Establishing Biological Potential to Support Restoration Goals and Connecticut's Anti-degradation Policy

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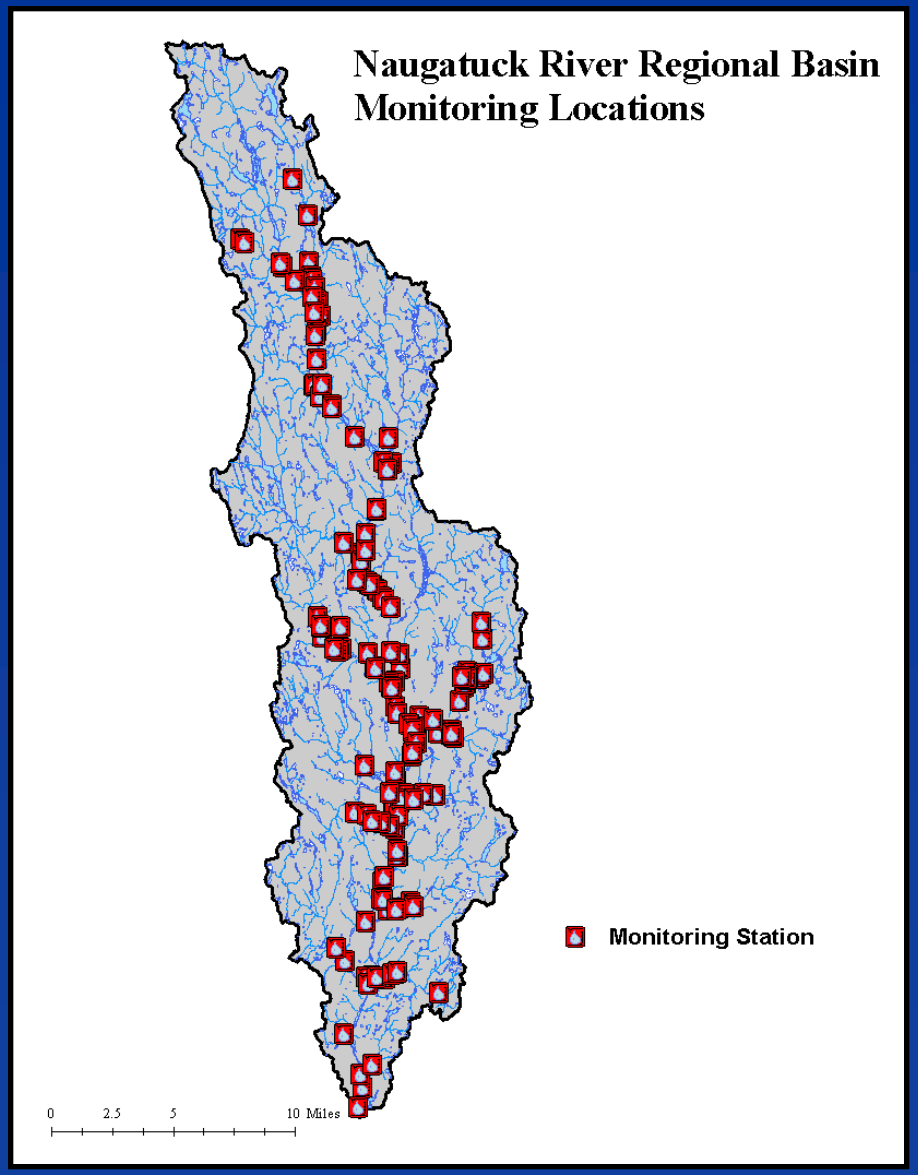
Tools to Support Water Quality Management

Targeted Monitoring

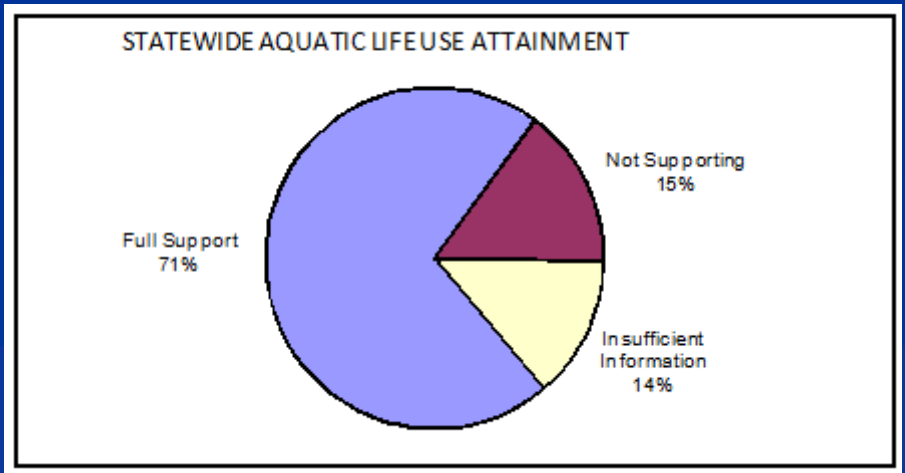
- Assess WQS Attainment
- Measure localized trends
- Identify sources of pollutants specific to waters
- Support development of local management measures (TMDLs, NPDES permits, NPS BMPs)

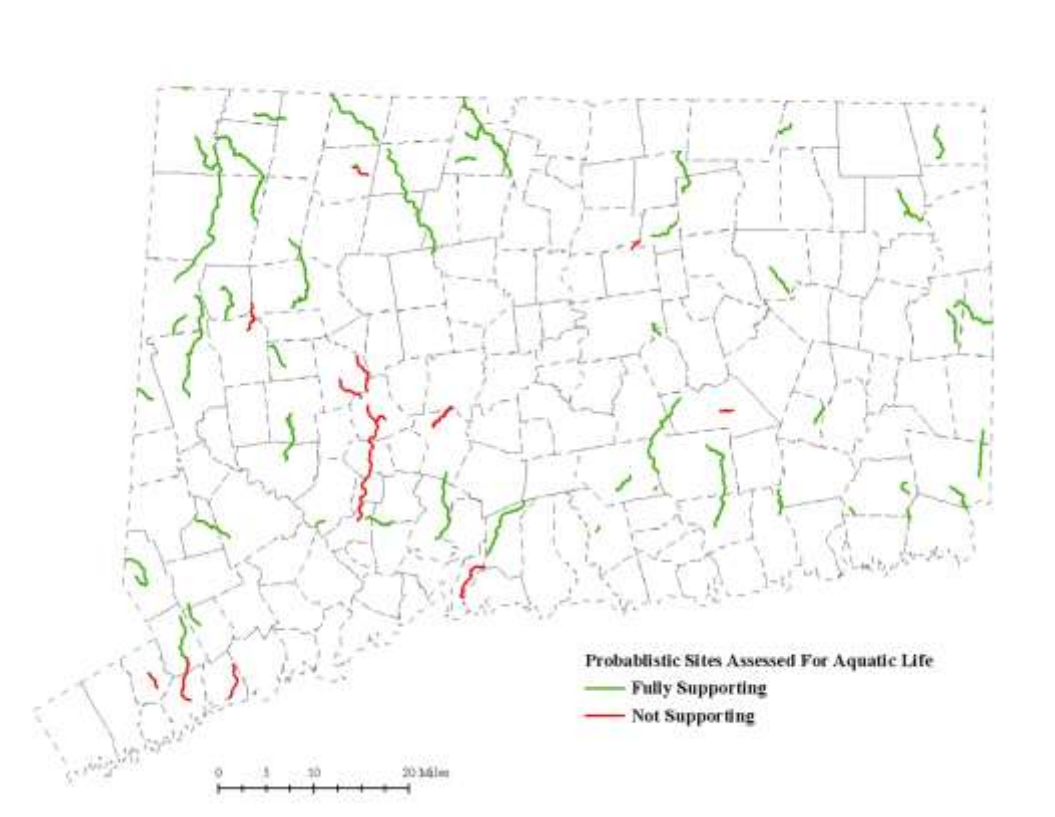


Tools to Support Water Quality Management

Statistical Monitoring

- Estimate proportion of all waters supporting water quality goals
- Measure overall State-wide water quality trends
- Support development of new water quality standards
- Prioritize targeted monitoring

