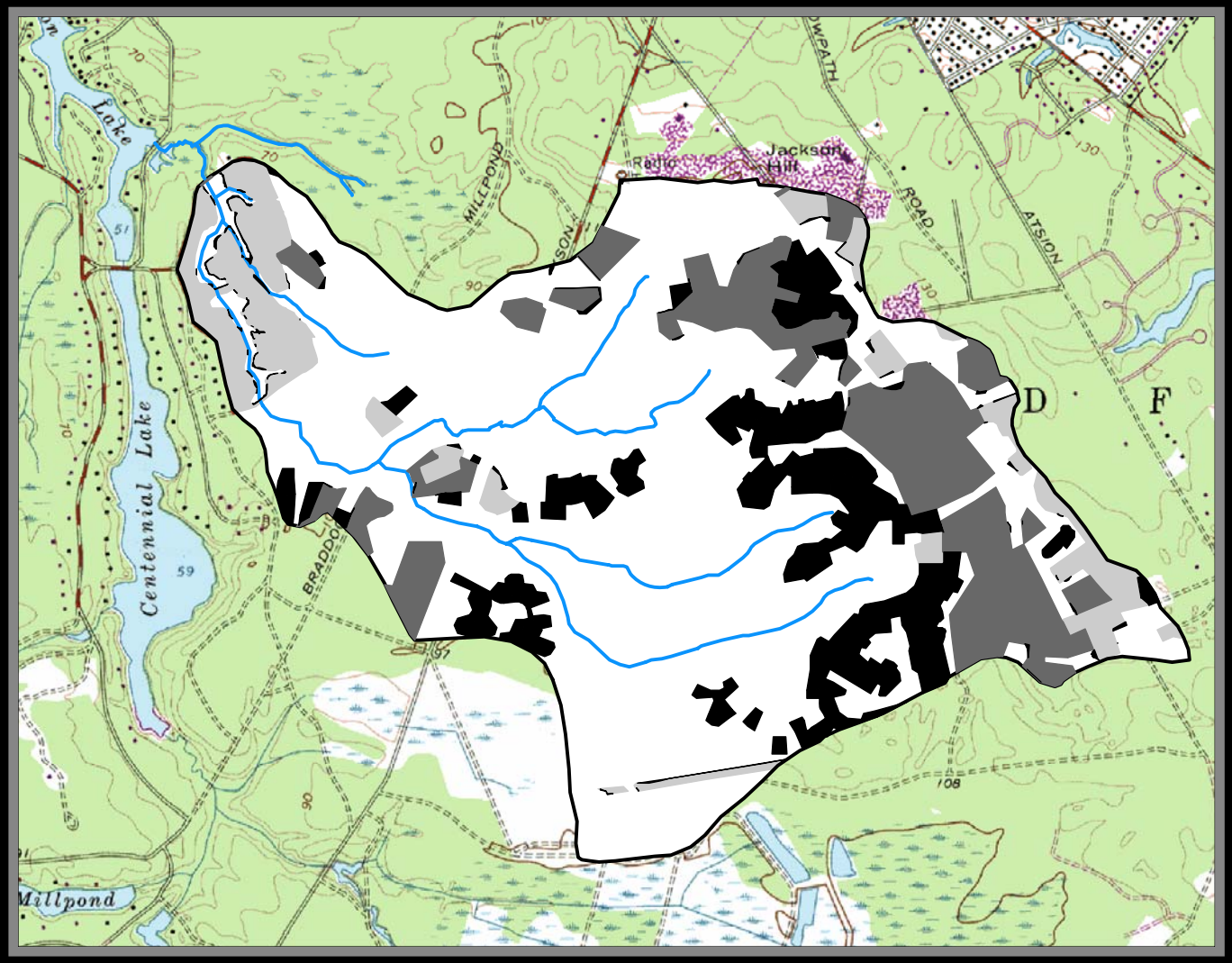
Watershed	n	pH	Specific conductance
Mullica River	103	0.83	0.59
Rancocas Creek	49	0.86	0.84
Great Egg Harbor River	49	0.79	0.55
Barnegat Bay	58	0.60	0.57

