

CT DEP Interim Nutrient Management Strategy for Non-Tidal Waste Receiving Streams

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*Connecticut Department of Environmental Protection
Bureau of Water Protection and Land Reuse*



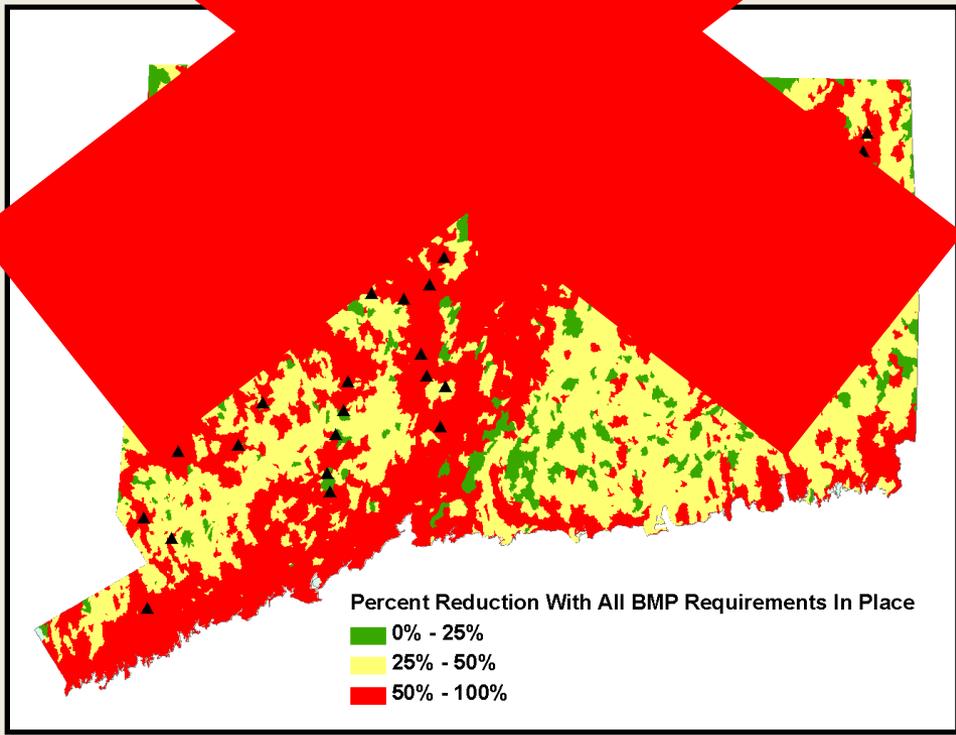
*35th Annual Meeting of the
New England Association of Environmental Biologists
Sturbridge, MA
March 16 – 18, 2011*



CT DEP 2009 Interim Nutrient Management Strategy

- **CT DEP Went to Public Notice with Beacon Falls NPDES Permit**
- **EPA Evaluated and Objected to the Permit Primarily Based on Concerns with Phosphorus Limits**

Load	Estimated Current Load (lbs/day)	Estimated BAC Load (lbs/day)	Estimated Percent Reduction
	1	67	
Total			70%



Addressing EPA Concerns: CT NPDES

Phosphorus Limits

EPA Concerns (Re: Beacon Fall CT NPDES Draft Permit Letter June 18, 2010)

- “The Naugatuck River is listed as **impaired for aquatic life**, and municipal point source discharges are listed as one of the causes of impairment.”
- “**No analyses of (aquatic life) data** relative to general impairment status or eutrophication impacts was presented.”
- “CTDEP must **conduct an appropriate analysis** of the potential that phosphorus in the discharge will cause or contribute to a violation of water quality standard and, if so, must establish a WQBEL...”

EPA Proposed Interim Nutrient Management Strategy

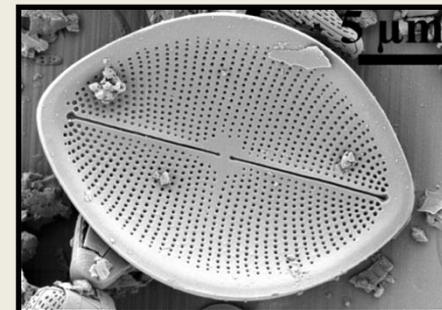
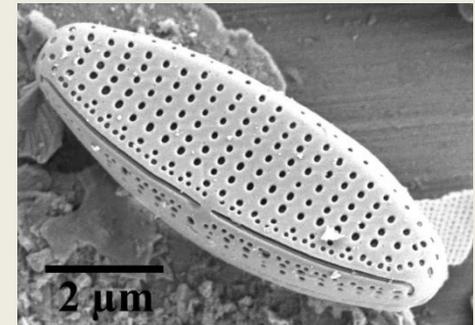
EPA 1986 Water Quality Criteria 'Gold Book' Total Phosphorus Recommendations

Habitat	Concentration
Stream at the point where it enters any lake or reservoir	50 µg/L
Within a lake or reservoir	25 µg/L
Stream or other flowing waters not discharging directly to lakes or impoundments	100 µg/L

Addressing EPA Concerns: CT Interim Nutrient Management Strategy for Waste Receiving Streams

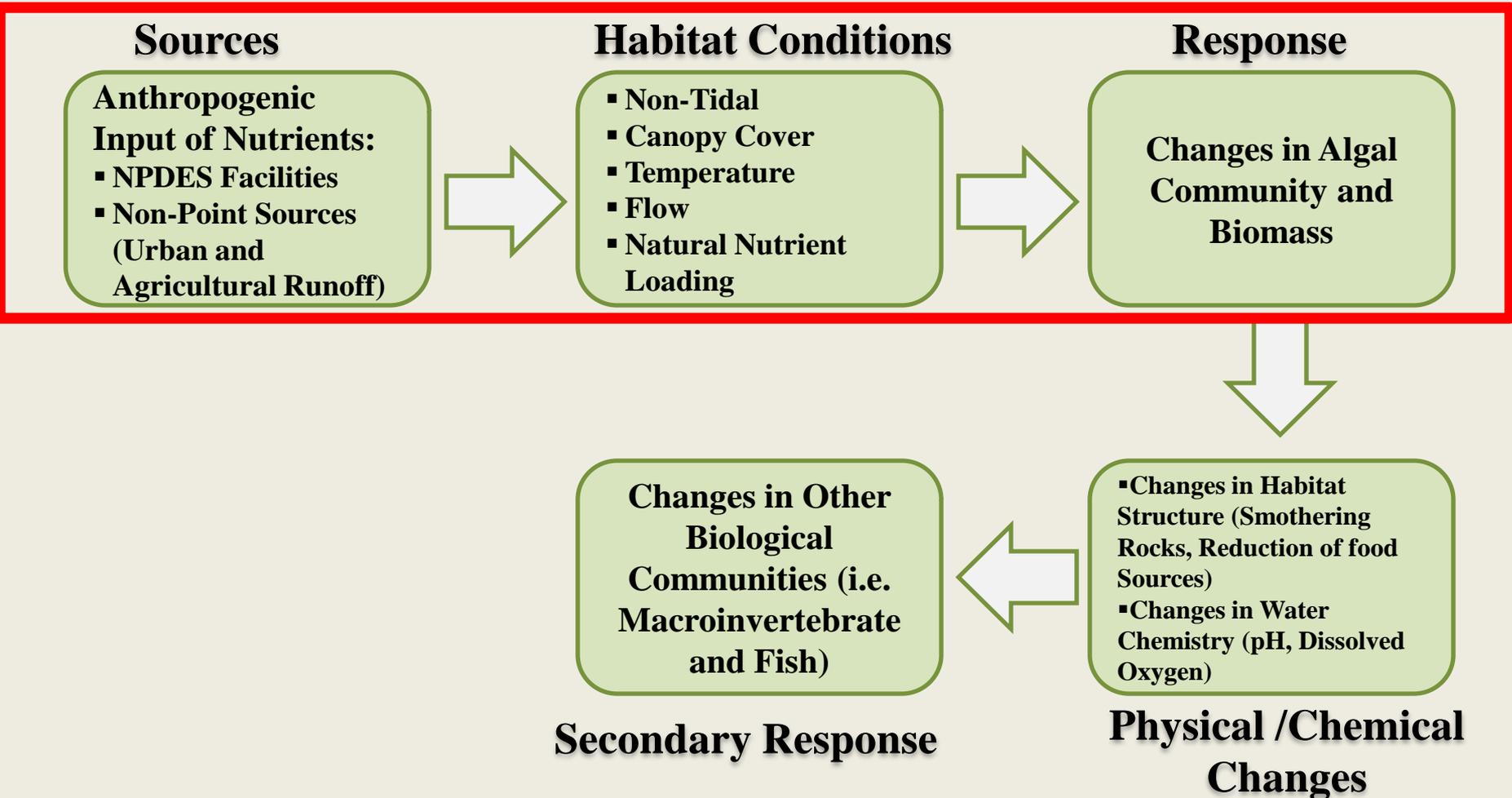
CT DEP Response (Re: Beacon Fall CT NPDES Draft Permit Letter June 18, 2010)