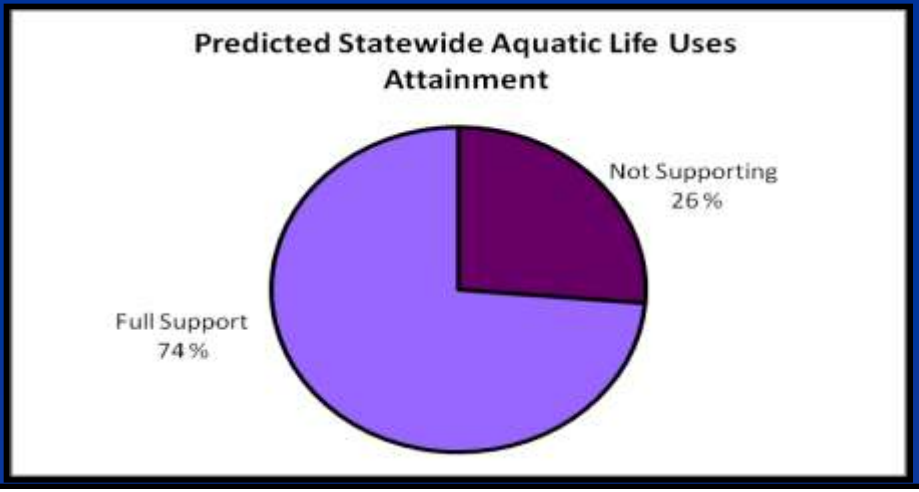


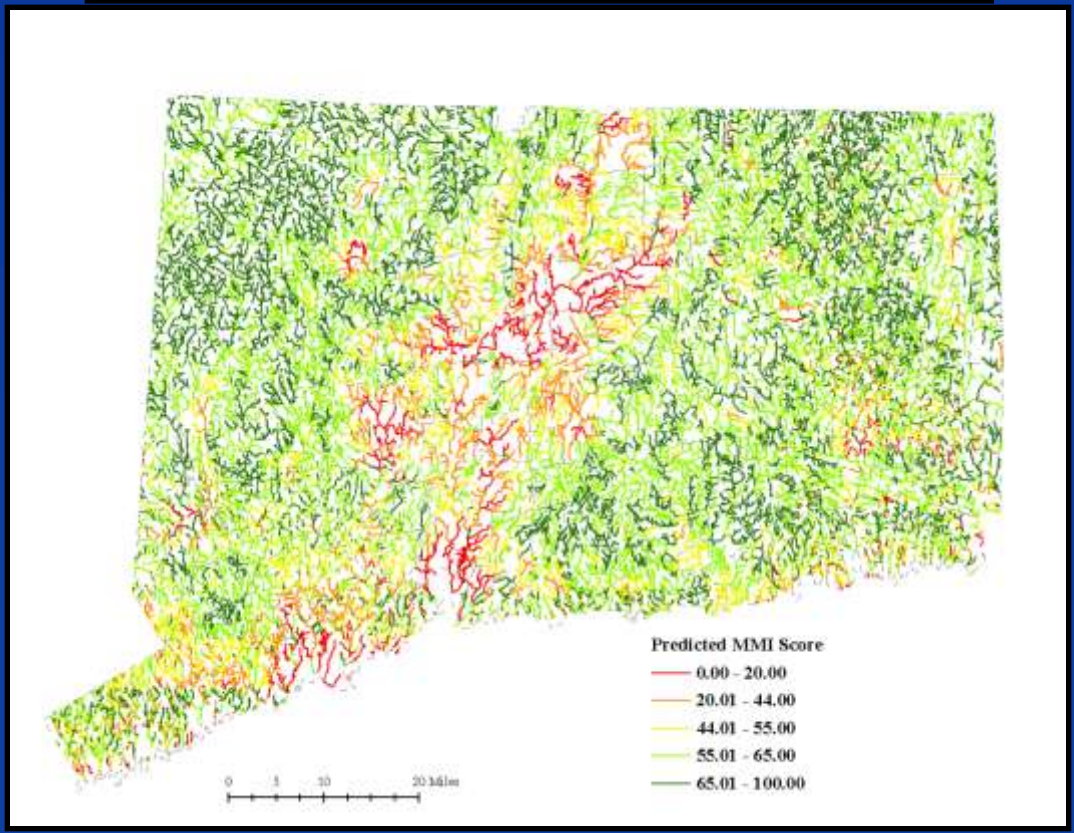


Tools to Support Water Quality Management

Modeling and landscape analysis

- Predict localized expected water quality condition
- Predict localized water quality trends
- Support development of local management measures (TMDLs, NPDES permits, NPS BMPs)
- Prioritize targeted monitoring

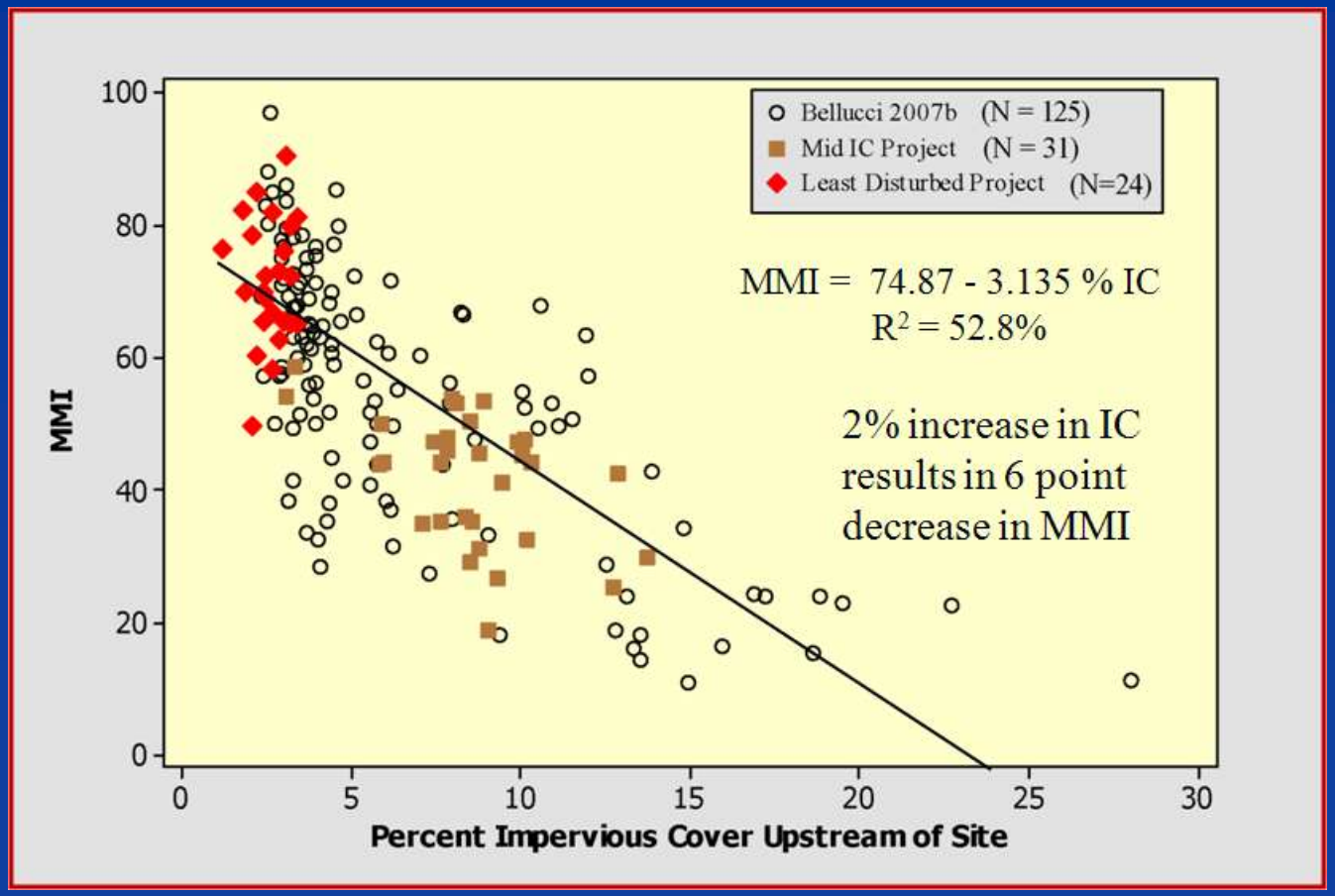




Prior Research

Modeling and landscape analysis: Impervious Cover

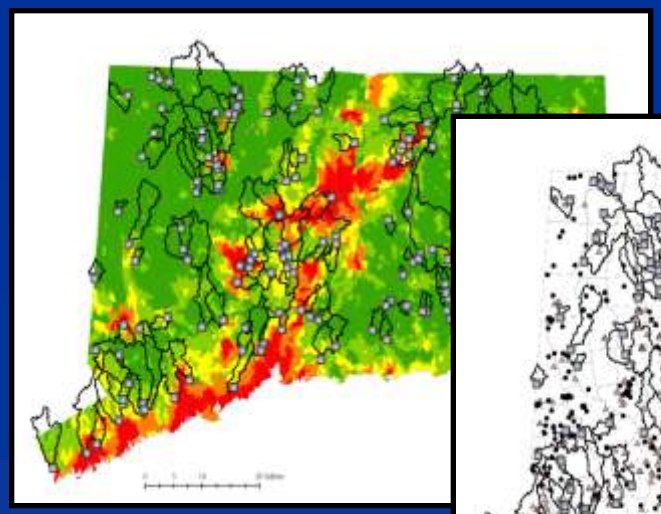
- Negative relationship between MMI and increasing total percent impervious cover
- Support development of local management measures (TMDLs, NPS BMPs)
- Prioritize targeted monitoring for TMDLs

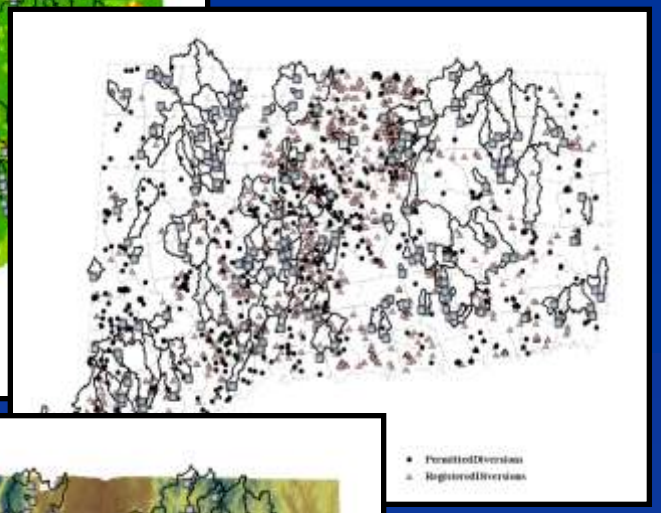


Project Plan

Modeling and landscape analysis: Expected Biological Condition

- Expand impervious cover work by including other factors that potentially effect the biological condition
- Establish a methodology to predict the expected biological condition at an unmonitored site utilizing geospatial analysis of readily available drainage basin data