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

1988 – median pH did not exceed 4.8 (Morgan, 1989)

2001 – median pH exceeded 6.0

Detrended Correspondence Analysis (DCA)

Ordination technique for community data

- stream-vegetation community
- fish assemblages
- anurans (frogs and toads) assemblages

Orders monitoring sites based on species present

Provides a numerical score for each site

Correlate scores with environmental variables

Native

Golden club

Blackbanded Sunfish

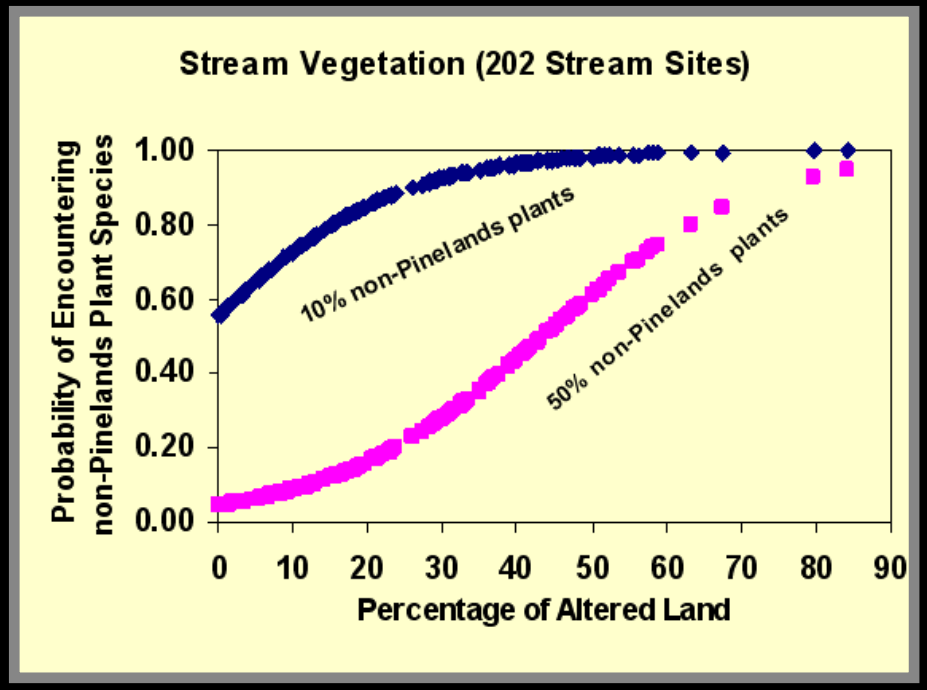
Pine Barrens Treefrog

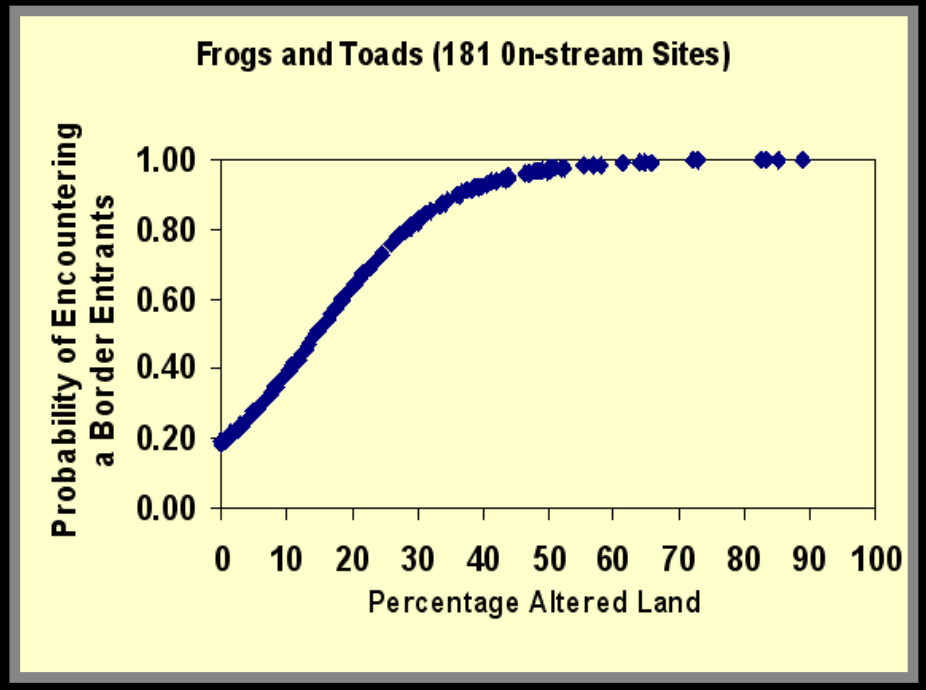
Nonnative

