Analysis of Water Quality and Land Use Dynamics within Connecticut’s Mystic River Watershed

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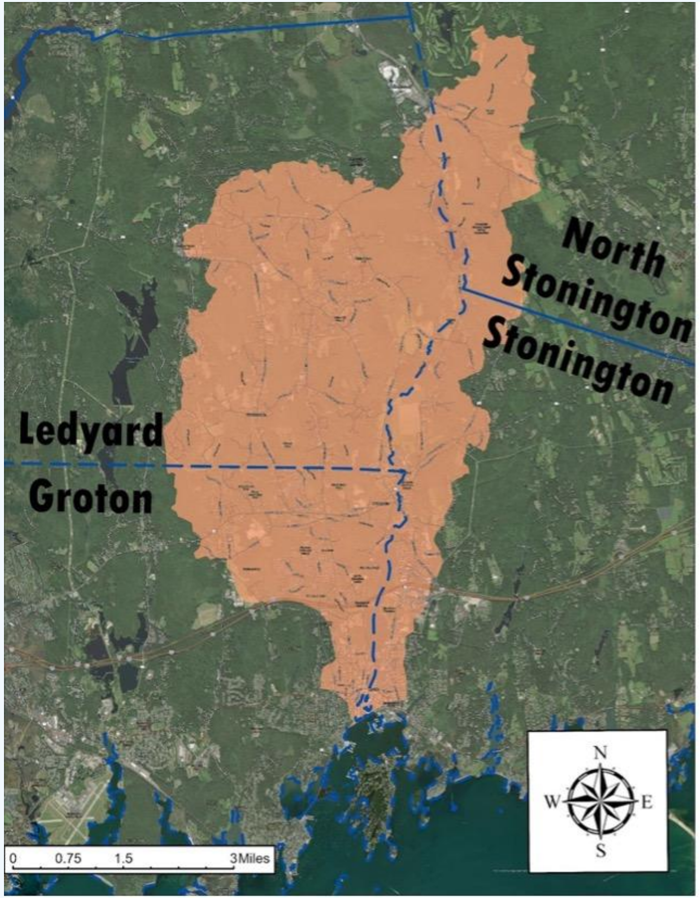
UConn Climate Corps - Spring 2024

Overview of Project

- Examine land use patterns and water quality dynamics in the Mystic River Watershed
- Utilize UConn CLEAR watershed assessment tool to observe spatial patterns of land use within the watershed
- Create actionable insights that will influence decision-making processes and assist the implementation of sustainable watershed management and conservation practices.