- Using best available science, we shifted the strategy to develop biologically based Phosphorus Limits for NPDES facilities that meet aquatic life designated uses

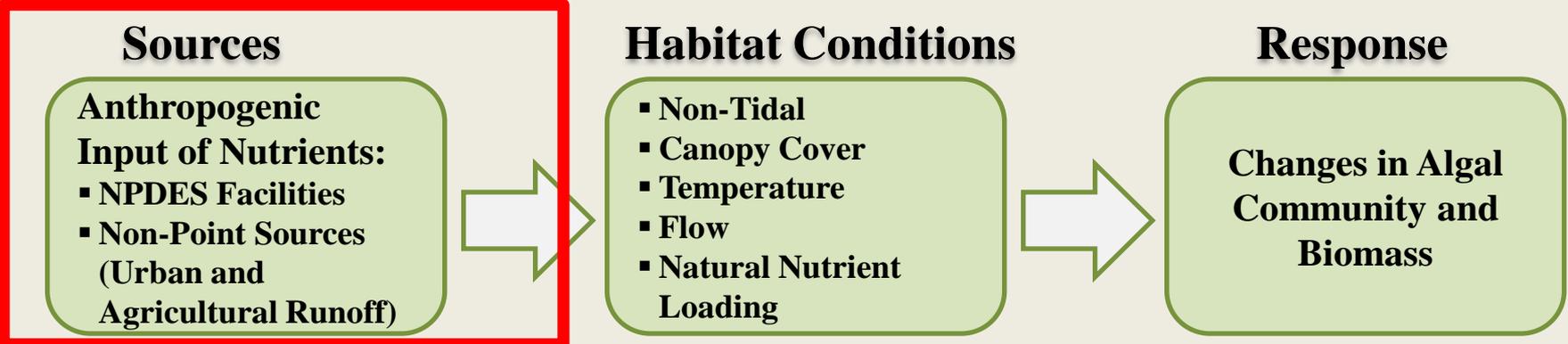


CT DEP Interim Nutrient Management Strategy

- Focused on changes in stream algal species composition because they respond directly to nutrients and provide a better indicator of enrichment condition in streams than assessment of water chemistry, macroinvertebrates, fish or algal biomass (EPA, 2000).
- Species composition of stream algae communities is also more likely to reflect actual stream conditions because they integrate the effects of stressors over time and space (Stevenson, 2006).



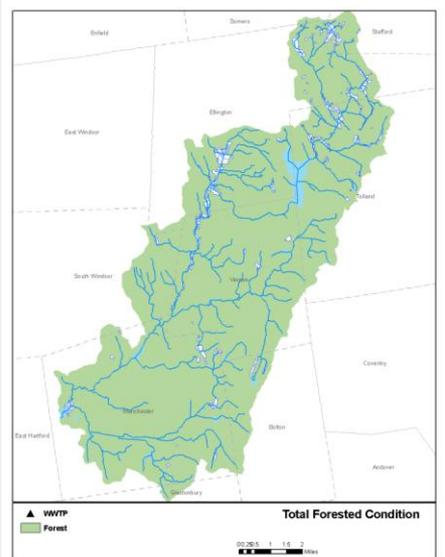
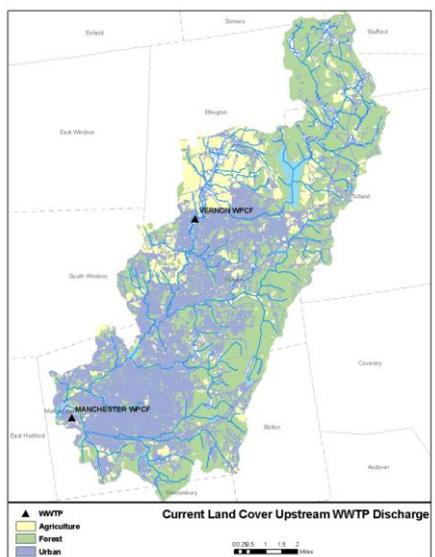
CT DEP Interim Nutrient Management Strategy



Total NPDES Load (lbs/day) + Land Cover Load (lbs/day)

Enrichment Factor (EF) =

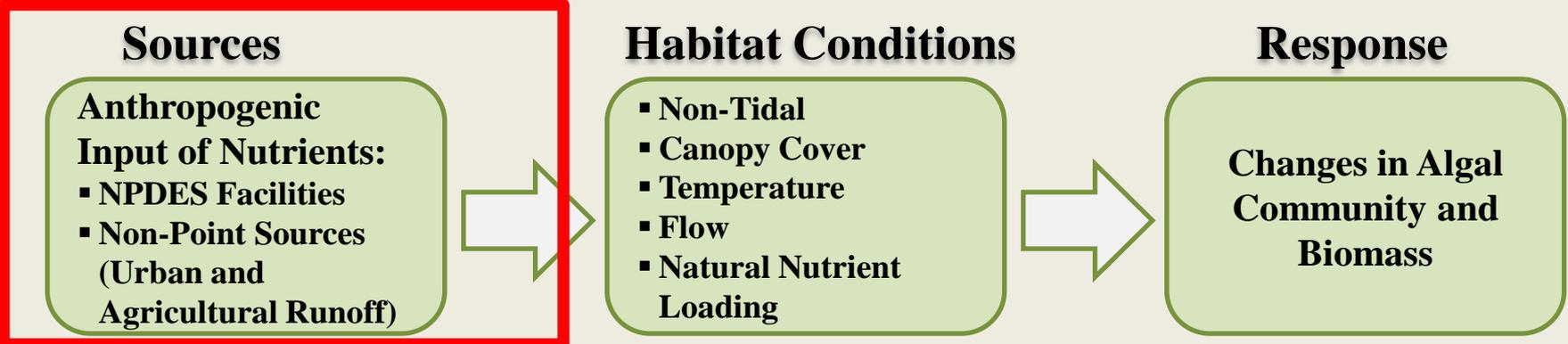
Forested Condition Load (lbs/day)



Calculated Current NPDES Load

- Identified NPDES facilities discharging phosphorus to freshwater rivers and streams
- Submitted DMR / NAR Flow and Concentration Data (Typically 2001 – 2007)
- Seasonal Data (April through October)

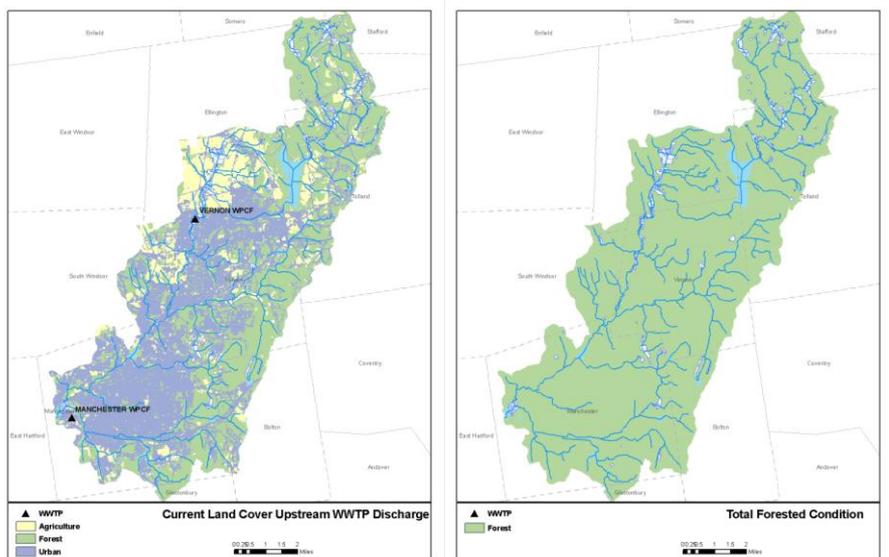
CT DEP Interim Nutrient Management Strategy