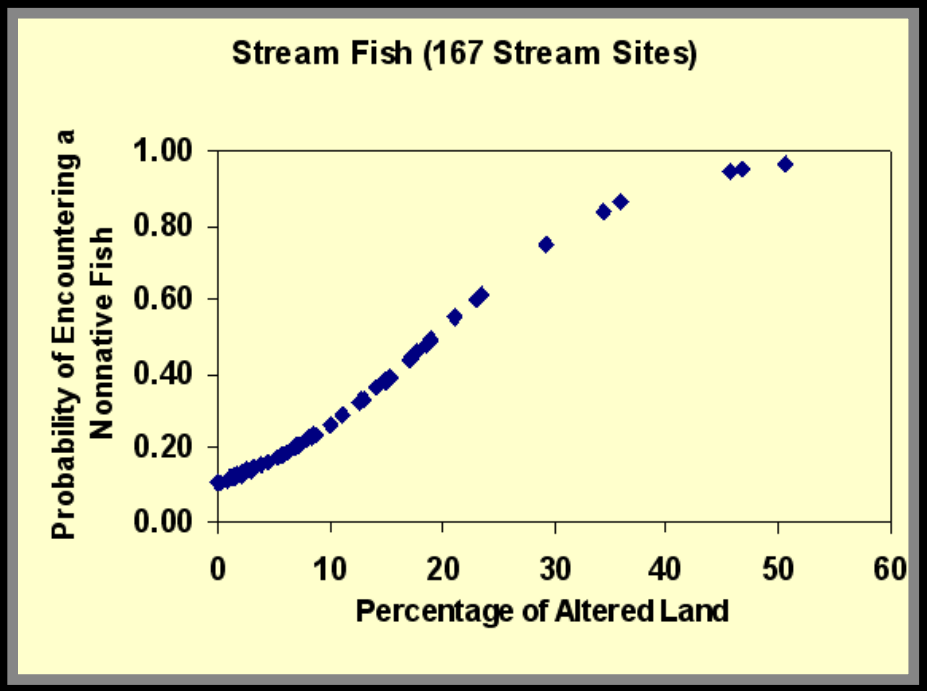
Callitriche heterophylla
water-starwort

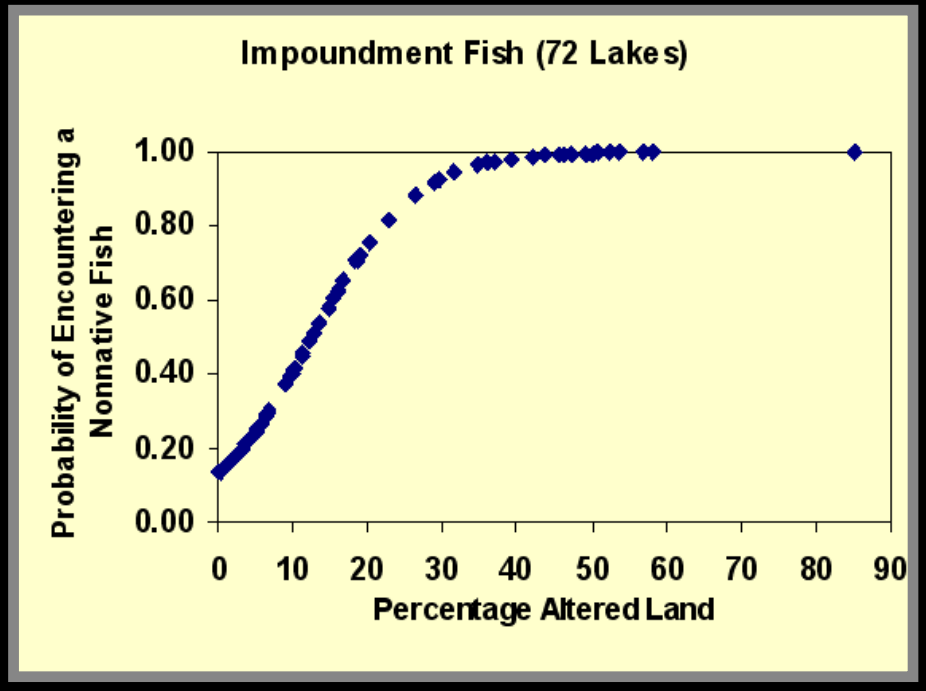
Pumpkinseed

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
10% non-Pinelands plants
50% non-Pinelands plants
0 10 20 30 40 50 60 70 80 90
Percentage of Altered Land


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

Comparison of Four Major Pinelands Watersheds

Table 3. Spearman rank correlation coefficients (r) relating altered land, pH, and specific conductance to biological-community gradients represented by the first axis of DCA ordinations. Altered land