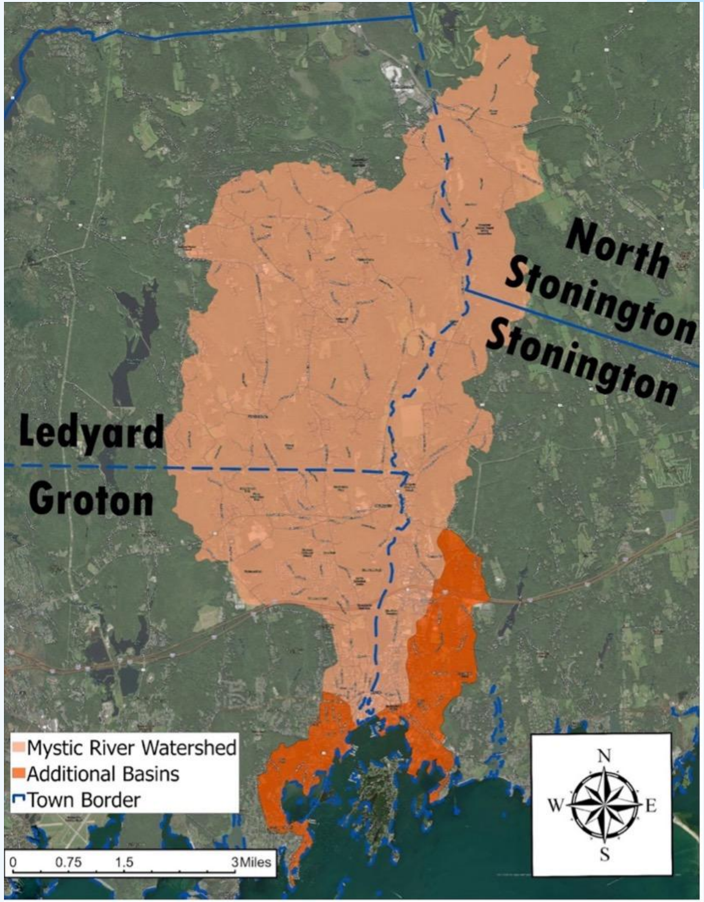
Mystic River Watershed

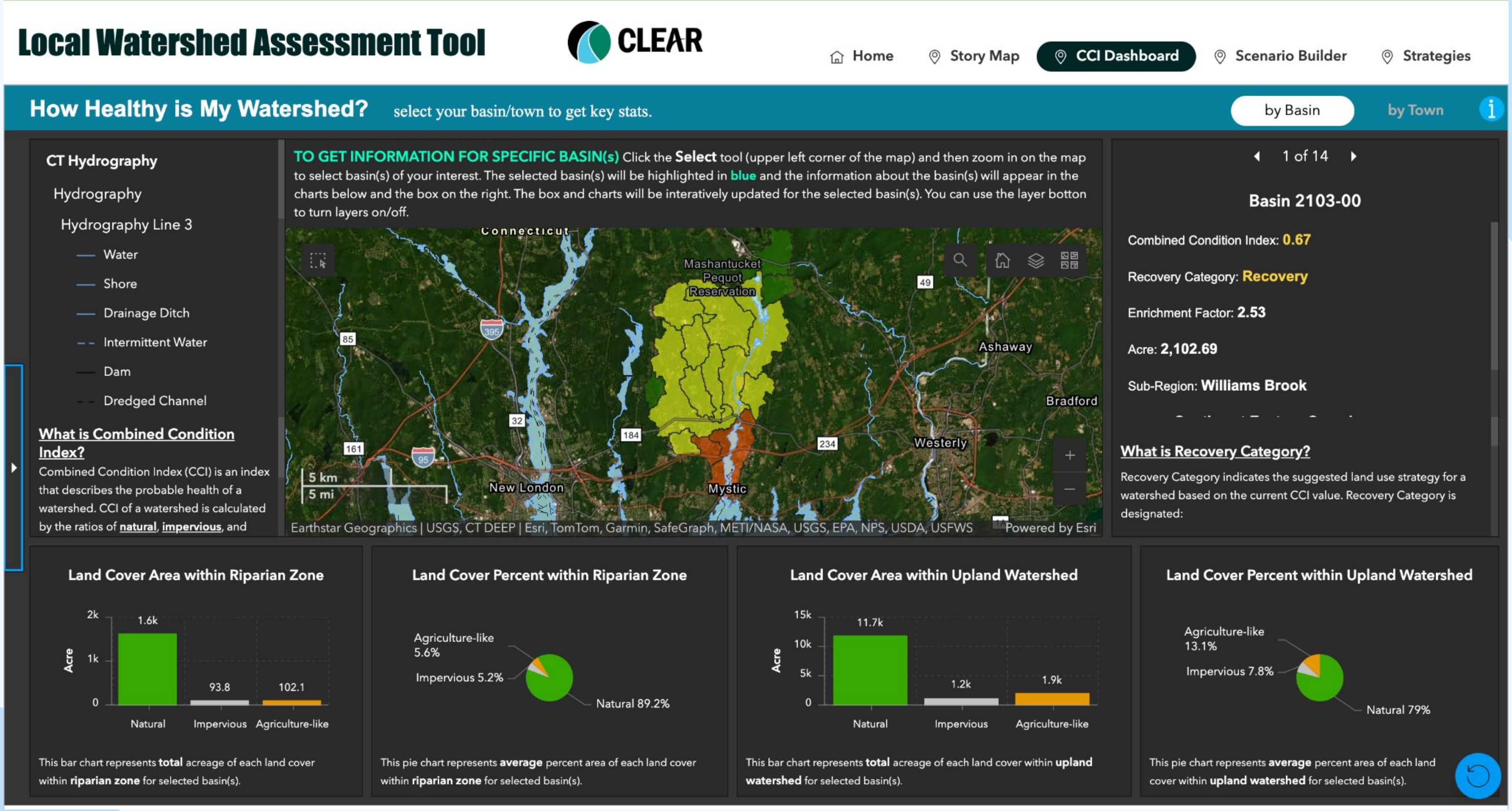


Methods

Watershed Research Area and Sub-regions:

- Utilized UConn CLEAR watershed assessment tool
- Defined Mystic River Watershed and its main sub-regions
  - Williams Brook, Haleys Brook, Mystic River, and Whitford Brook
- Included five additional basins to represent larger hydrological environment
  - Basins include areas in Pequotsepos Brook, Noank, and Mystic Harbor





Source: UConn CLEAR

Methods

Data Collection and Mapping:

- Downloaded NOAA's 2016 C-CAP Connecticut Land Use Cover dataset
- Mapped dataset on ArcGIS Pro for Mystic River Watershed
- Shapefiles and data related to watershed variables obtained from UConn CLEAR

Data Analysis:

- Combined and examined datasets using ArcGIS Pro
- Created spatial representations and maps of water quality dynamics, land use patterns, and other factors in watershed
- Utilized natural breaks (Jenks natural breaks classification) method for land use and enrichment maps

Variables

Combined Condition Index (CCI)

- Describes projected health of a basin within Mystic River Watershed
- Calculated using ratios of natural, impervious, and agriculture-like land cover
- Ranges from 0 to 1, with recovery categories based on CCI rating
  - Conservation ($CCI \geq 0.75$)
  - Recovery ($0.43 \leq CCI < 0.75$)
  - Mitigation ($CCI < 0.43$)

Enrichment Factor (EF)

- Measures nitrogen (N) anticipated in basin's waters relative to a theoretical baseline
- Indicates nitrogen pollution threat, especially for watersheds draining into large bodies of water like Long Island Sound
- EF is a ratio, with higher values indicating higher nitrogen load compared to a pristine watershed

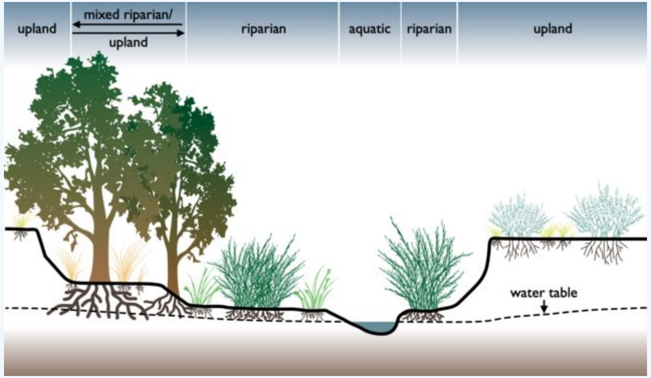
Variables

Riparian Zone

- Ecosystems at boundary of terrestrial and freshwater habitats along waterways
- Small area but provide significant biodiversity and ecological services
- Functions include habitat provision, water quality preservation, bank stabilization, floodwater velocity reduction
- Vulnerable to land use changes
- NOAA Land Cover dataset uses an 100-foot riparian zone