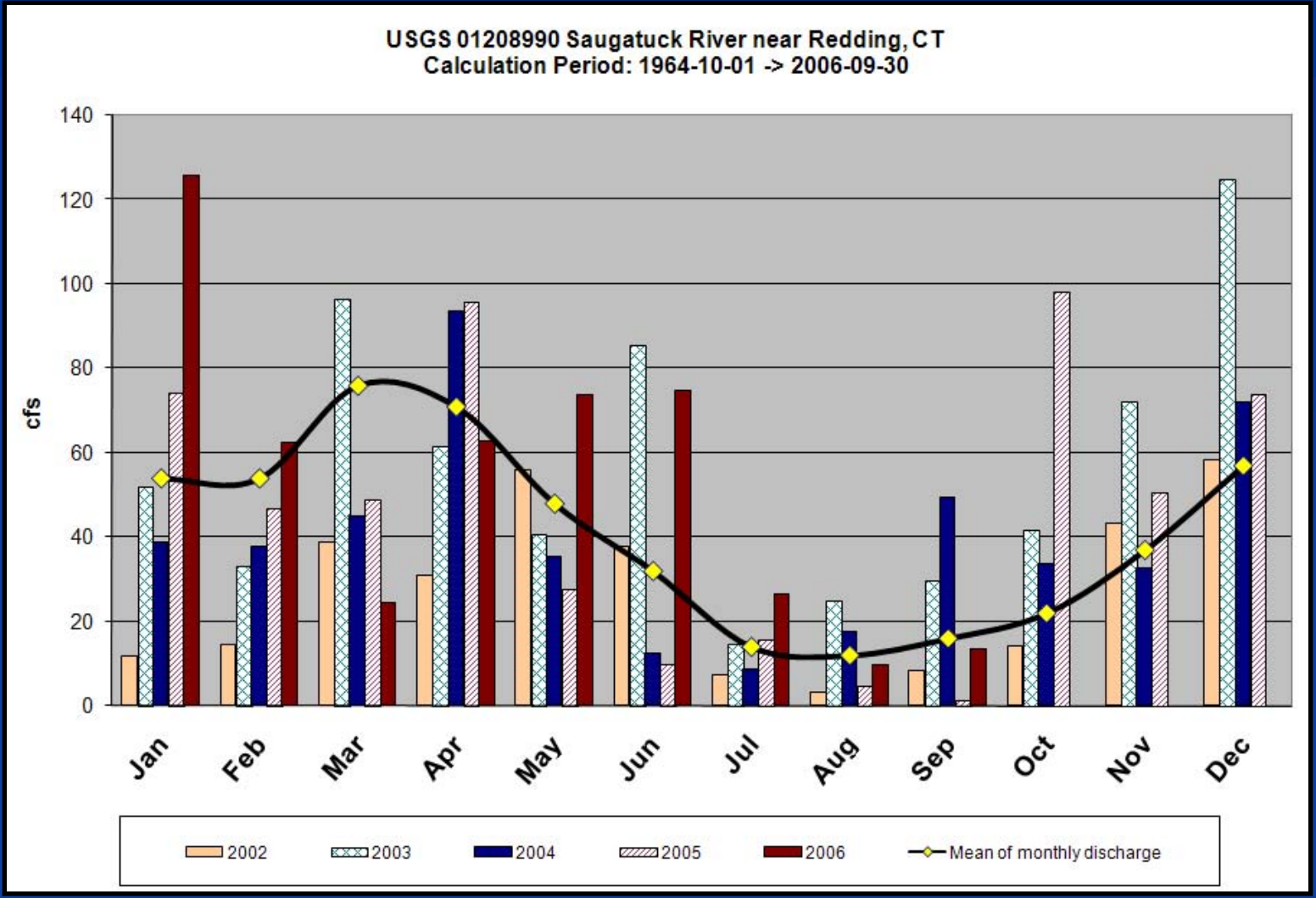




Methodology

Site Selection

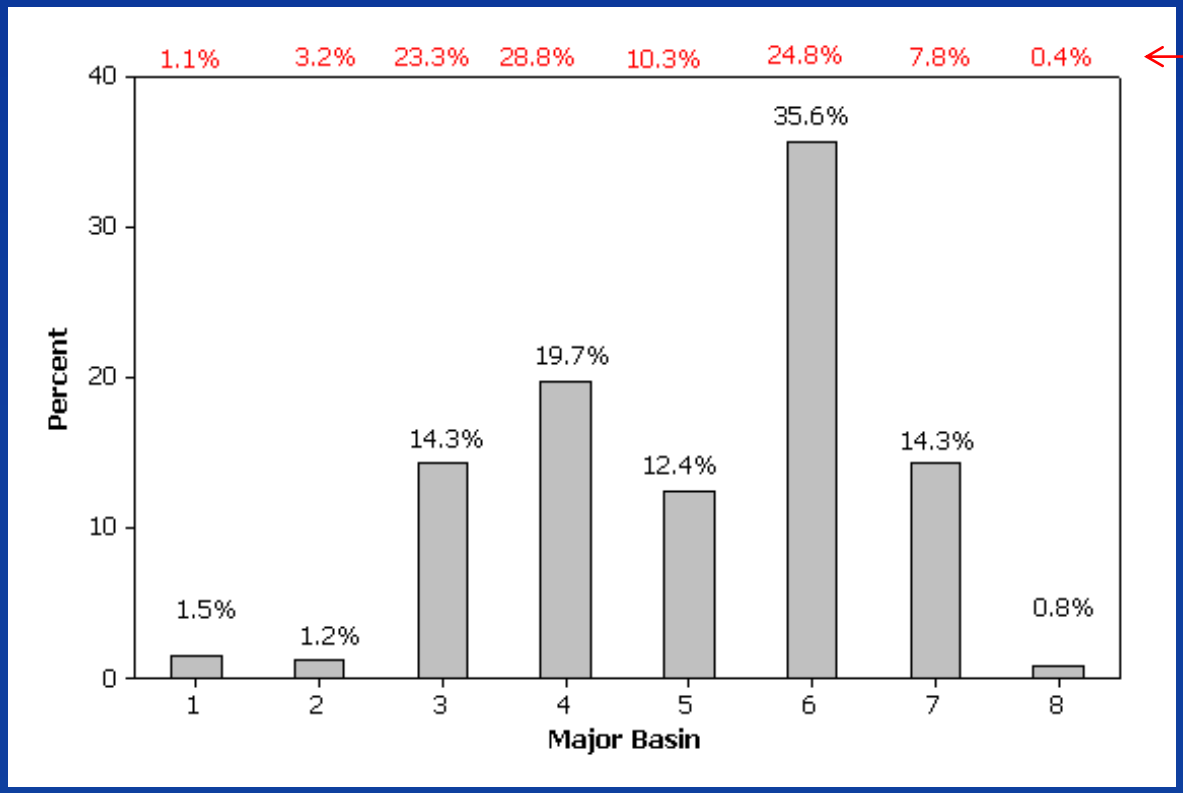
- Initial list of 266 sites from 2002 – 2007 (excluding 2005)
- 2002 – 2007 captured the range of flow conditions



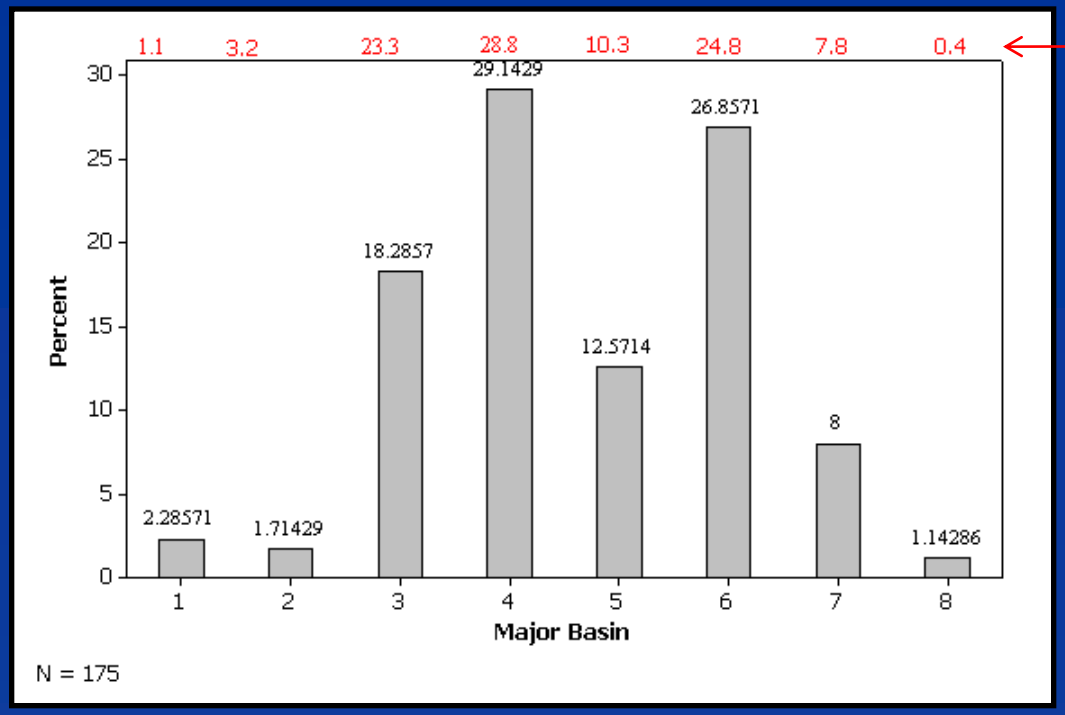
Methodology

Site Selection

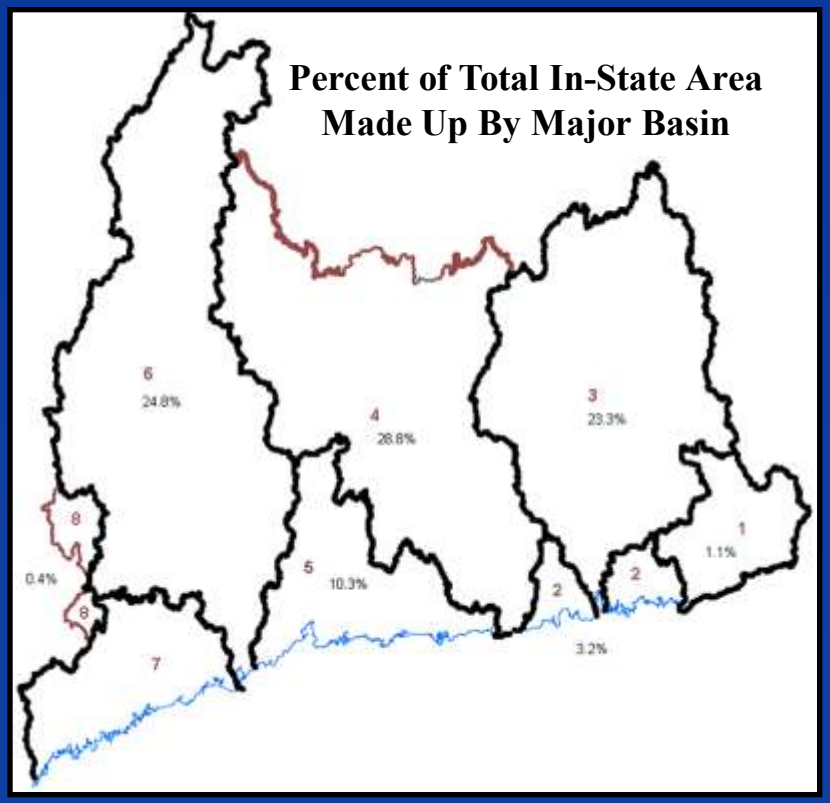
- Included probabilistic, rotating basin and targeted monitoring sites
- Noted skew of sites by major basin



Methodology



Site Selection



- Matched the sample size of each 8 major basins by the proportion of surface area each basin makes up in the State
- Randomly selected sites in each major basin based on targeted percentages so that selection of sites were weigh by In-State basin area.