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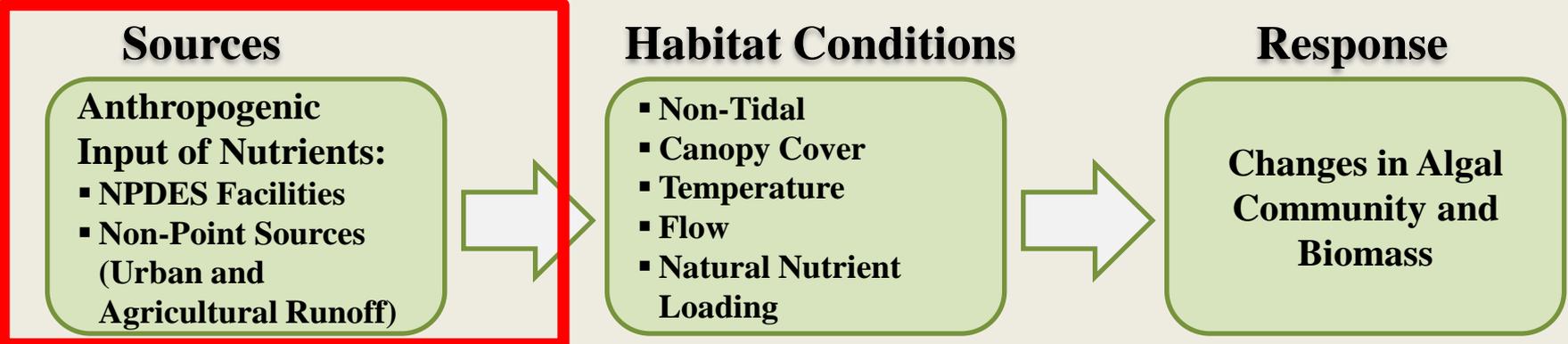


Estimated Seasonal Land Cover Load Using Export Coefficients

Land Cover*	Export Coefficient ** (lbs/acre/day)
Forest	1.03×10^{-4}
Urban	4.33×10^{-4}
Agriculture	19.75×10^{-4}

** 2002 CLEAR Land Cover Data
* Becker & Dunbar, 2009

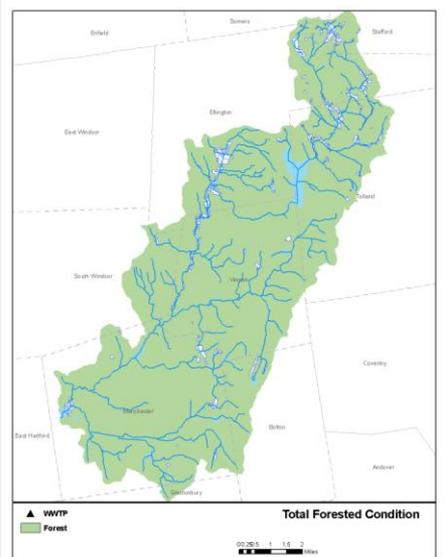
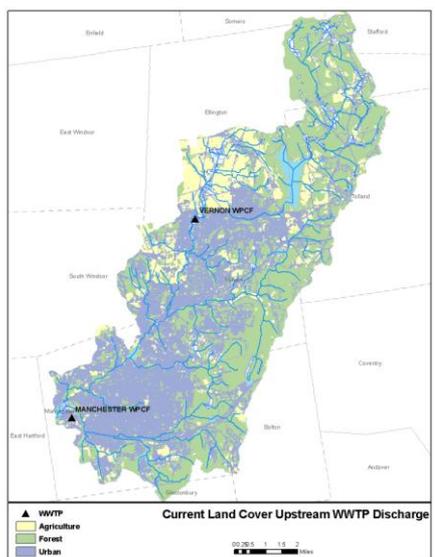
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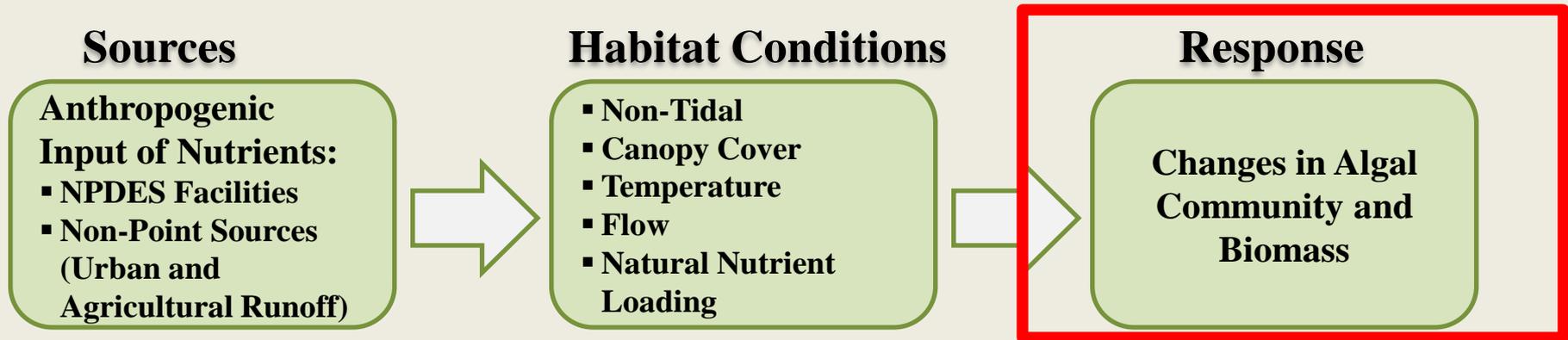


Enrichment Factor (EF)

Example:

Current Load (lbs/day)	205.3
Forested Load (lbs/day)	4.80
Enrichment Factor	42.79

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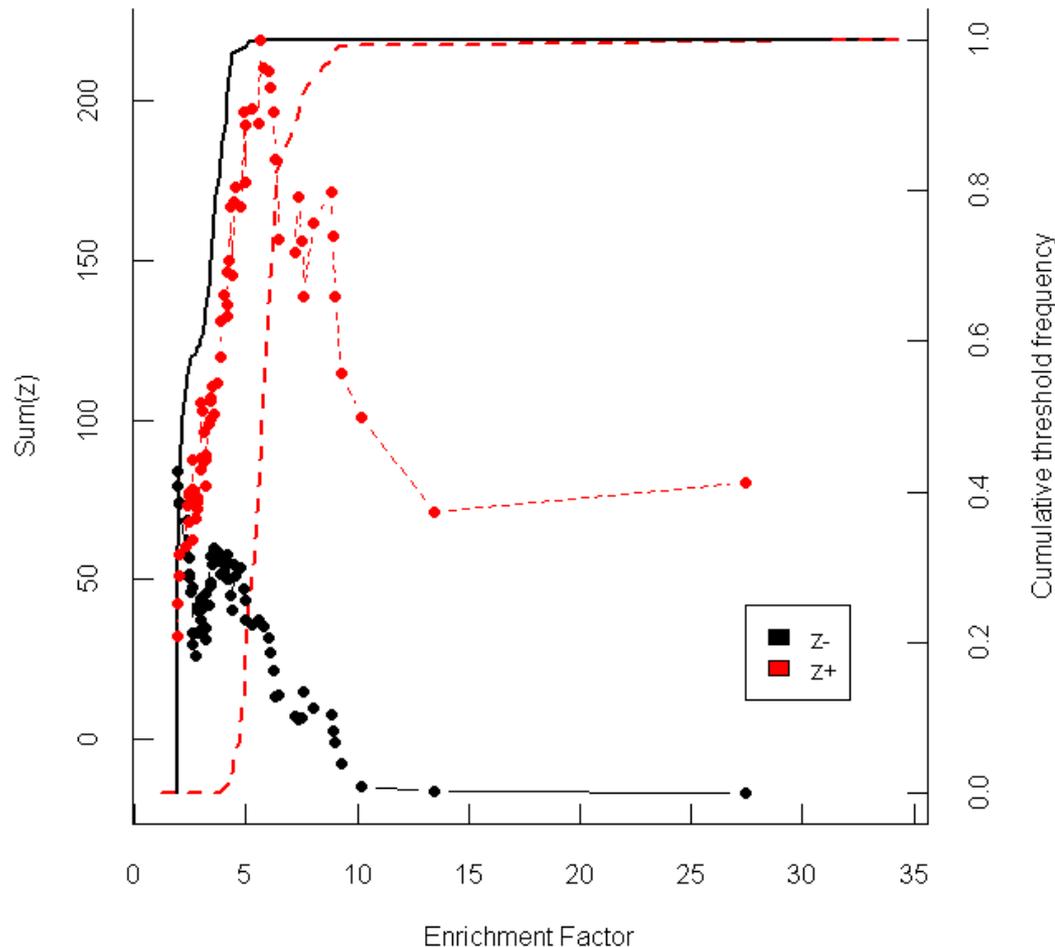


