THE EFFECT OF LAND DEVELOPMENT ON STREAM ECOSYSTEM HEALTH IN THE MILL BROOK PRESERVE IN NEW PALTZ, NY

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INTRODUCTION

Mill Brook Preserve:

- 134-acre nature preserve in New Paltz (90 miles N of NYC)
- Created to conserve biodiversity and for recreation and education[5]
- Its tributaries are one of the last undeveloped areas in New Paltz[5]
- Degradation of water quality as surrounding land development increased[1][5][7]

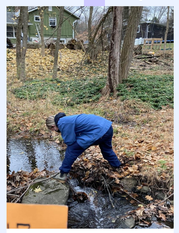


Figure 1: Sampling in Mill Brook

Land Development

- Impacts on stream ecosystem health are growing in severity and expansiveness

Macroinvertebrates:

- Land development can alter the species composition and distribution of macroinvertebrates[2]
- Prime indicators of stream ecosystem health[3]

Figure 2: Crayfish (left) and Mayfly (right). Two macroinvertebrates commonly found in NY

Stream Ecosystem Health:

- Changes in conjunction with surrounding land use impact[4]
- Barometer of land use pressures on a watershed[6]

HYPOTHESIS

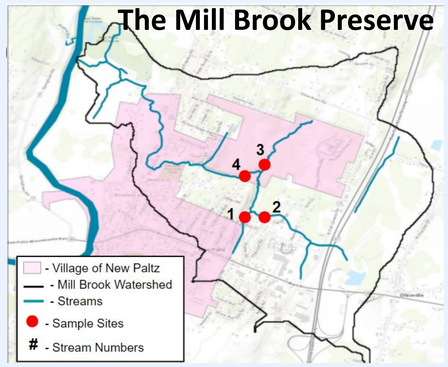
There is a negative correlation between the percent of developed land in the watersheds of the Mill Brook Preserve and their stream ecosystem health

METHODOLOGY

Biodiversity indices were compared to the percentages of developed land within each Mill Brook watershed

Streams

- 4 streams were sampled for macroinvertebrates
- The watershed of stream 4 is comprised of the watersheds of streams 1, 2, 3, and 4



Macroinvertebrate Sampling

1 round of sampling per site during September, 2020

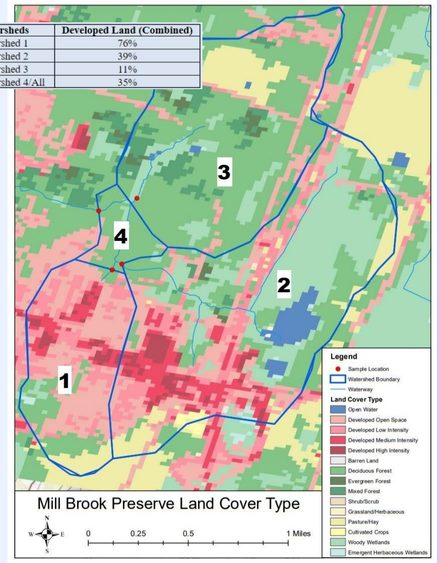
- A physical survey was conducted for each site
- A stream bottom sample was collected from 5 meters of each site
- 100 macroinvertebrates were taken from each sample and identified to the order
- 3 Biodiversity indices were calculated for each sample
  - -Ephemeroptera, Plecoptera, Trichoptera (EPT) Richness Estimate: Mayfly, caddisfly, and stonefly count
  - -Percent Model Affinity: Compares sample to a model community
  - -Major Group Biotic Index: Calculated using pollution tolerance values

	LEVEL OF IMPACT			
INDEX	NON	SLIGHTLY	MODERATELY	SEVERELY
EPT RICHNESS	>7	3-7	1-2	0
BIOTIC INDEX	0-4.50	4.51-5.50	5.51-7.00	7.01-10
PERCENT MODEL AFFINITY	>64	50-64	35-49	<35

Land Development

- Using ArcGIS, the watershed of each stream was delineated
- Land Cover data set was utilized to calculate the percentage of developed land in each watershed

Watersheds	Developed Land (Combined)
Watershed 1	76%
Watershed 2	39%
Watershed 3	11%
Watershed 4/All	35%



1 = watershed of stream 1
2 = watershed of stream 2
3 = watershed of stream 3
1, 2, 3, and 4 = watershed of stream 4

Analysis

- The relationships between % developed land and biodiversity indices scores were calculated on a graph using a trendline and the correlation was calculated using the coefficient of determination (R^2)
- Calculated for Percent Model Affinity and Major Group Biotic Index scores