Upland Watershed

- Areas not regularly flooded from a stream



Limitations

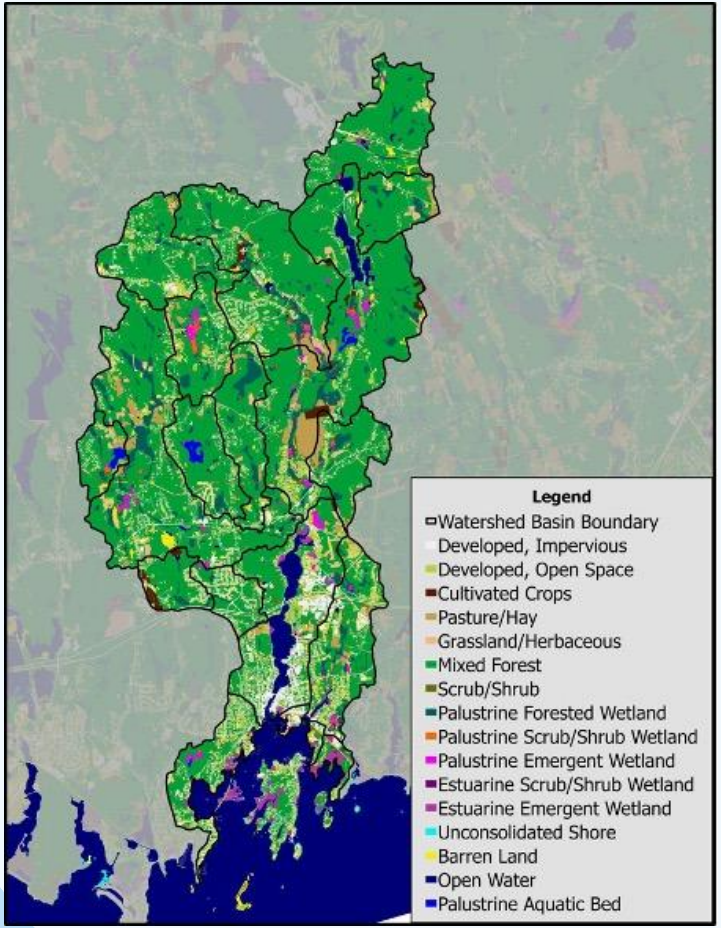
Exclusion of Mason's Island

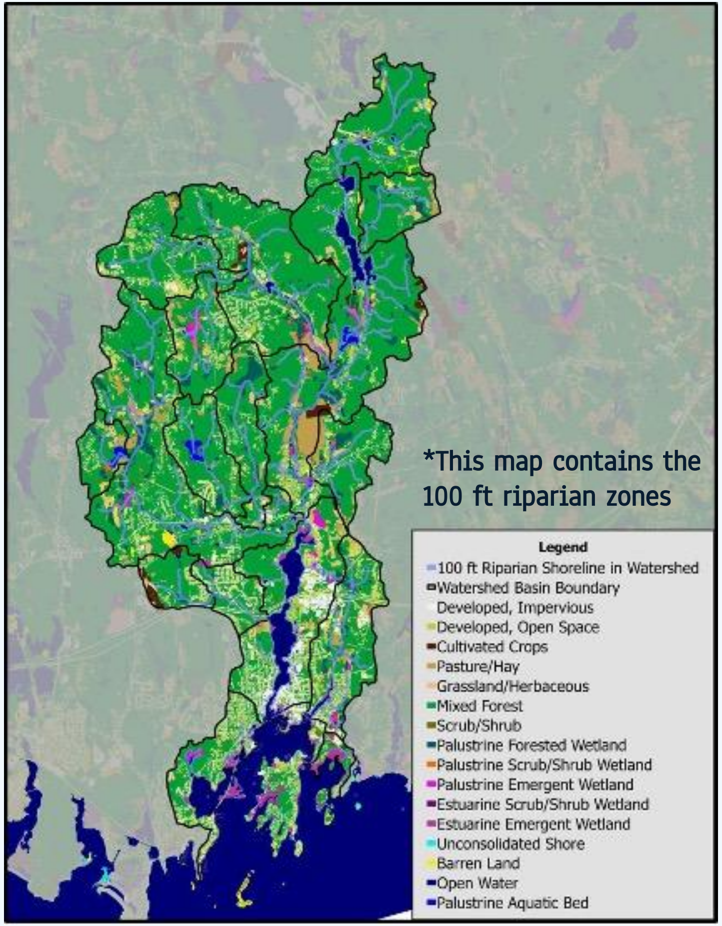
- Due to lack of CCI data

Data Set Limitation

- 2016 Land cover dataset was used despite efforts to use the most recent datasets

Results


Legend
Watershed Basin Boundary
Developed, Impervious
Developed, Open Space
Cultivated Crops
Pasture/Hay
Grassland/Herbaceous
Mixed Forest
Scrub/Shrub
Palustrine Forested Wetland
Palustrine Scrub/Shrub Wetland
Palustrine Emergent Wetland
Estuarine Scrub/Shrub Wetland
Estuarine Emergent Wetland
Unconsolidated Shore
Barren Land
Open Water
Palustrine Aquatic Bed