- Stream Algae Species (Epilithic Diatoms)
Data Collected From 2002 – 2004
- 78 Sites
- EF Range from 1.2 - 76



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Threshold Indicator Taxa Analysis (TITAN)* : Community Plot



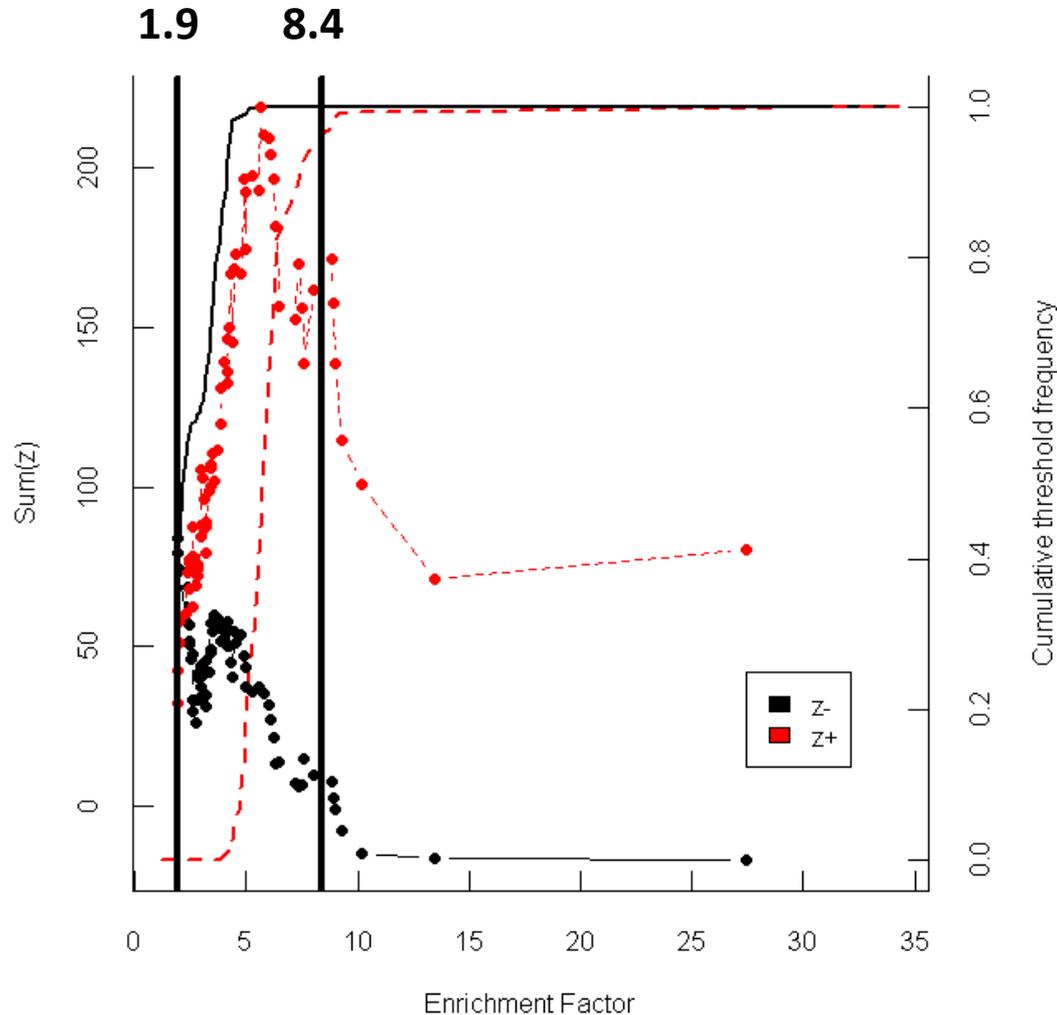
Community plot shows additive response of diatom species

- Z- (black dots) are the sum of individual diatom (algae) species that decrease when the Enrichment Factor (EF) increases
- Z+ (red dots) are the sum of individual diatom (algae) species that increase when EF increases
- Evidence for community threshold comes from synchronous taxa response
- Sharp peaks denote threshold changes in community
- Curve height shows signal strength

* Baker & King, 2010

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TITAN Analysis	Observed Change Point	Bootstrap Replicate Change Points At Quantiles				
		0.05	0.1	0.5	0.9	0.95
sumz-	1.9	1.9	1.9	2.305	4.1665	4.27
sumz+	6.16	4.485	4.845	5.89	7.55	8.435



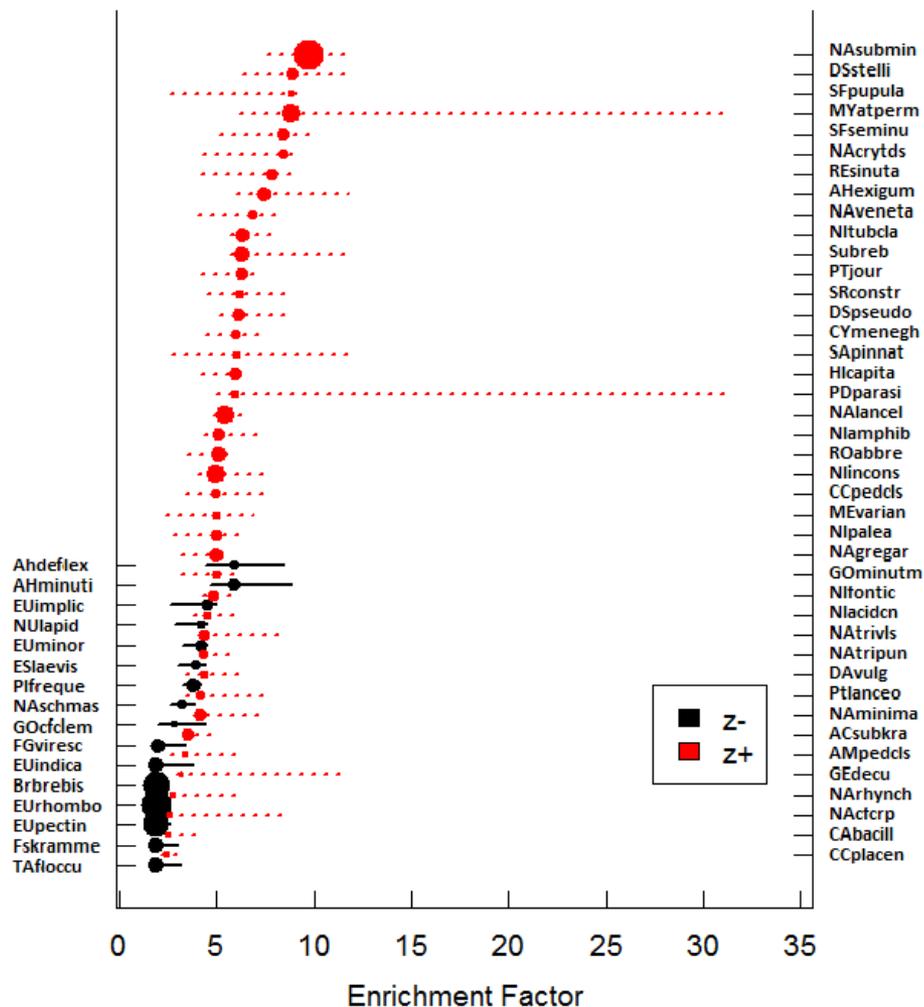
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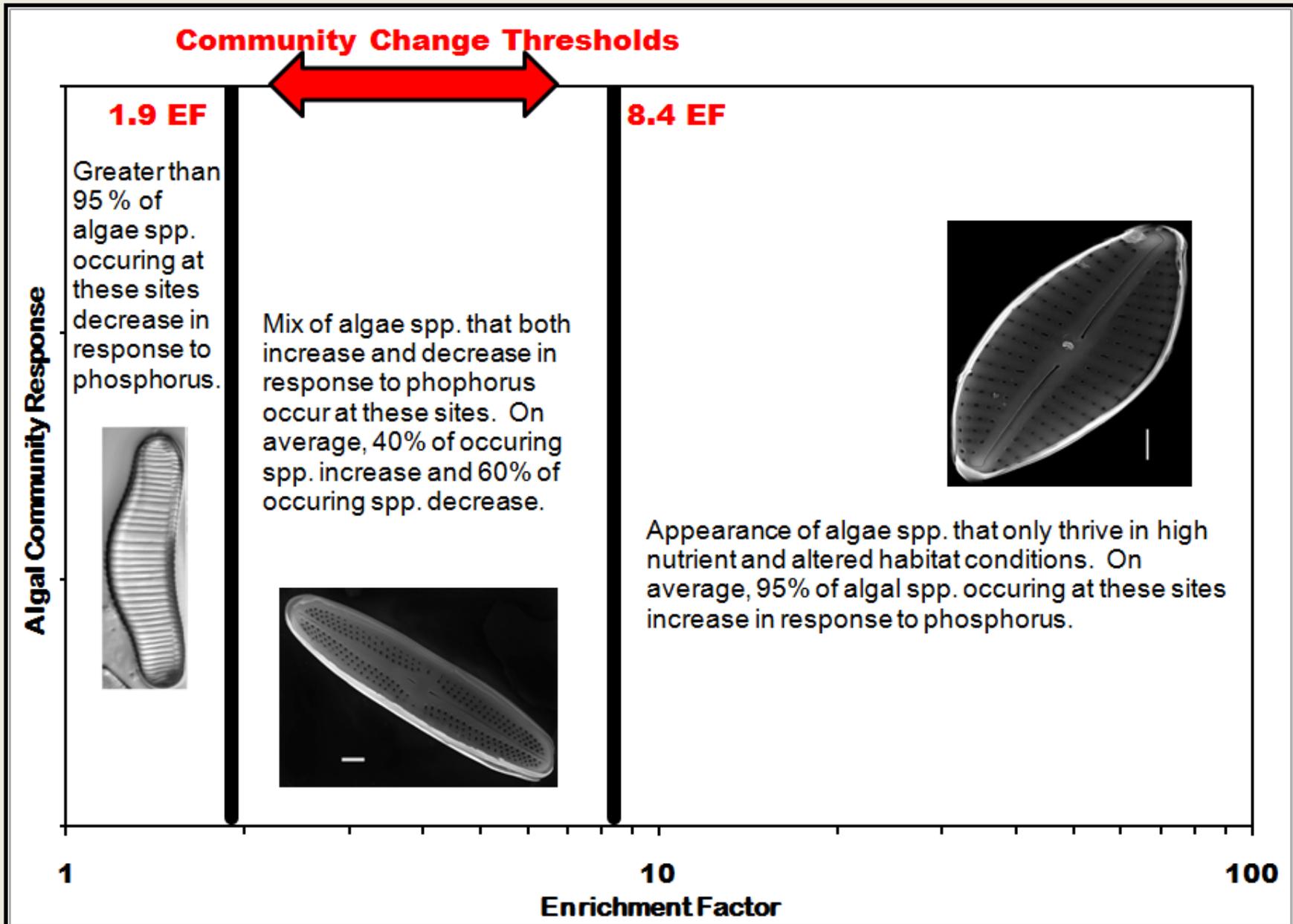