RESULTS

Habitat Assessment

Question	Site 01	Site 02	Site 03	Site 04
Epifaunal Substrate/Available Cover	A	A	B	B
Embeddedness	B	A	A	A
Velocity/Depth Combinations	B	A	B	B
Sediment Deposition	B	B	A	B
Channel Flow Status	A	A	A	B
Channel Alteration	A	B	A	A
Frequency of Riffles	A	A	B	A
Bank Stability Left	A	B	A	A
Bank Stability Right	A	A	A	A
Bank Vegetative Protection Left	A	B	A	A
Bank Vegetative Protection Right	A	A	A	B
Riparian Vegetation Zone Left	B	A	A	A
Riparian Vegetation Zone Right	B	B	A	A

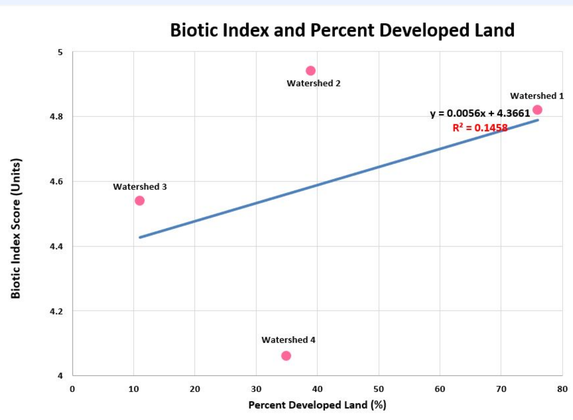
Optimal	A
Marginal	B
Poor	C

- Site 1, 2, and 4 had 8 optimal habitat qualities and 5 marginal habitat qualities
- Site 3 had 10 optimal habitat qualities and 3 marginal habitat qualities

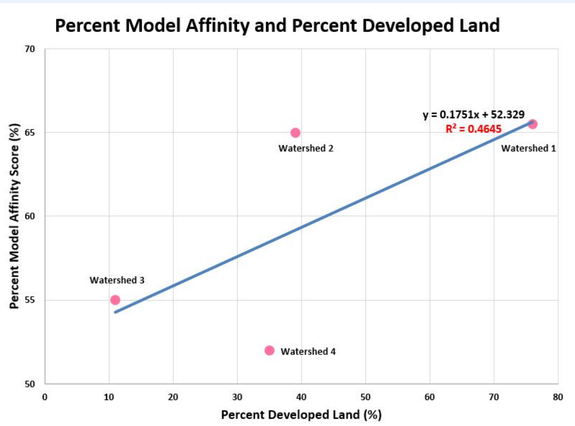
Test Scores

Tests	Stream 01	Stream 02	Stream 03	Stream 04
EPT Richness	3 - Slightly Impacted	3 - Slightly Impacted	7 - Non Impacted	3 - Slightly Impacted
Major Group Biotic Index Score	4.82 - Slightly Impacted	4.94 - Slightly Impacted	4.54 - Non Impacted	4.06 - Non Impacted
Percent Model Affinity	55.0% - Slightly Impacted	52.0% - Slightly Impacted	65% - Non Impacted	65.5% - Non Impacted

- Streams 1 and 2 had ratings of "slightly impacted" on all three tests.
- Stream 4 had a rating of "non-impacted" on the Biotic Index and Percent Model Affinity and a rating of "slightly impacted" on EPT Richness.
- Stream 3 had a rating of "non-impacted" for all three tests.



- The correlation between percent land development and Biotic Index (R^2) is **0.1458**.
- A higher Biotic Index score indicates a more impacted stream



- The correlation between percent land development and Percent Model Affinity (R^2) is. **0.4645** .
- A higher Percent Model Affinity score indicates a less impacted stream

DISCUSSION

Habitat Assessment

- Stream 3 - highest habitat quality
- Watershed of stream 3 - lowest percent of developed land (11%)

Indices

- 2 streams with lowest % of developed land are least impacted
- 2 streams with highest % of developed land are most impacted

Biotic Index and % Developed Land	% Model Affinity and % Developed Land
R^2 = 0.1458	R^2 = 0.4645
Weak relationship	Moderate relationship

Negative relationship between percent developed land and stream ecosystem health

Stream 4 is an anomaly

2 Biodiversity scores indicate
- -it is less impacted than stream 3
- -it has a higher percentage of developed land than stream 3

CONCLUSION

- Negative correlation between the percent of developed land of a watershed and the impact on the stream ecosystem health
- Findings support the hypothesis
- Future research could determine cause of the anomaly

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