*This map contains the 100 ft riparian zones
Legend
100 ft Riparian Shoreline in Watershed
Watershed Basin Boundary
Developed, Impervious
Developed, Open Space
Cultivated Crops
Pasture/Hay
Grassland/Herbaceous
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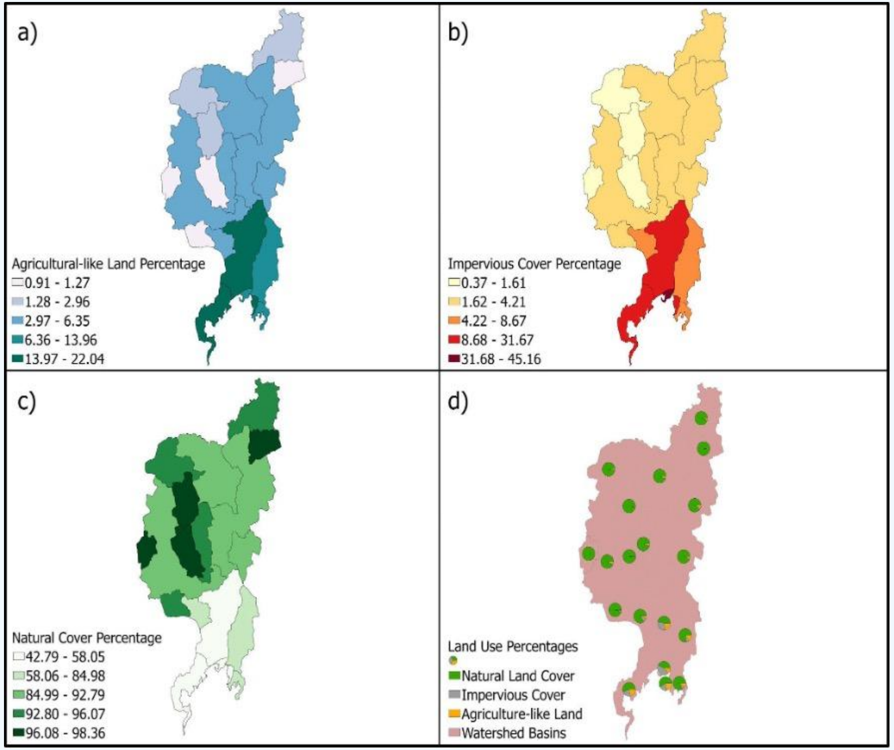
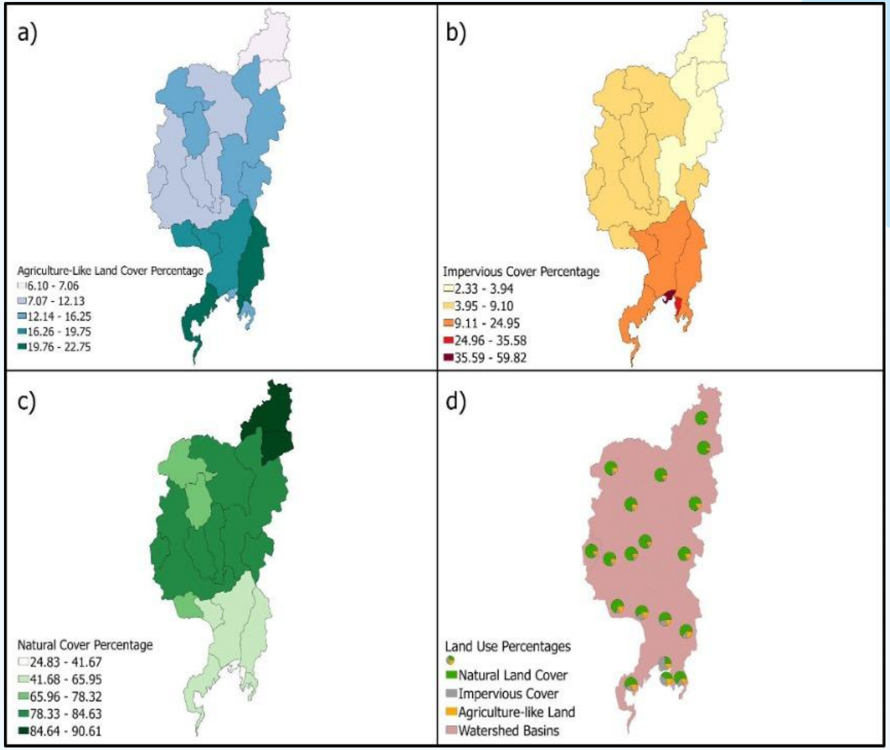
Riparian Zone