Species plot shows taxon specific responses

- Z- (black dots) are individual diatom (algae) species that decrease when the Enrichment Factor (EF) increases
- Z+ (red dots) are individual diatom (algae) species that increase when EF increases
- Symbols are proportional to signal strength (Larger dots show stronger change signal)
- Horizontal lines show 95th quantile from bootstrap re-sampling (uncertainty)

* Baker & King, 2010

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Beach Brook in Granby

(EF = 1.89)



Community Change Thresholds

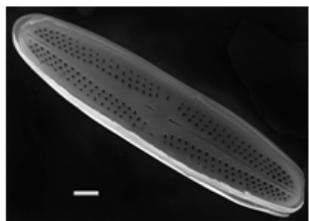


1.9 EF

Greater than 95 % of algae spp. occurring at these sites decrease in response to phosphorus.

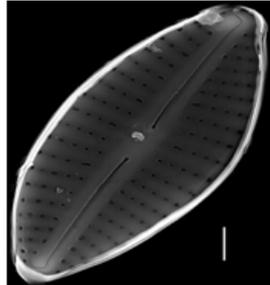


Mix of algae spp. that both increase and decrease in response to phosphorus occur at these sites. On average, 40% of occurring spp. increase and 60% of occurring spp. decrease.



8.4 EF

Appearance of algae spp. that only thrive in high nutrient and altered habitat conditions. On average, 95% of algal spp. occurring at these sites increase in response to phosphorus.



- Small Drainage Basin (1.2 mi²)
- Minimal Disturbance
- Dense Canopy (Tree Cover)

Algal Community Response

1 10 100

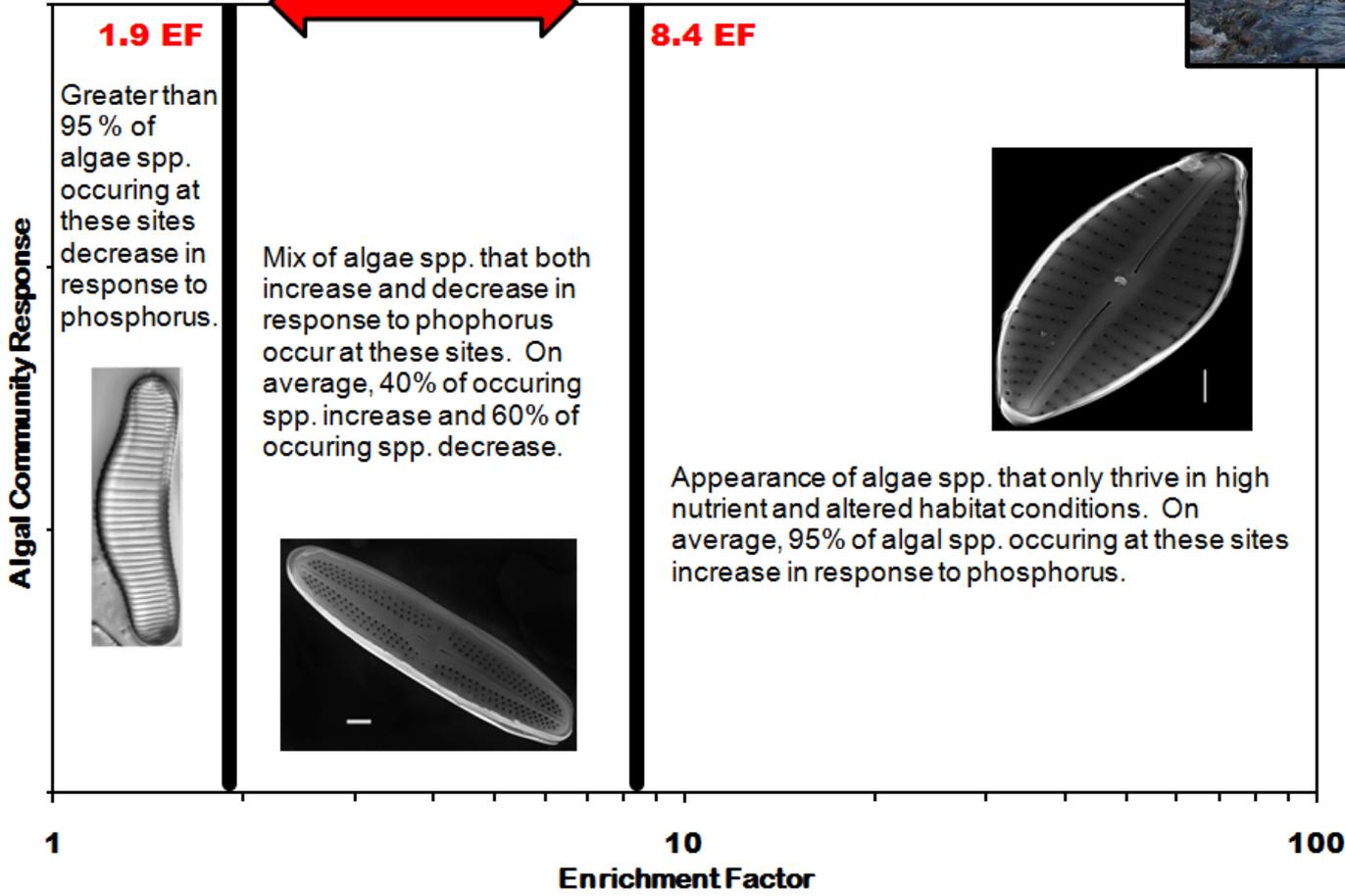
Enrichment Factor

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Farmington River in Canton (EF = 3.8)