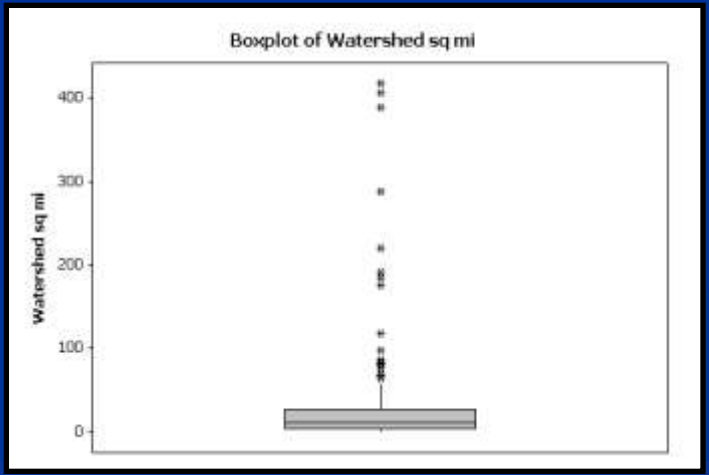
Methodology

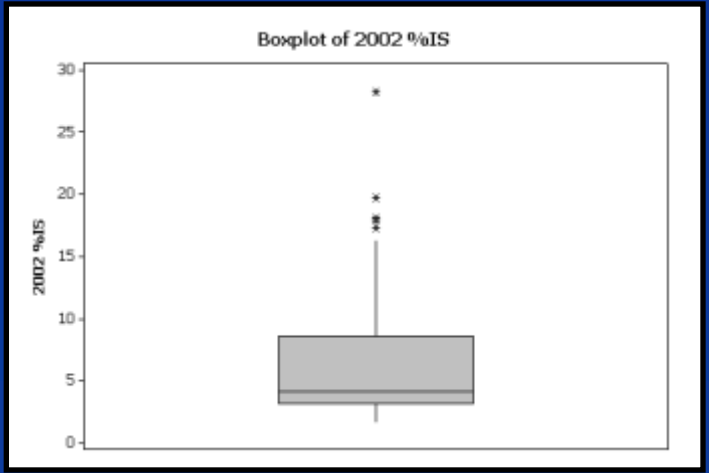
Site Selection

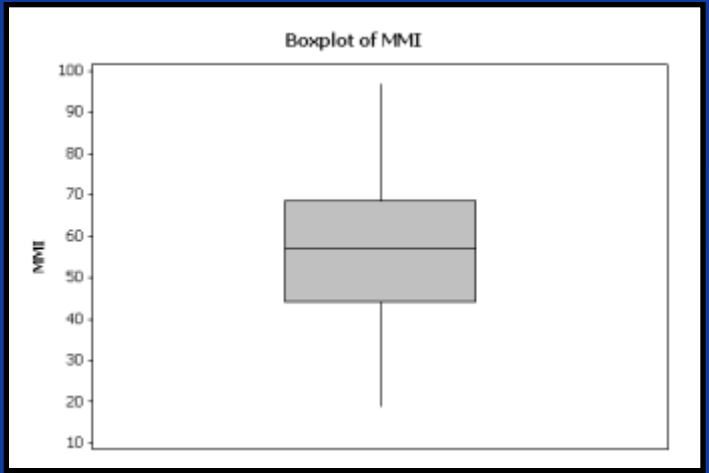
- Refined selection to exclude some outliers
- Removed 'outlier' large streams from dataset
- Removed streams with large majority of drainage basin outside State borders from dataset

Descriptive Statistics: MMI, 2002 %IS, Watershed sq mi

Variable	Total Count	Mean	StDev	Minimum	Median	Maximum
MMI	175	56.05	17.65	18.71	57.13	97.09
2002 %IS	175	6.018	4.195	1.616	4.099	28.248
Watershed sq mi	175	30.55	63.14	0.47	11.74	416.93



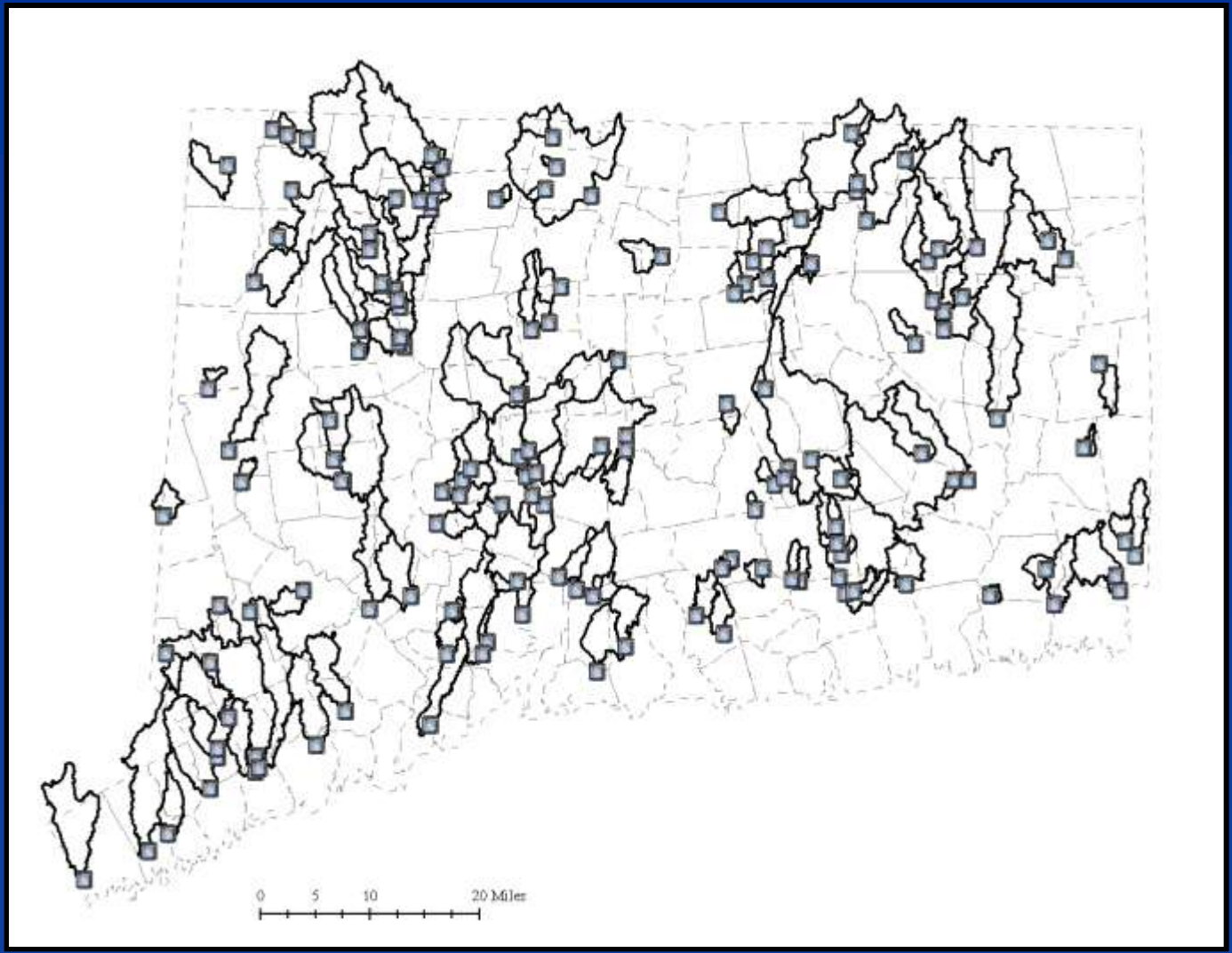




Methodology

Landscape Variable Selection

- Delineated drainage basin from stream site using **ArcHydro Batch Global Watershed Delineation***
- Assembled best available and geospatial datasets relevant to the biological condition of water resources

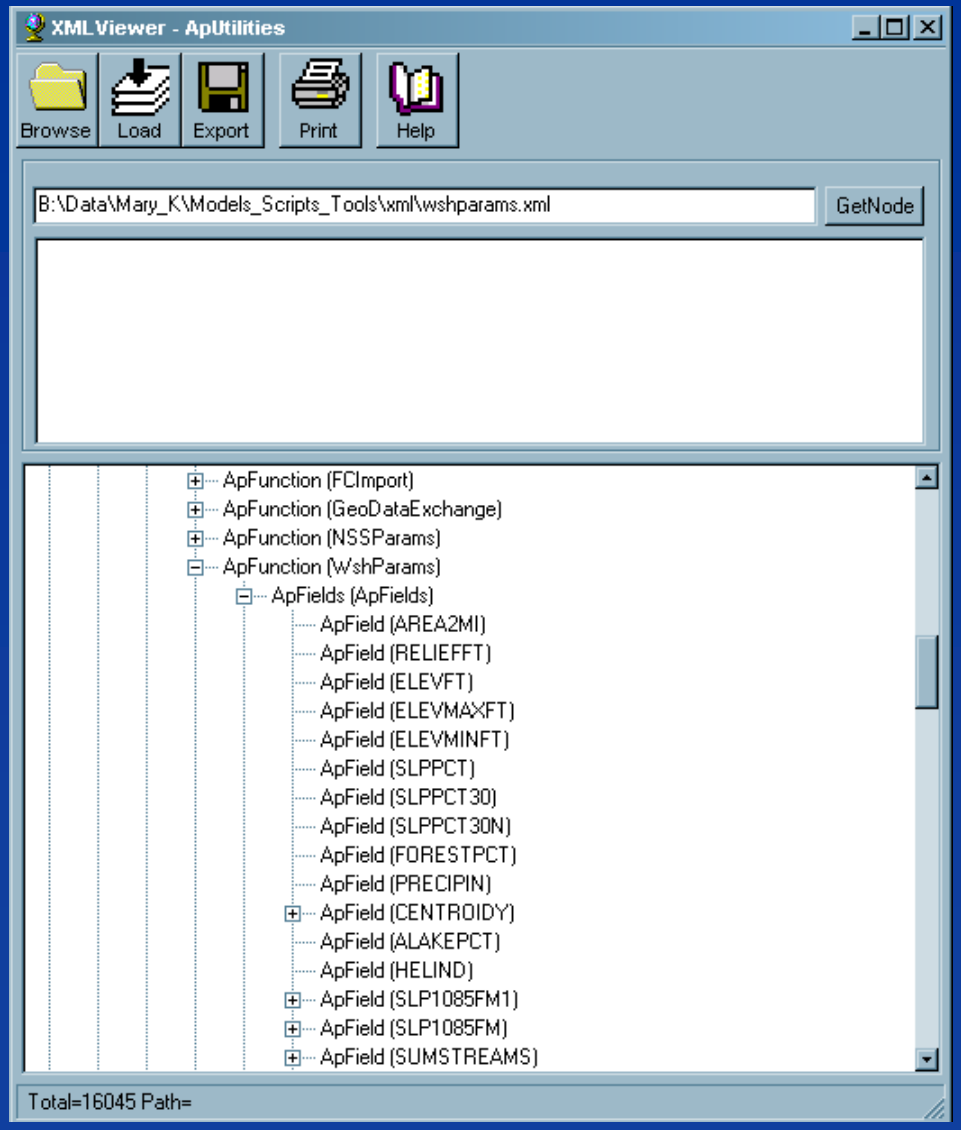


*Underlying layers needed for basin delineation and Stream Stats created by Pete Steeves (MA USGS)

Methodology

Landscape Variable Selection

- Calculated landscape variables for each site drainage basin using the **Compute Local Parameters** function
- Reads List of Available Parameters from the XML
- Added parameters using the **XML Viewer** to calculate relevant landscape variables.
- Calculated some additional variables based on combinations of 'local parameters' using **Model Builder**