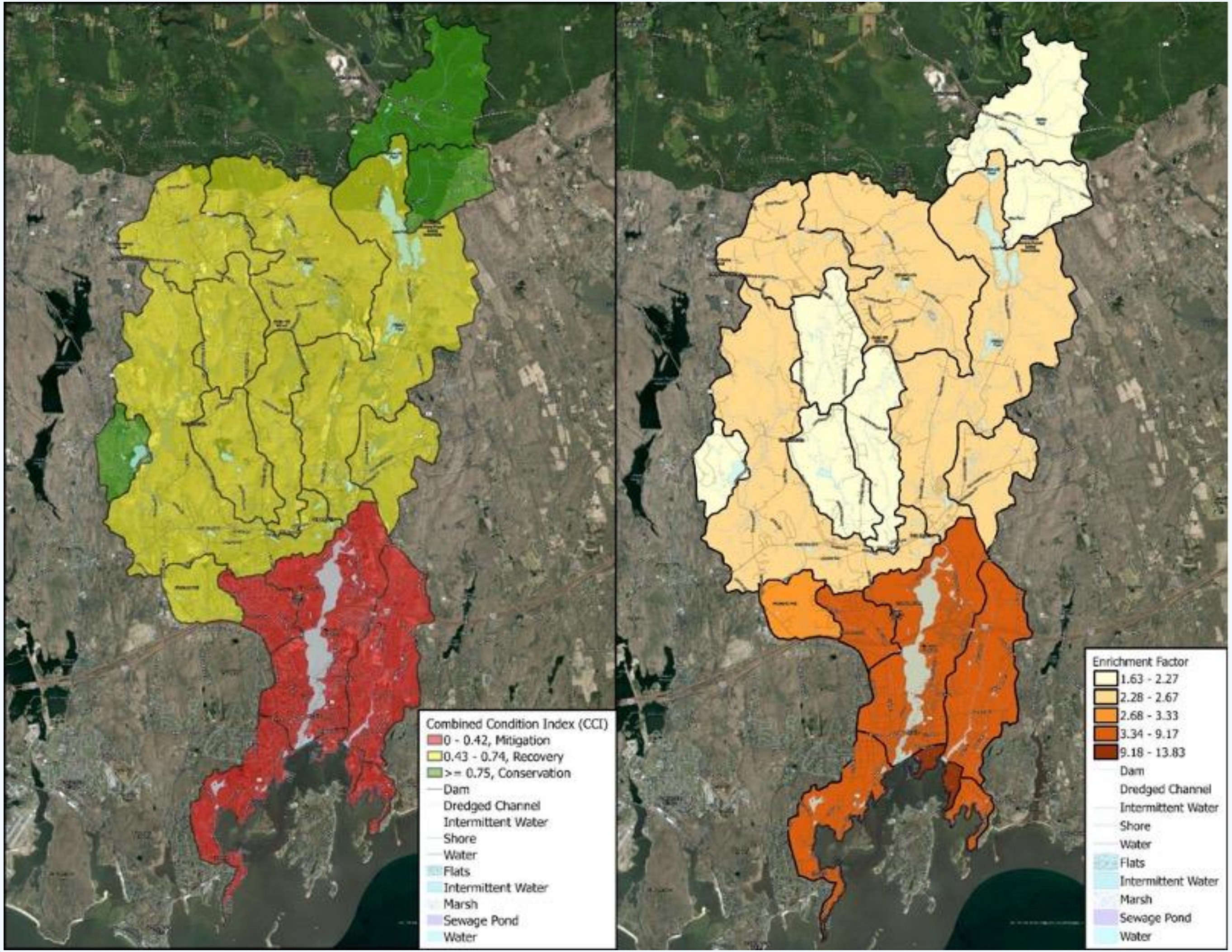


Land Use Distribution within <u>Riparian Zones</u> (a) Agriculture-like land. (b) Impervious Cover. (c) Natural Land. (d) Percentage of land use in each basin.