represents the combined percentage of developed land and upland agriculture in a drainage basin.

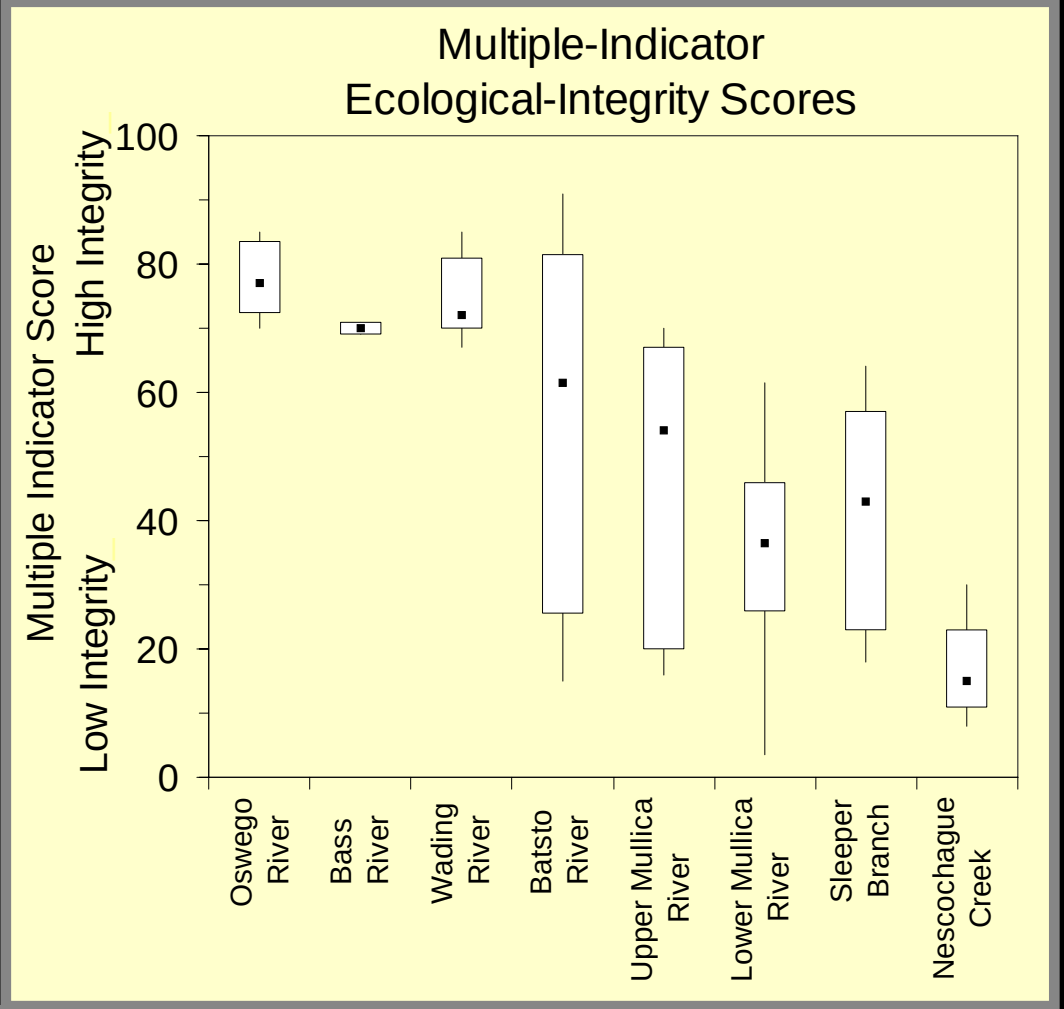
Watershed	Stream vegetation			Anurans			Stream fish			Impoundment fish		
Variable	n	r	*p*	n	r	*p*	n	r	*p*	n	r	*p*
Mullica River												
Altered land	72	0.79	<0.001	78	0.77	<0.001	54	0.82	<0.001	30	0.90	<0.001
pH	72	0.73	<0.001	41	0.77	<0.001	54	0.82	<0.001	30	0.89	0.000
Specific conductance	72	0.68	<0.001	41	0.61	<0.001	54	0.62	<0.001	30	0.41	0.024
Rancocas Creek												
Altered land	44	0.75	<0.001	42	0.71	<0.001	41	0.75	<0.001	15	0.50	0.057
pH	44	0.66	<0.001	29	0.74	<0.001	41	0.87	<0.001	11	0.65	0.029
Specific conductance	44	0.70	<0.001	29	0.62	<0.001	41	0.63	<0.001	11	0.32	0.332
Great Egg Harbor River												
Altered land	36	0.61	<0.001	27	0.15	0.456	32	0.31	0.081	10	0.66	0.038
pH	36	0.73	<0.001	23	0.28	0.197	32	0.36	0.046	10	0.64	0.048
Specific conductance	36	0.33	<0.001	23	0.11	0.611	32	0.05	0.806	10	0.01	0.987
Barnegat Bay												
Altered land	50	0.61	<0.001	34	0.64	<0.001	40	0.55	<0.001	17	0.56	0.019
pH	50	0.46	<0.001	19	0.68	0.001	40	0.64	<0.001	16	0.56	0.025
Specific conductance	50	0.54	<0.001	19	0.00	1.000	40	0.46	0.003	16	0.67	0.005