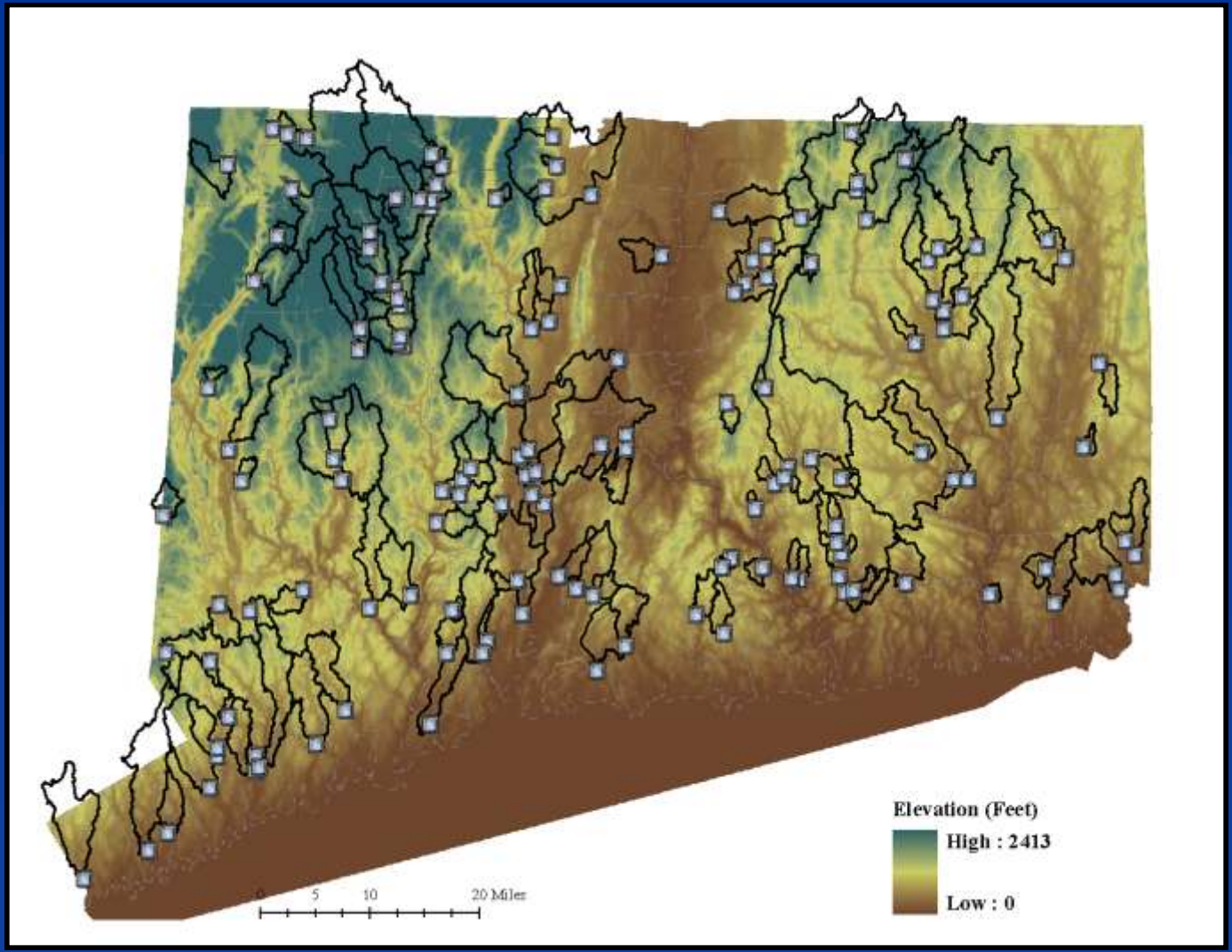


Methodology

Landscape Variable Selection

Physical Variables

- Drainage Area
- Stream Density
- Stream Order
- Elevation (Used Lidar Dataset At Site, Max, Min)

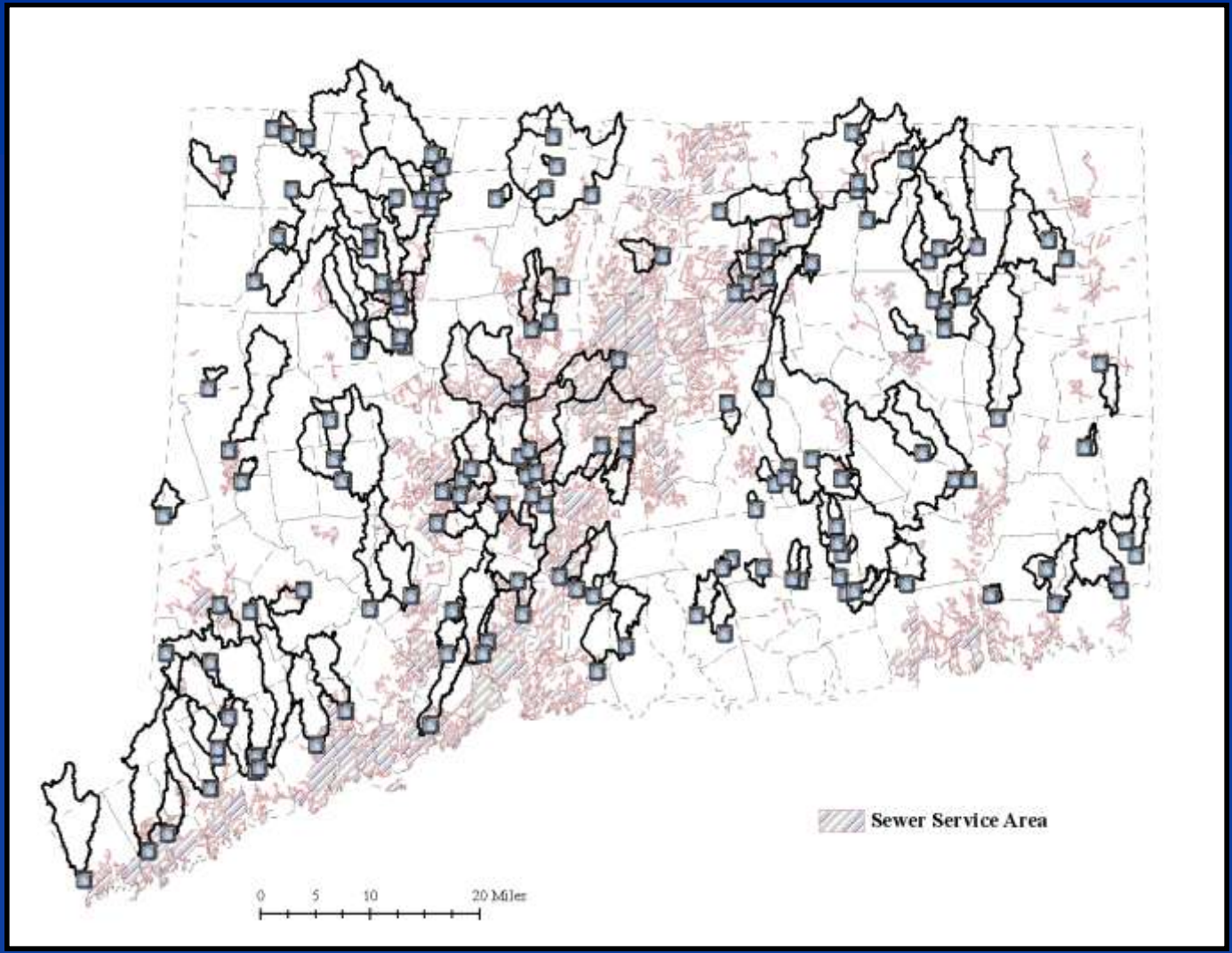


Methodology

Landscape Variable Selection

Land Cover / Land Use Variables

- Percent Land Cover
- Percent Forest Fragmentation
- Percent Impervious Cover
- Percent Sewer Service Area
- Human Population Density
- Percent Lake Area