Community Change Thresholds



- Large Drainage Basin (354 mi²)
- Moderate Disturbance
- Open Canopy (Tree Cover)

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Naugatuck River in Beacon Falls

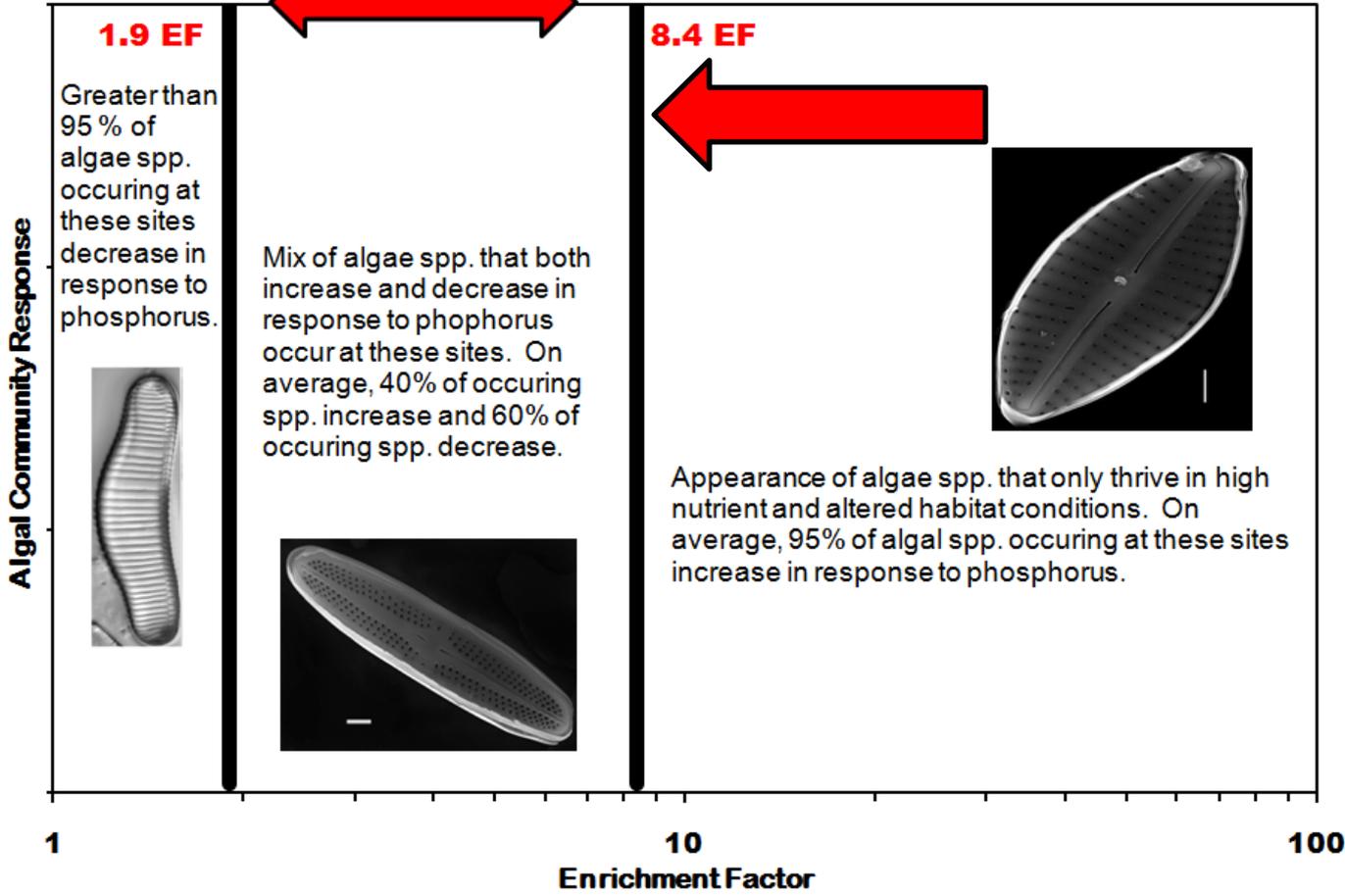
(EF = 50)

Quinnipiac River in Meriden

(EF = 52)



Community Change Thresholds



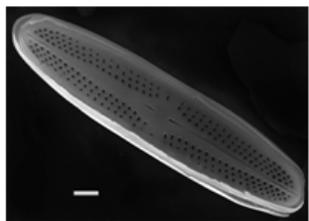
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8.4 EF

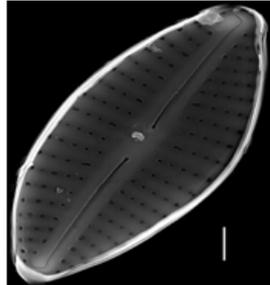
Greater than 95% of algae spp. occurring at these sites decrease in response to phosphorus.



Mix of algae spp. that both increase and decrease in response to phosphorus occur at these sites. On average, 40% of occurring spp. increase and 60% of occurring spp. decrease.



Appearance of algae spp. that only thrive in high nutrient and altered habitat conditions. On average, 95% of algal spp. occurring at these sites increase in response to phosphorus.



1

10

100

Enrichment Factor

DEP Interim Strategy for Issuing NPDES Permits Until Full Nutrient Strategy Criteria is Developed

- Maintain an in-stream enrichment factor of 8.4 throughout the drainage basin

Margin of Safety

- Conservatively Assumed No Reductions in Current Land Cover / Use Loadings
- Assumed No Attenuation
- NPDES Facilities Load Based on Current Flow Rate (Increases in Flow Rate Would Require NPDES Facilities to Lower Effluent Concentrations of Nutrients in Order to Meet Mass-based Nutrient Loading Limit)



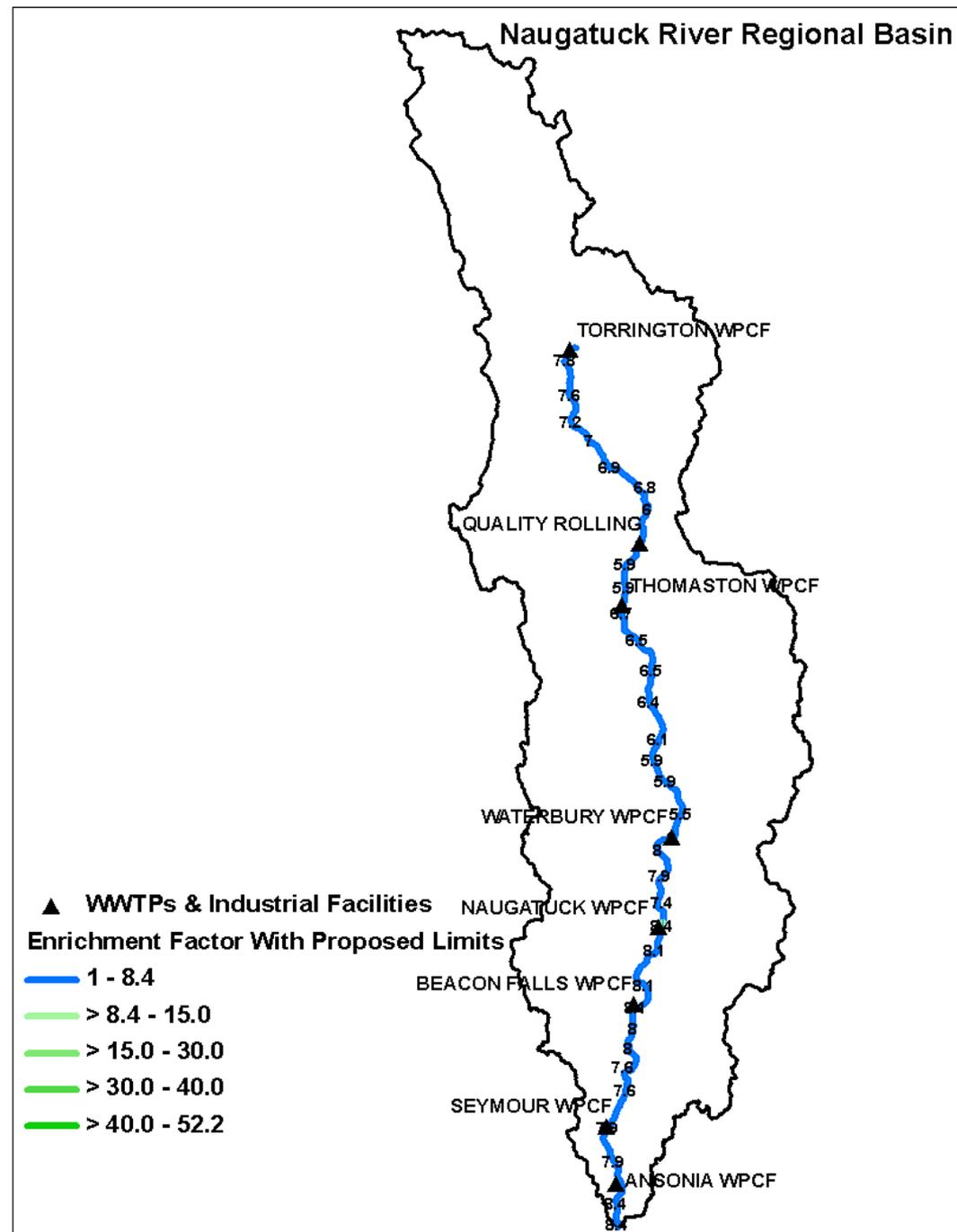
*East Branch Naugatuck River in Torrington.
July 2010.*