Table 4. The percentage of survey sites in each major watershed where nonative plants, fish, and bullfrogs were found. Stream-vegetation values represent the percentage of sites where at least 10% or 20% of the classified species were non-Pinelands species.

	Stream vegetation			Bullfrogs		Stream fish		Impoundment fish	
Watershed	n	% ≥10%	% ≥20%	n	%	n	%	n	%
Mullica River	72	75	40	67	49	56	44	30	50
Rancocas Creek	45	96	84	42	52	41	54	15	40
Great Egg Harbor River	36	97	89	27	89	32	78	10	50
Barnegat Bay	50	60	36	34	62	40	43	17	82

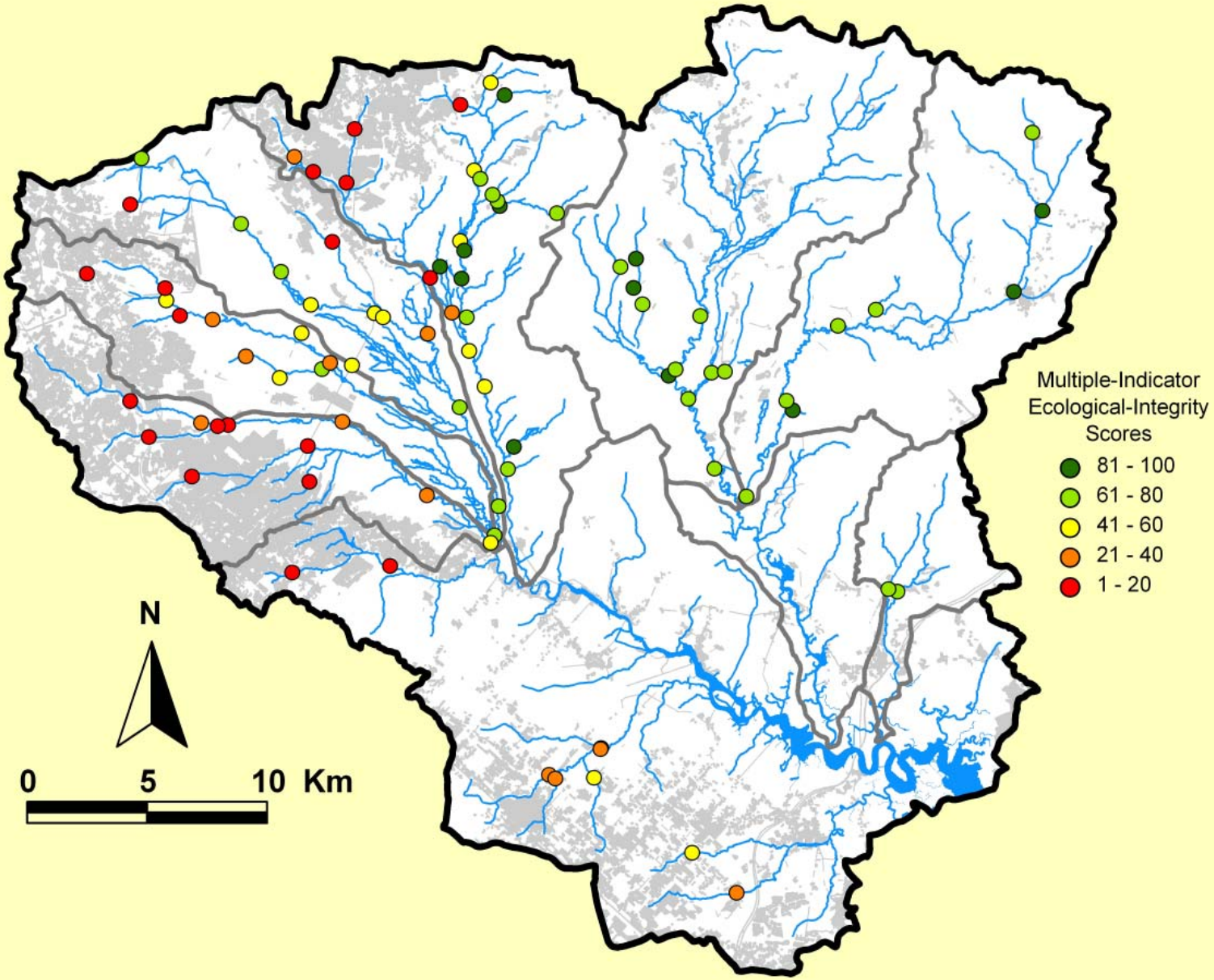
Multiple-indicator Ecological-integrity Scores for the Mullica River Basin

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



Spearman rank correlations based on original water-quality data, community-ordination scores, and multiple-indicator, ecological integrity scores

Environmental variable	pH, $n = 88$	Specific conductance, $n = 88$	Community-ordination scores (DCA axis 1)				Multiple-indicator scores, $n = 88$
			Stream vegetation, $n = 72$	Stream fish, $n = 54$	Impoundment fish, $n = 30$	On-stream anurans, $n = 41$	
Altered land (%)	0.84	0.64	0.79	0.82	0.90	0.76	−0.89
Developed land (%)	0.84	0.58	0.72	0.78	0.85	0.76	−0.84
Upland agriculture (%)	0.76	0.55	0.70	0.76	0.82	0.65	−0.81
pH	–	0.44	0.73	0.82	0.90	0.75	−0.88
Specific conductance $\mu S\ cm^{-1}$	0.44	–	0.68	0.65	0.41	0.61	−0.63


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

Conclusions

- Clear relationship between pH and specific conductance and upstream land-use patterns.
- Clear relationship between pH and specific conductance and biological community gradients.
- Multiple indicator approach works well to characterize monitoring sites.

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