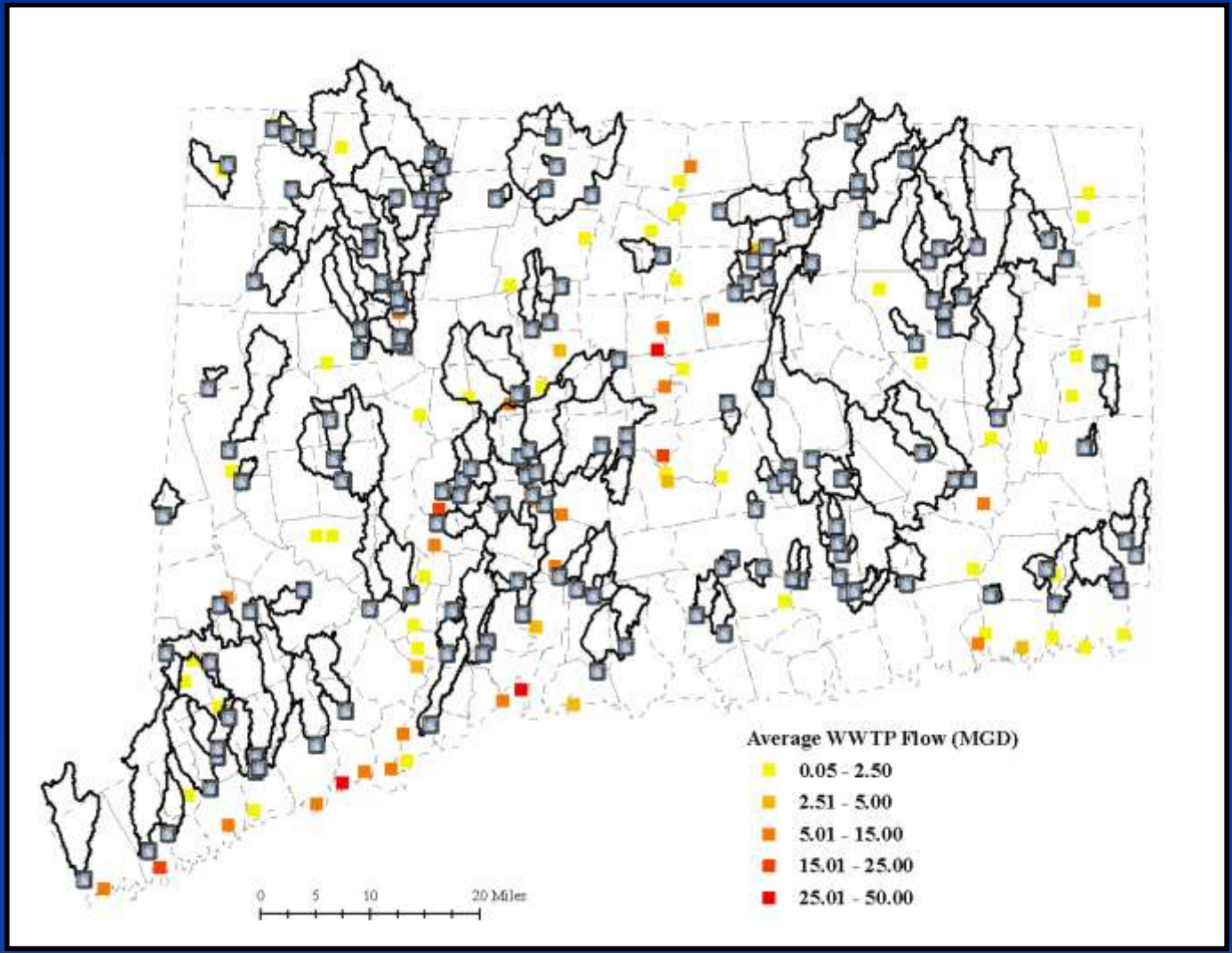


Methodology

Landscape Variable Selection

Flow Regime Variables

- Water Withdrawal Diversions
- WWTP Flow
- Estimated 7Q10

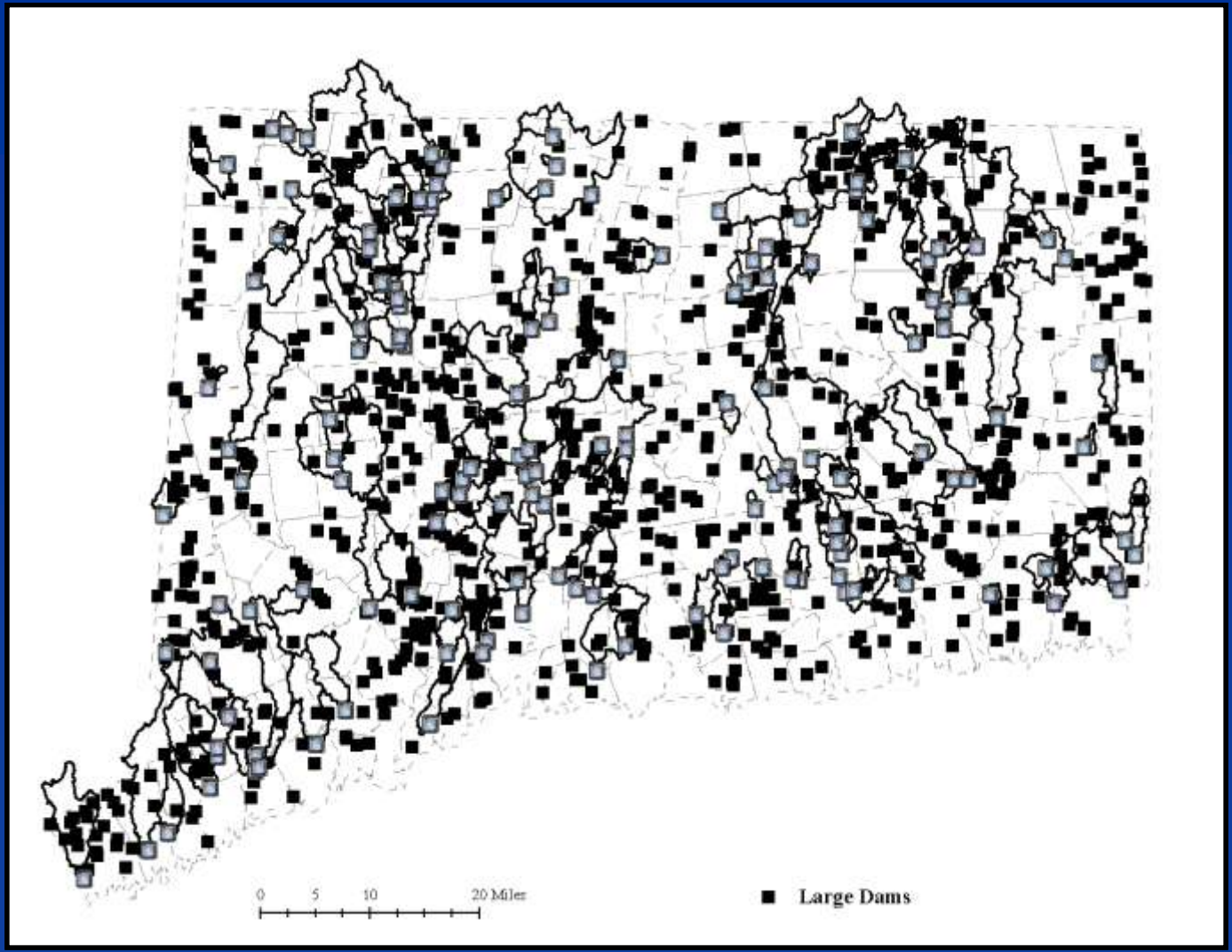


Methodology

Landscape Variable Selection

Habitat Fragmentation Variables

- Road Crossings / Density
- Large Dams
- Number of Farms



Methodology

Reduce Landscape Variables By Eliminating Redundant Variables

- Calculated 44 Landscape Variables
- Reduced Dataset By Identifing Highly Correlated Variables
- Transformed Variables and Checked Statistical Assumptions
- Identified Redundant Variables Using Principle Components Analysis
- Best Professional Judgment

PCA Analysis

Reduced Set of Variables (Transformation)
Percent Impervious Cover (Log 10)
Drainage Basin Area (Log 10)
Max Elevation (Log 10)
Summer Regulated Diversion Withdrawals / Drainage Area (Log 10)
Stream Density (Log 10)
Percent Agriculture (SQRT)
Dam Density
Percent Edge Forest
Percent Forested Wetland (SQRT)

Methodology

Multiple Regression Analysis to Predict MMI

Model	Variables
1	Percent IC
2	Percent IC; Basin Area
3	Percent IC; Basin Area; Summer Regulated Diversion Withdrawals / Drainage Area

Predict Biological Indicator Scores Based on Reduced Set of Landscape Variables

- Develop a predictive equation using multiple regression analysis
- Predict macroinvertebrate community indicators, such as MMI Score and BCG Tier
- Predict fish community indicators, such as IBI score

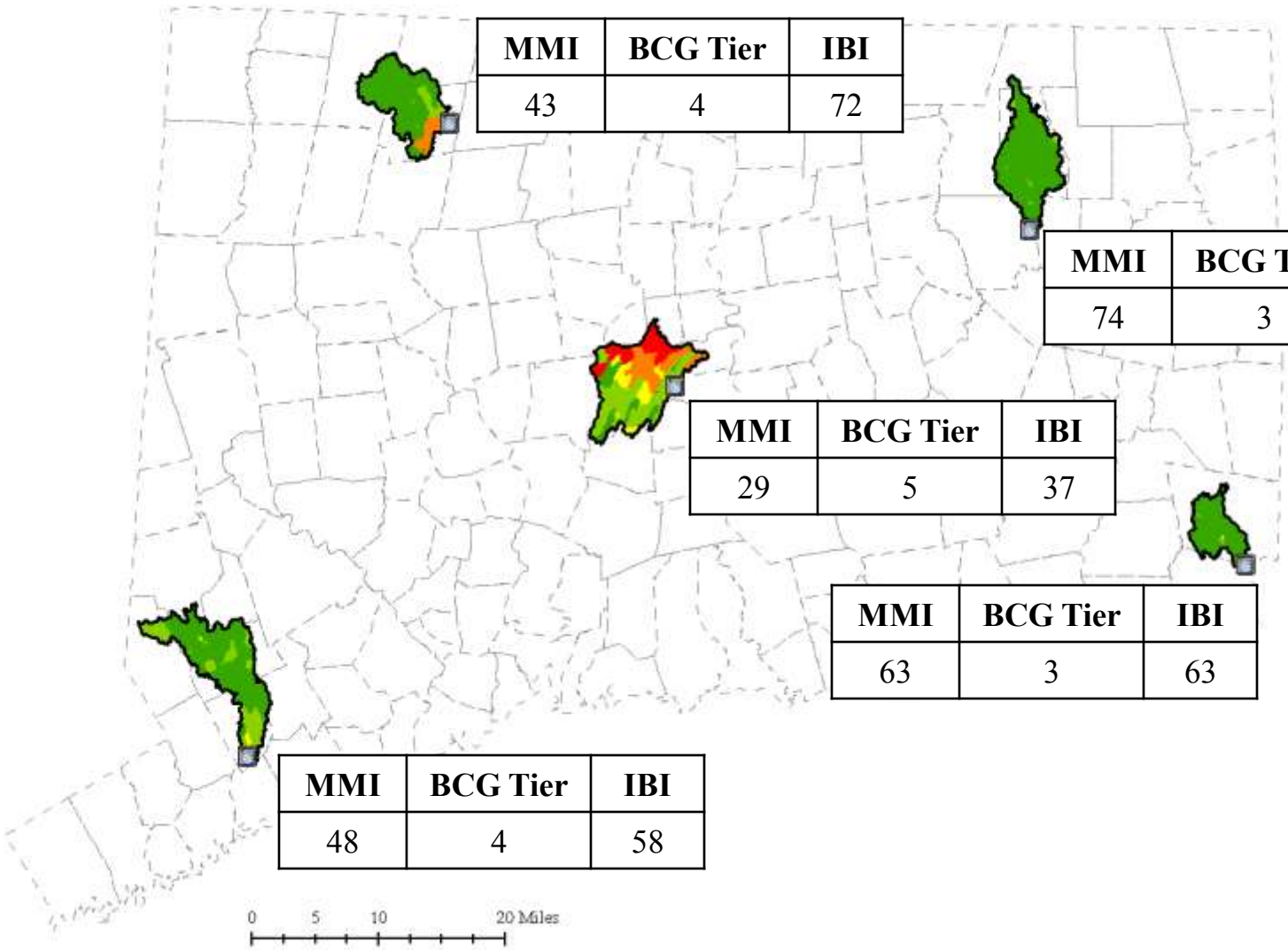
Model Summary(d)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.701	0.491	0.488	12.72	0.491	145.782	1	151	0.000	
2	0.768	0.590	0.585	11.46	0.099	36.137	1	150	0.000	
3	0.778	0.606	0.598	11.28	0.016	5.935	1	149	0.016	2.188

a. Predictors: (Constant), LogIC
b. Predictors: (Constant), LogIC, LogArea2MI
c. Predictors: (Constant), LogIC, LogArea2MI, Loglowflowreg2mi
d. Dependent Variable: AvgOfMMI