Upland Watershed



Land Use Distribution within <u>Upland Watershed</u> (a) Agriculture-like land. (b) Impervious Cover. (c) Natural Land. (d) Percentage of land use in each basin.

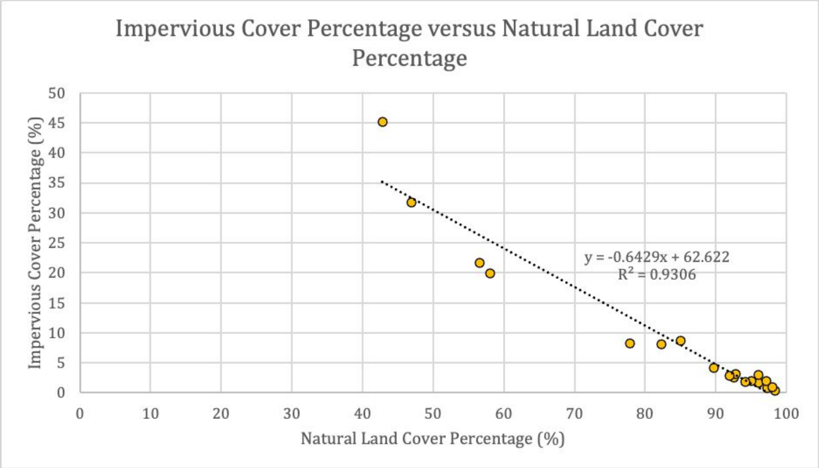

Combined Condition Index (CCI)
0 - 0.42, Mitigation
0.43 - 0.74, Recovery
>= 0.75, Conservation
Dam
Dredged Channel
Intermittent Water
Shore
Water
Flats
Intermittent Water
Marsh
Sewage Pond
Water
Enrichment Factor
1.63 - 2.27
2.28 - 2.67
2.68 - 3.33
3.34 - 9.17
9.18 - 13.83
Dam
Dredged Channel
Intermittent Water
Shore
Water
Flats
Intermittent Water
Marsh
Sewage Pond
Water