Implementation

Example:

Naugatuck River Basin

- Watershed-Based Analysis Using GIS To Assess Current Phosphorus Loads
- Calculated the Current Enrichment Factor at Multiple Locations along Waste Receiving Streams
- Conducted a Loading-Based Analysis to Determine Reductions in Phosphorus Needed at Each Facility to Meet the Goal of 8.4 or Less



Implementation Example: Naugatuck River Basin

Total NPDES Load (lbs/day) + Land Cover Load (lbs/day)

Enrichment Factor (EF) =

Forested Condition Load (lbs/day)

Current

NPDES	Flow (MGD)	Concentration (mg/L)	NPDES Load (lbs/day)	Forested Load (lbs/day)	Enrichment Factor At Discharge
TORRINGTON WPCF	5.18	1.68	64.73	3.63	21.0
QUALITY ROLLING & DEBURRING	0.09	0.7	0.53	6.72	13.1
THOMASTON WPCF	0.88	3.29	22.68	7.29	15.5
WATERBURY WPCF	20.52	3.19	539.92	13.87	49.0
NAUGATUCK WPCF	4.92	4.3	159.97	16.26	52.2
BEACON FALLS WPCF	0.32	3.19	7.91	17.66	48.7
SEYMOUR WPCF	1.29	3.98	41.09	20.05	45.4
ANSONIA WPCF	2.04	2.89	43.32	20.65	46.2



Current Average Seasonal (April through October) Flow, Concentration and Load Based on Submitted NAR Data (Typically 2001 – 2007)

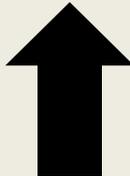
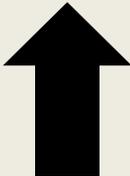
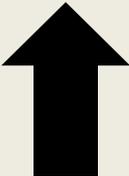
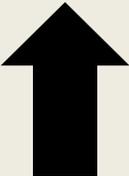
Implementation Example: Naugatuck River Basin

Total NPDES Load (lbs/day) + Land Cover Load (lbs/day)

Enrichment Factor (EF) =
$$\frac{\text{Total NPDES Load (lbs/day) + Land Cover Load (lbs/day)}}{\text{Forested Condition Load (lbs/day)}}$$

Proposed Seasonal (April through October) Management Limits

NPDES	Flow (MGD)	Concentration (mg/L)	NPDES Load (lbs/day)	Forested Load (lbs/day)	Enrichment Factor At Discharge
TORRINGTON WPCF	5.18	0.40	17.29	3.63	7.9
QUALITY ROLLING & DEBURRING	0.09	0.70 (Cap)	0.53	6.72	6.0
THOMASTON WPCF	0.88	1.00	7.35	7.29	6.9
WATERBURY WPCF	20.52	0.20	34.26	13.87	8.0
NAUGATUCK WPCF	4.92	0.40	16.43	16.26	8.4
BEACON FALLS WPCF	0.32	1.00	2.67	17.66	8.1
SEYMOUR WPCF	1.29	0.70	7.54	20.05	7.9
ANSONIA WPCF	2.04	0.70	11.92	20.65	8.4



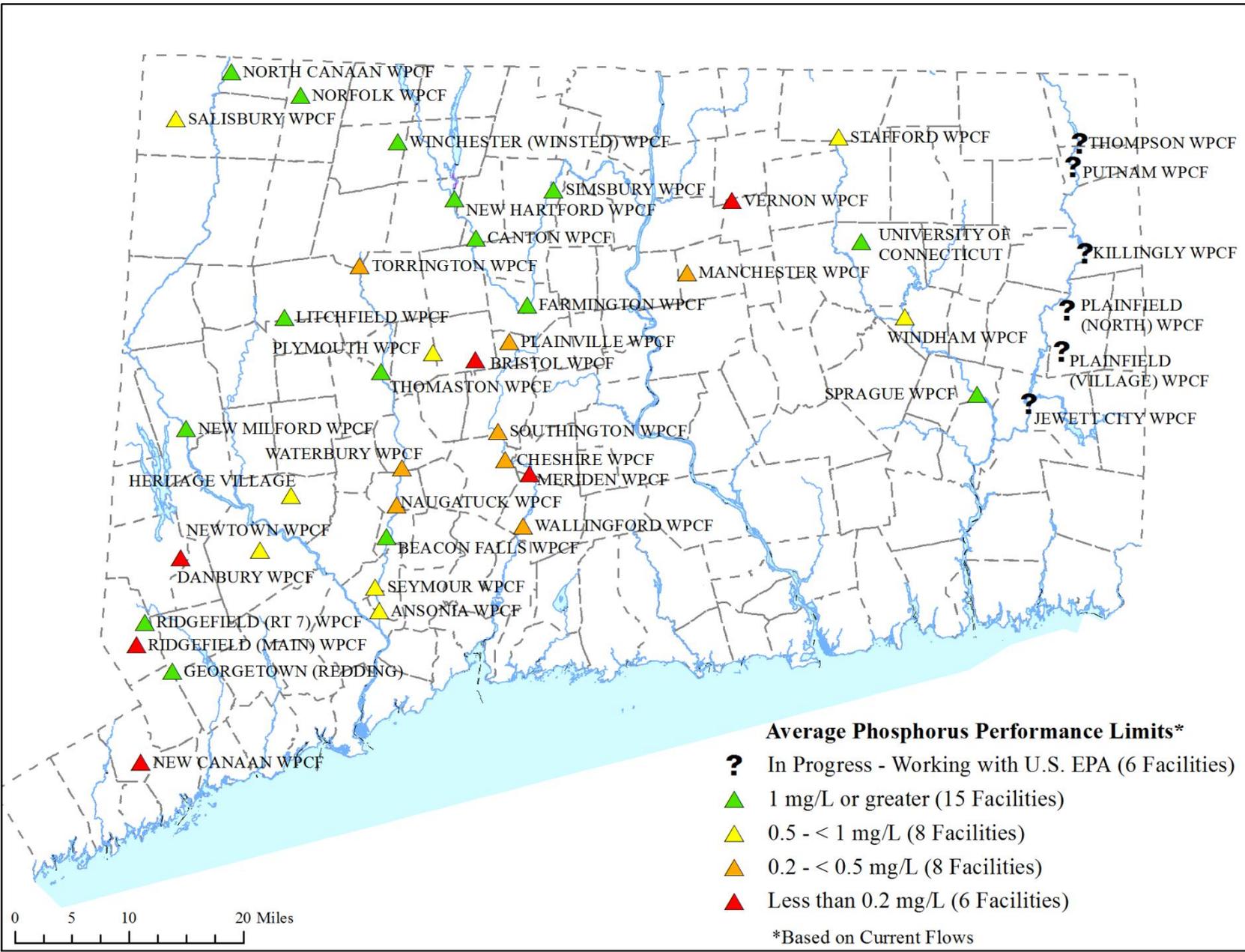
Current Average Seasonal (April through October) Flow Based on Submitted NAR Data (Typically 2001 – 2007)