Methodology

Predict Biological Indicator Scores Based on Landscape Variables



MMI	BCG Tier	IBI
43	4	72

MMI	BCG Tier	IBI
74	3	61

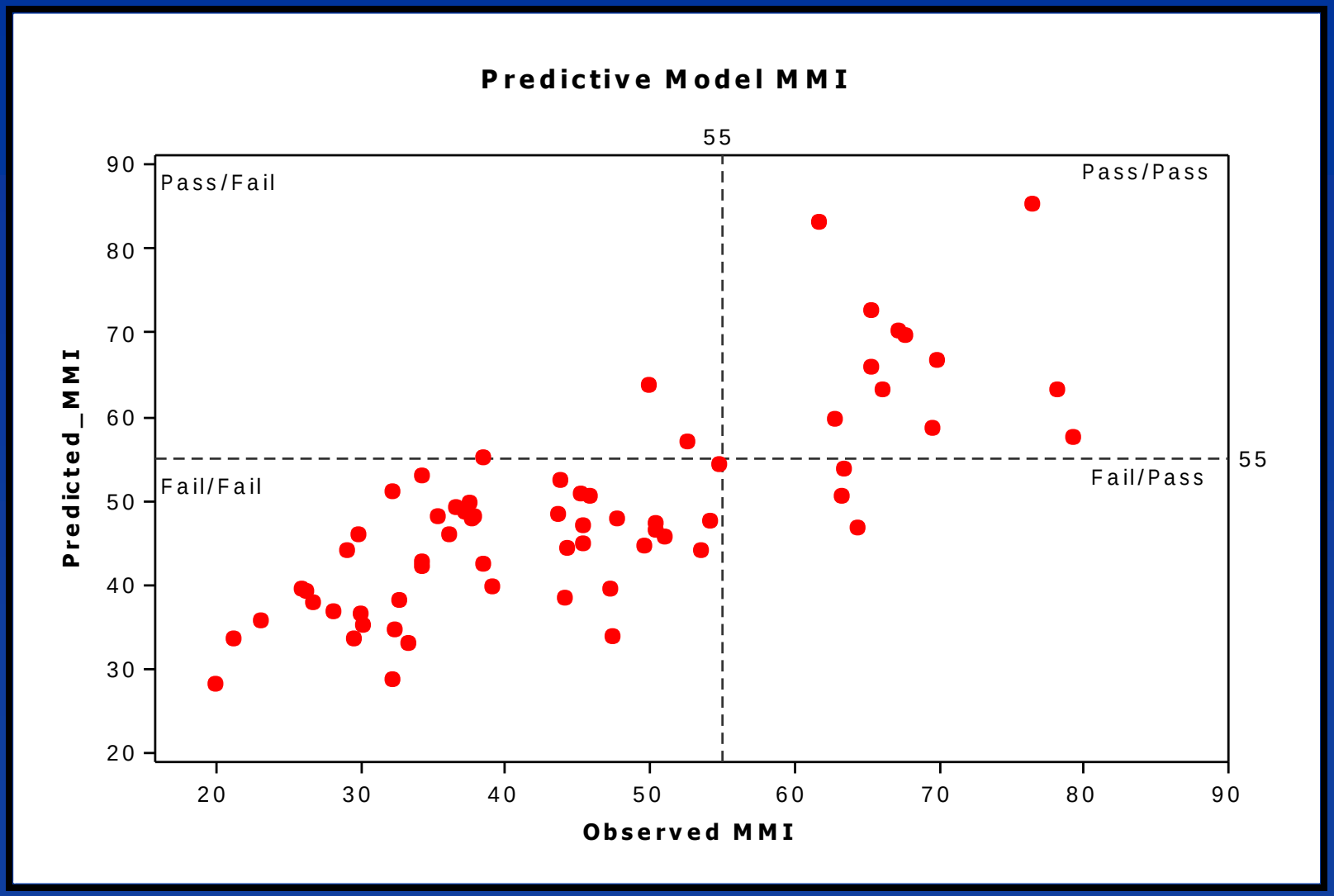
MMI	BCG Tier	IBI
29	5	37

MMI	BCG Tier	IBI
63	3	63

MMI	BCG Tier	IBI
48	4	58

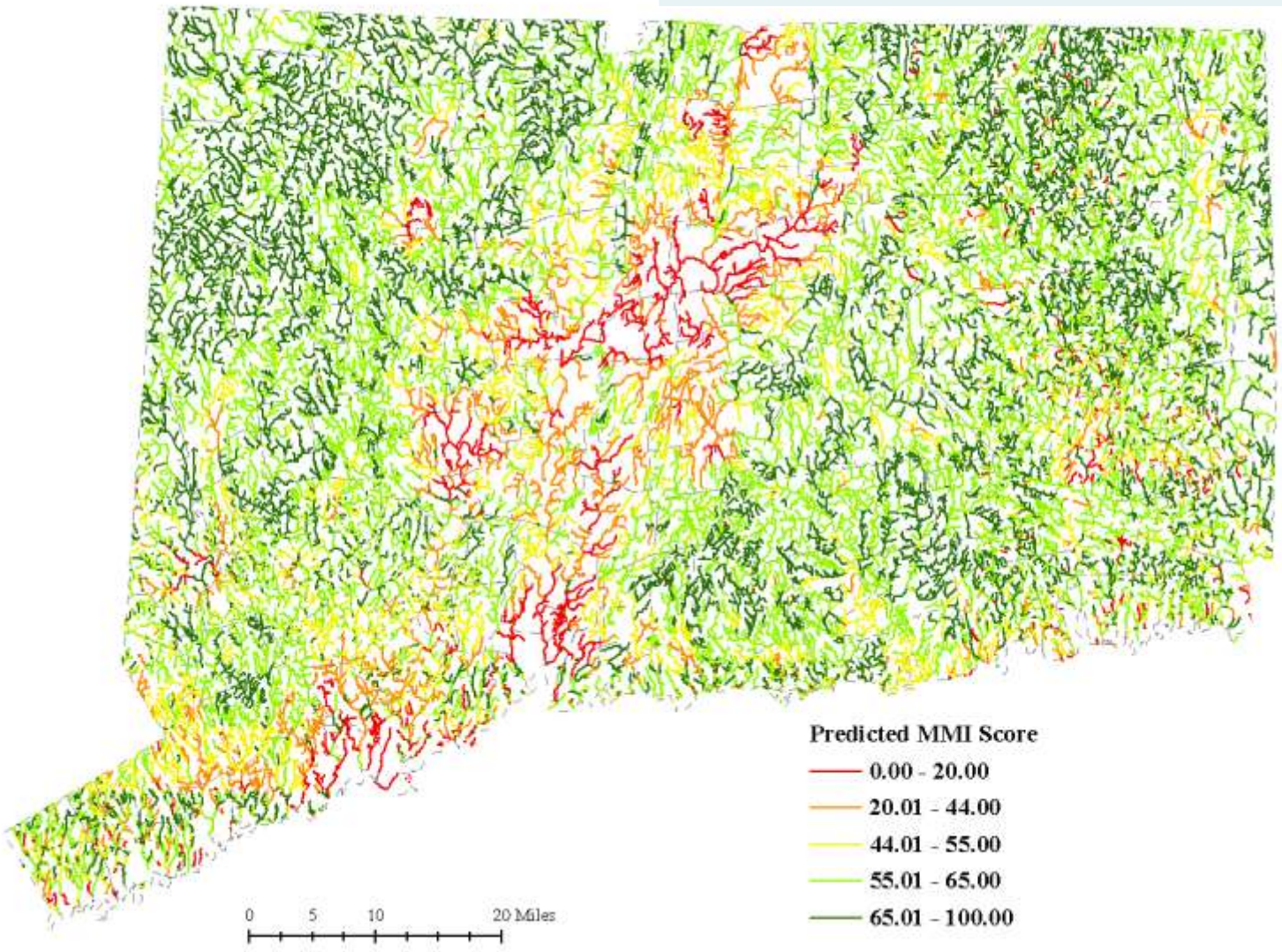
Methodology

Test Out On Sites Not Included In The Model



Methodology

Predict Biological Indicator Scores Based on Landscape Variables



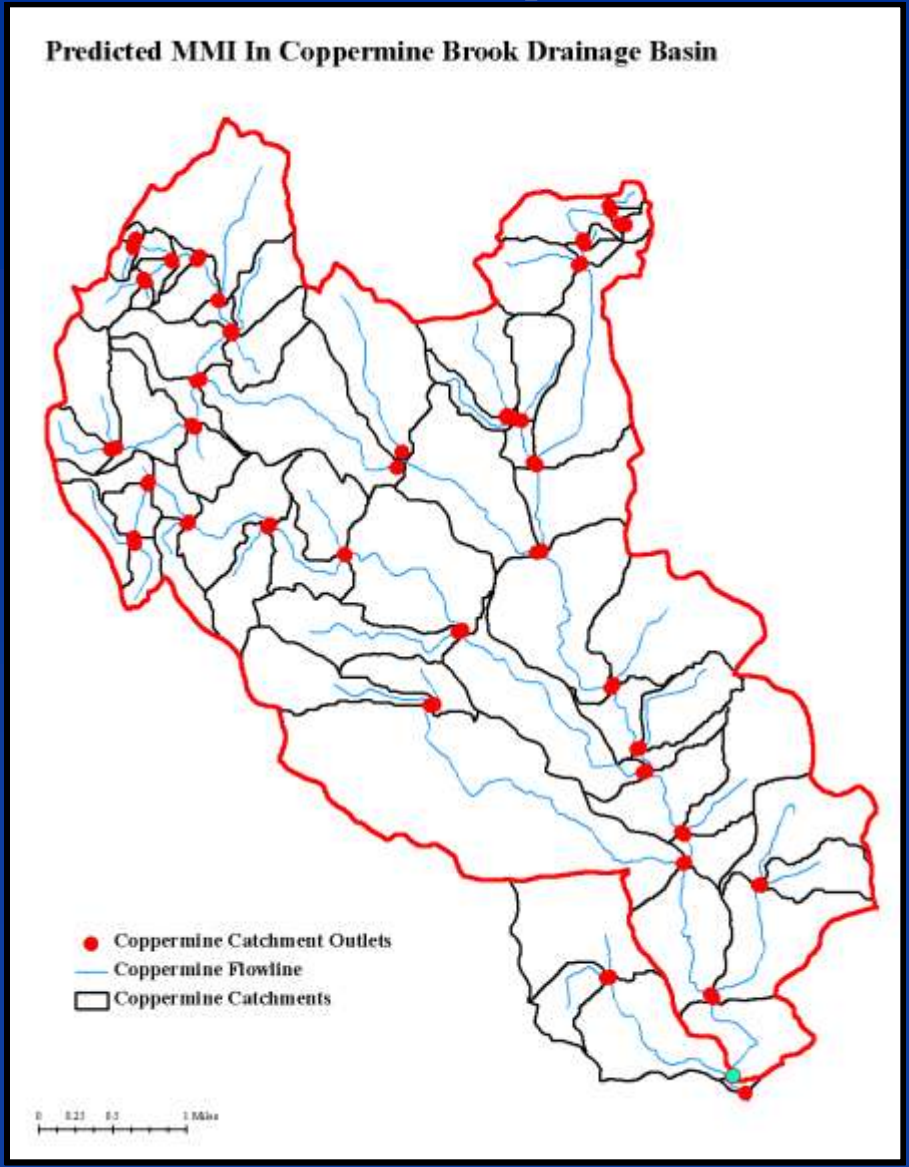
Tools to Support Water Quality Management

Predict Biological Condition To Enhance Water Quality Management

- Identify catchments that represent individual NHD stream segments*
- Identify catchment outlet on stream segment. Use **Feature Vertices To Point** tool and identify second downstream point on line.
- **Batch Global Watershed Delineation** to delineate upstream drainage basin and run model parameters
- QA Batch Delineations
- Run **Model Builder** model to calculate predicted MMI

*Created using WRAP Hydro by Cheryl Rose at the Institute for the Application of Geospatial Technology