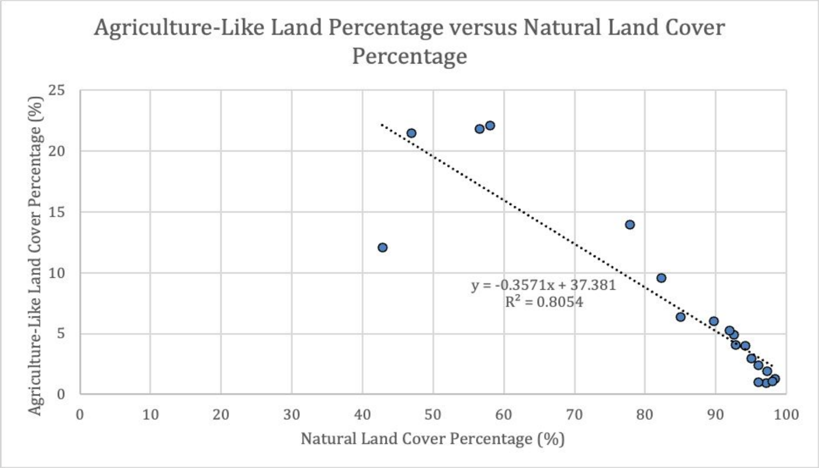
Results

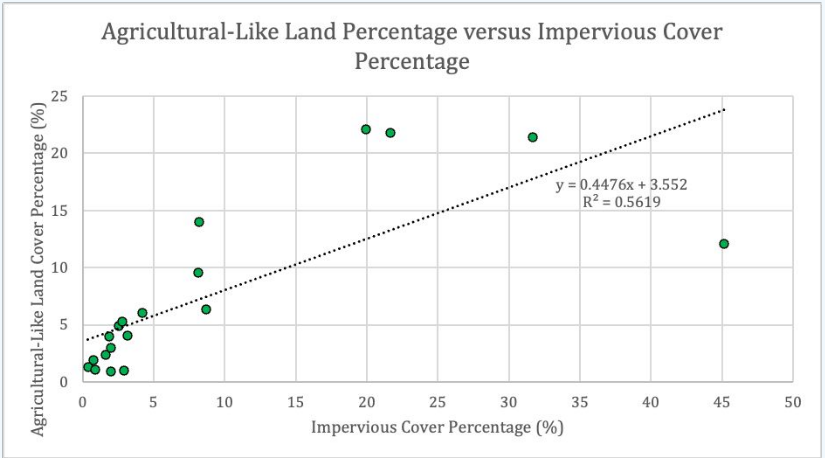
Table 1: Mystic River Watershed Health Categories

	Mitigation	Recovery	Conservation
Number of Basins	7	9	3
Average Impervious Cover Percent	20.49%	2.30%	1.45%
Average Agricultural-Land Like Cover Percent	15.31%	3.40%	1.71%
Average Natural Cover Percent	64.20%	94.3%	96.8%
Average CCI	0.24	0.67	0.80
Average EF	8.71	2.56	0.63

Results


Impervious Cover Percentage versus Natural Land Cover Percentage
y = -0.6429x + 62.622
R² = 0.9306
Impervious Cover Percentage (%)
Natural Land Cover Percentage (%)
0 10 20 30 40 50 60 70 80 90 100
0 5 10 15 20 25 30 35 40 45 50


Agriculture-Like Land Percentage versus Natural Land Cover Percentage
y = -0.3571x + 37.381
R² = 0.8054
Agriculture-Like Land Cover Percentage (%)
Natural Land Cover Percentage (%)
0 10 20 30 40 50 60 70 80 90 100
0 5 10 15 20 25


Agricultural-Like Land Percentage versus Impervious Cover Percentage
y = 0.4476x + 3.552
R² = 0.5619
Agricultural-Like Land Cover Percentage (%)
Impervious Cover Percentage (%)
0 5 10 15 20 25 30 35 40 45 50
0 5 10 15 20 25

Summary of Results

- Prominent pattern of higher concentrations of agricultural-like and impervious cover land uses south of CT-184 highway.
- Concerning environmental impact observed in yellow and red basins by human development, emphasizing need for restoration measures in riparian zone.
- Decrease in natural cover in southern basins, highlighting potential ecological implications of intensified human development.
- Urban development around Mystic Harbor leads to reduced rainwater infiltration, higher storm runoff volumes, and negative impact on water bodies.
- Urban impervious surfaces significantly impact watershed hydrology, limiting ecosystems' ability to remove excess nutrients.
- Rapid transport of pollutants, facilitated by impervious surfaces and agricultural land uses, poses significant risks to human health, aquatic ecosystems, and water quality.

Strategies to Improve Watershed Health

- Implement vegetative and forest buffer zones to reduce pollution.
- Incorporate low-impact building options like green roofs and pervious pavements
- Implement rain gardens in areas with impermeable surfaces to regulate runoff and treat contaminants, improving groundwater recharge and pollutant removal.
- Avoid actions impairing ecosystems and water quality, such as excessive lawn maintenance and clear-cutting vegetation.
- Create riparian buffers with native coastal plants and reduce grass size to improve habitat and water quality.

Next Steps

- Conduct additional geospatial assessments to pinpoint specific areas contributing most to pollution and impacted by runoff.
- Utilize watershed assessment tool's scenario builder feature to simulate land use scenarios and calculate required changes for shifting basin recovery categories.
- Once high-impact zones are identified, implement measures such as riparian buffer zones, low-impact development approaches, and improved stormwater management practices.
- Foster collaboration among stakeholders, including local communities, government agencies, and environmental organizations.

Conclusion

- Human activities deeply influence Mystic River Watershed health.
- Land uses like agriculture and urbanization significantly affect the watershed.
- Conservation efforts and sustainable land management strategies are vital.
- Need for collaboration and evidence-based decisions.

Acknowledgements

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