Concentration Rounded to the Nearest Hundredth

Load = Current Flow * Proposed Concentration

In some cases the EF is below 8.4 to ensure that the goal is met downstream

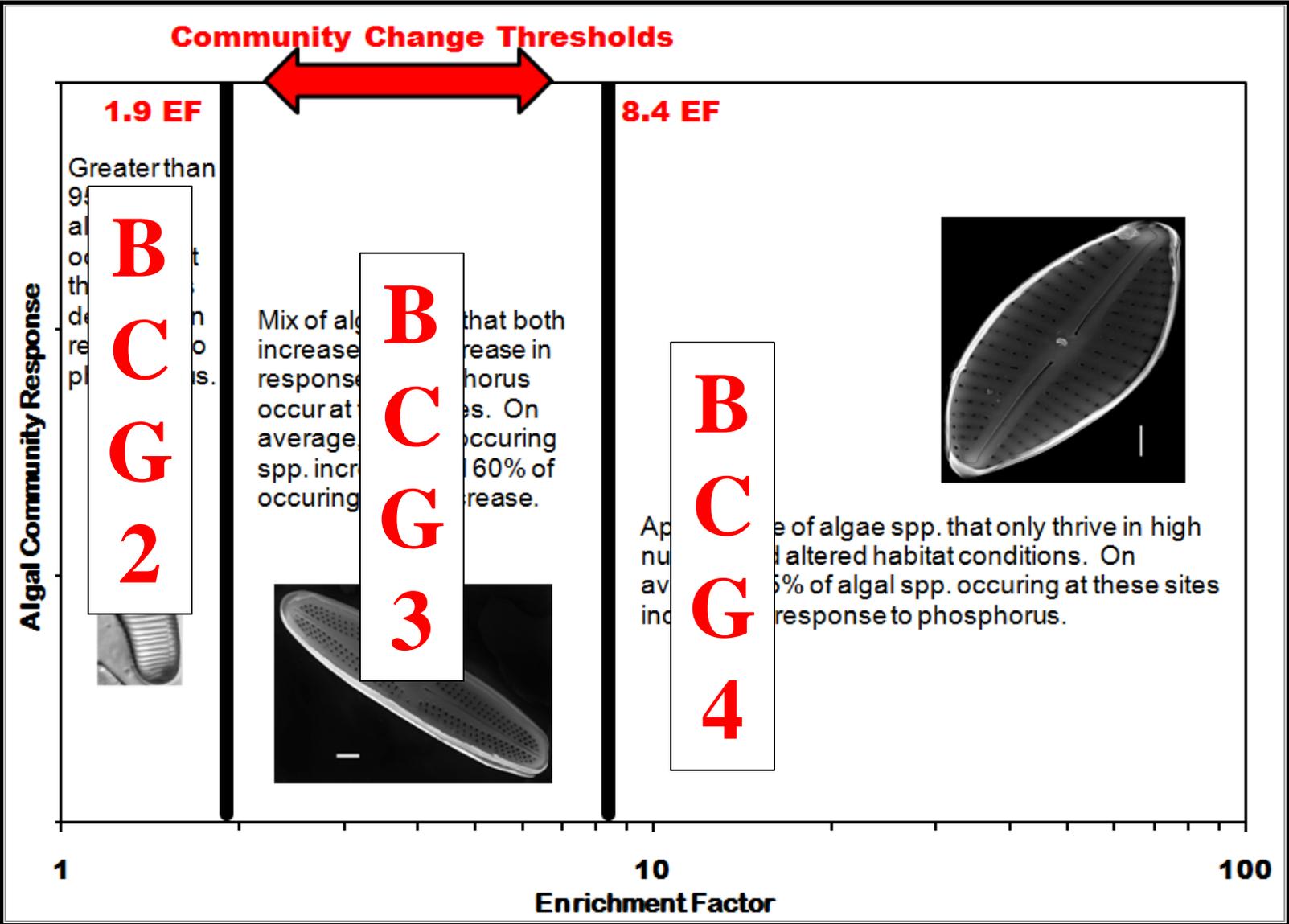
Statewide Average Phosphorus Performance Limits To Date



Next Steps: Adaptive Management

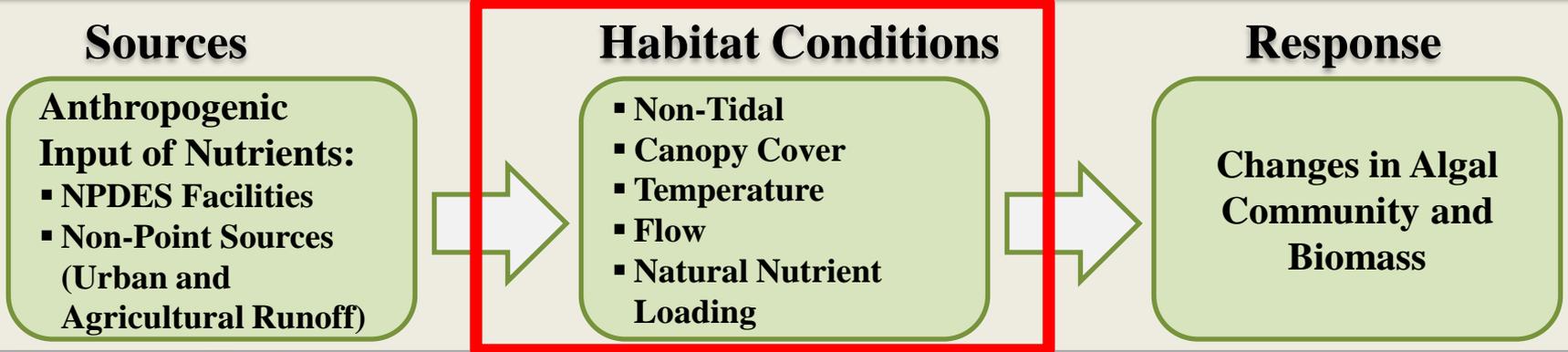
- Expand Approach to Include Non-Waste Receiving Streams.

Thoughts for Future Work: Incorporate Biological Condition Gradient Into Criteria Development



Next Steps: Adaptive Management

- Better Incorporate Spatial and Temporal Habitat Conditions That Effect Changes in Stream Algae.



Field Image



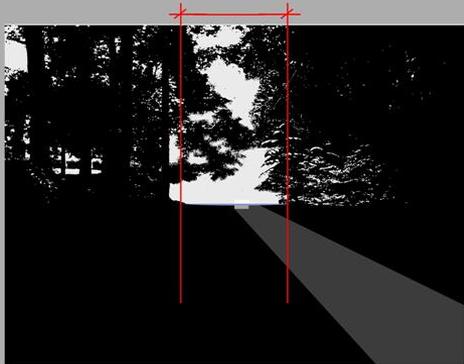
Measured Canopy Cover

SITE 554
Sasco Brook
Westport, CT

Average Canopy Cover: 77.65%
of 6.23m Mean Wetted Width



Plan View



Section View



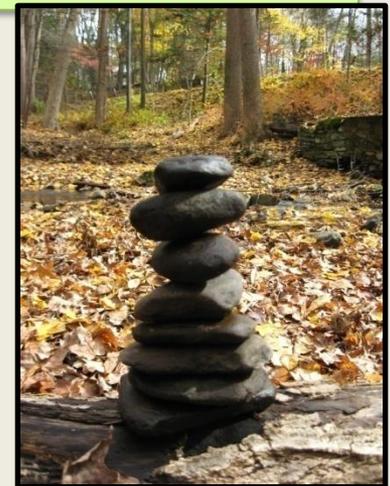
Average Substrate Rating:
"4" Cobble (3"-12")



Mean Wetted Depth
19.50cm
Substrate Mean
Embeddedness
54.88%

Next Steps: Adaptive Management

- **Expand Approach to Include Non-Waste Receiving Streams.**
- **Better Incorporate Spatial and Temporal Habitat Conditions That Effect Changes in Stream Algae.**
- **Collecting Additional Stream Algae (Diatom) Species Data to Test and Improve Statistical Models.**
- **Continue Ongoing Monitoring and Research that Incorporates the Responsiveness of the Aquatic Systems to these Initial Steps to Manage Phosphorus from NPDES Permitted Sources as well as Growing Emphasis on Land-Based Management Practices Required Under Connecticut's WQS.**
- **May Refine the EF Target Goal in Waste Receiving Streams to Better Reflect Watershed-Specific Conditions if Sufficient Information is Available in the Future.**



Acknowledgements

- **Ralph Abele, U.S. EPA Region 1**
- **Matt Baker, University of Maryland**
- **Paul Stacey, Great Bay National Estuarine Research Reserve**
- **CT DEP Monitoring and Municipal Staff**

Questions?

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