71 Catchments in 19 Sq. Mile Watershed

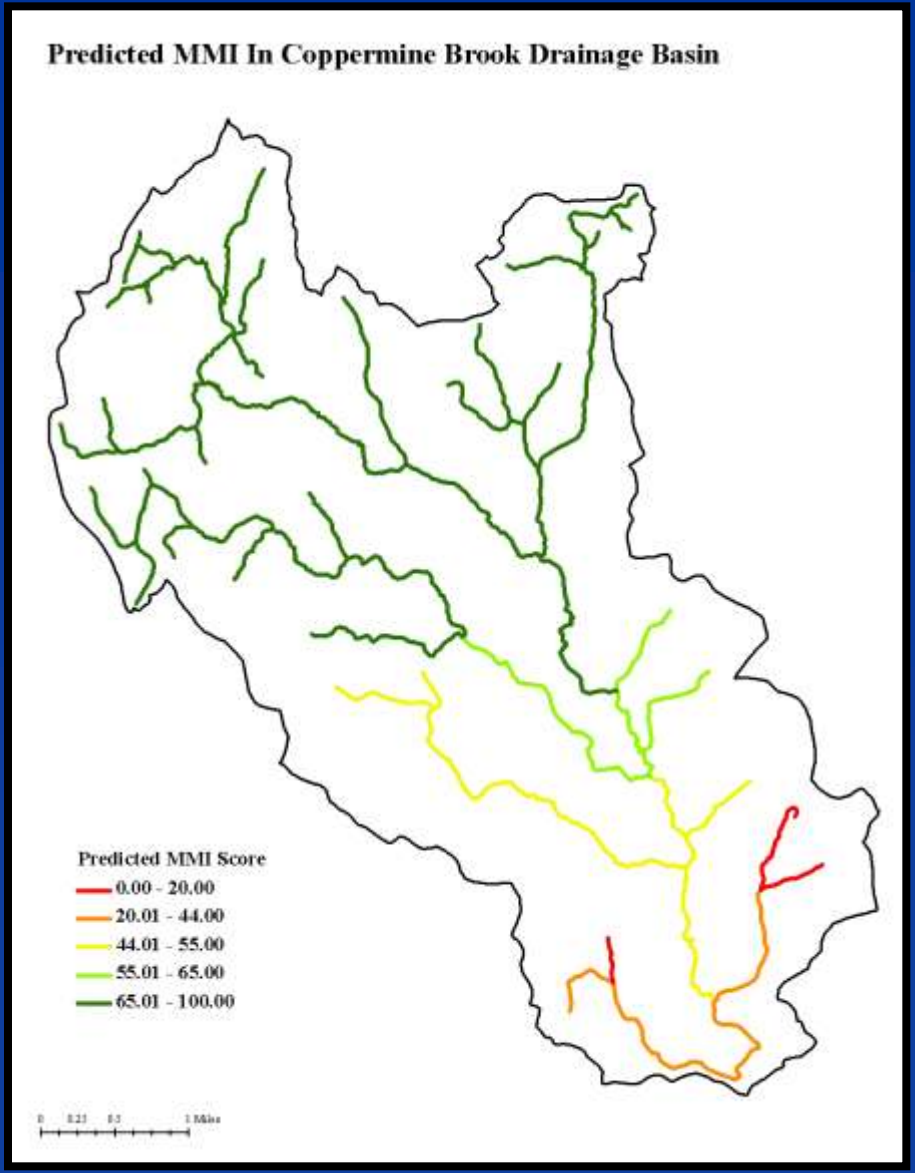


Tools to Support Water Quality Management

Predict Biological Condition To Enhance Water Quality Management

Without Monitoring Data…

- Predict localized expected water quality condition
- Predict localized water quality trends
- Support development of local management measures (TMDLs, NPDES permits, NPS BMPs)
- Prioritize targeted monitoring

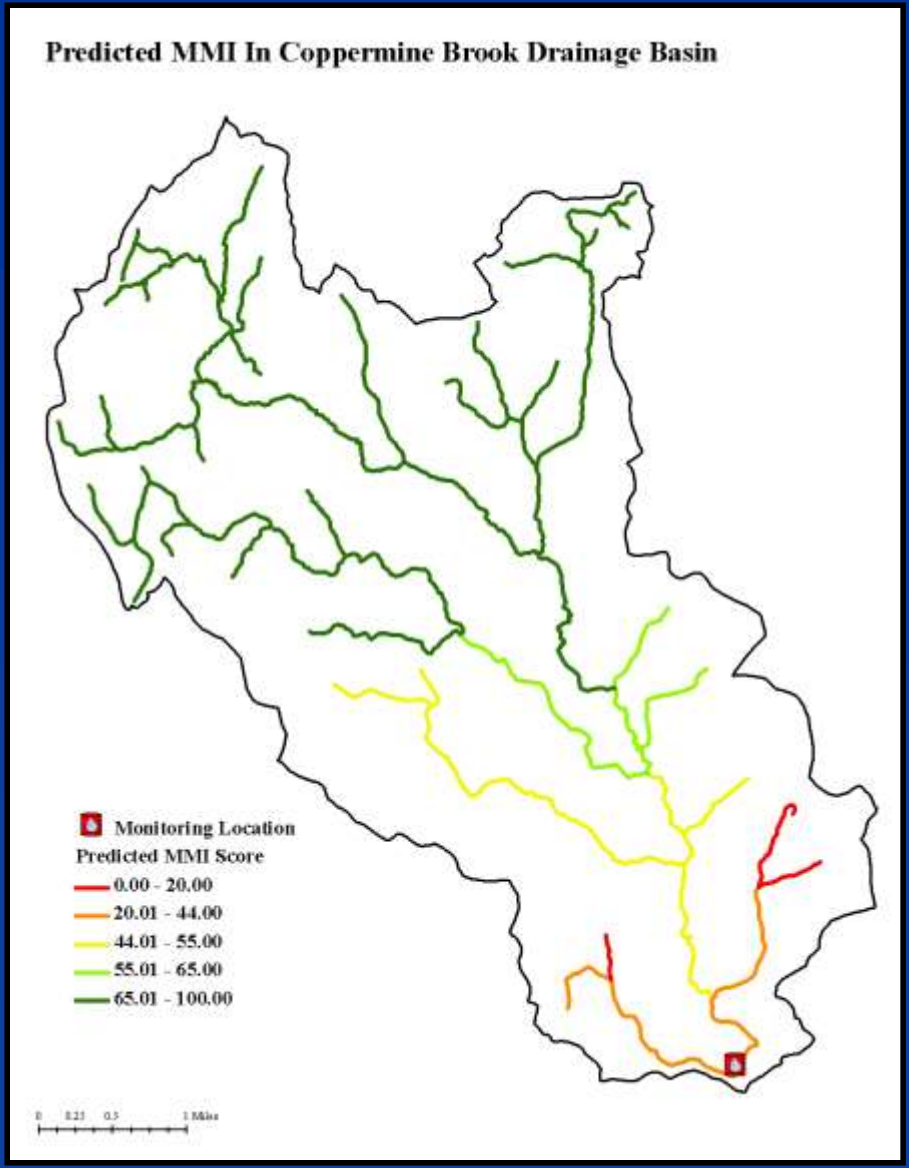


Tools to Support Water Quality Management

Predict Biological Condition To Enhance Water Quality Management

With Monitoring Data…

- Identify waterbody segments that disagree with the model and figure out why
- Predict changes water quality trends
- Prioritize targeted monitoring for stressor identification studies
- Support development of local management measures (TMDLs, NPDES permits, NPS BMPs)

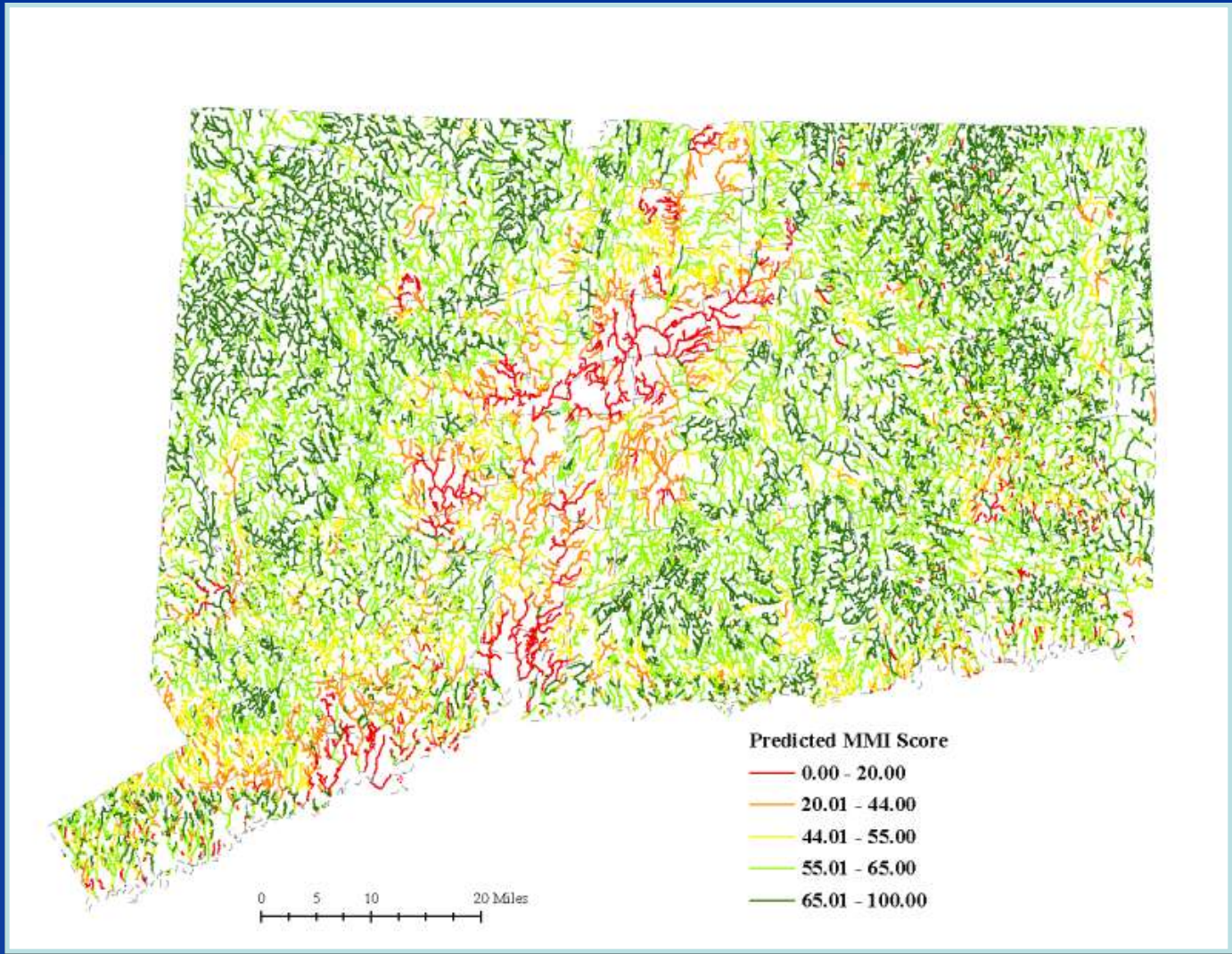


Tools to Support Water Quality Management

Extend Model Statewide

Over 36,000 Catchments

- Afford better protection to high quality waters
- Provide intermediate goals for mixed landuse waters
- Provide recovery potential goals for urban rivers



Questions / Suggestions?

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