Biological Assessments of Maine Wetlands

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NAWM's MAWWG-NEBAWWG Webinar Series:
Developing Wetland Conditional and Functional Assessments
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Maine DEP Biological Monitoring Program

Evaluates ecological health of aquatic resources

Determines if water bodies meet State aquatic life criteria ("biological criteria")

Provides data and technical support to other programs to protect and restore Maine waters

Integrated assessment approach for wetlands, rivers, and streams

Clean Water Act

Objective: Restore and maintain chemical, physical, and biological integrity of the Nation's waters.

State Responsibilities (all waters, including wetlands):

- Develop monitoring and assessment programs
- Adopt water quality standards
- Report to EPA on condition of waters every two years

Narrative Biological Criteria

Fresh Surface Waters (rivers/streams, associated wetlands)

AA Habitat natural and free flowing (no dams allowed).
Aquatic life as naturally occurs.

A Habitat natural. Aquatic life as naturally occurs.

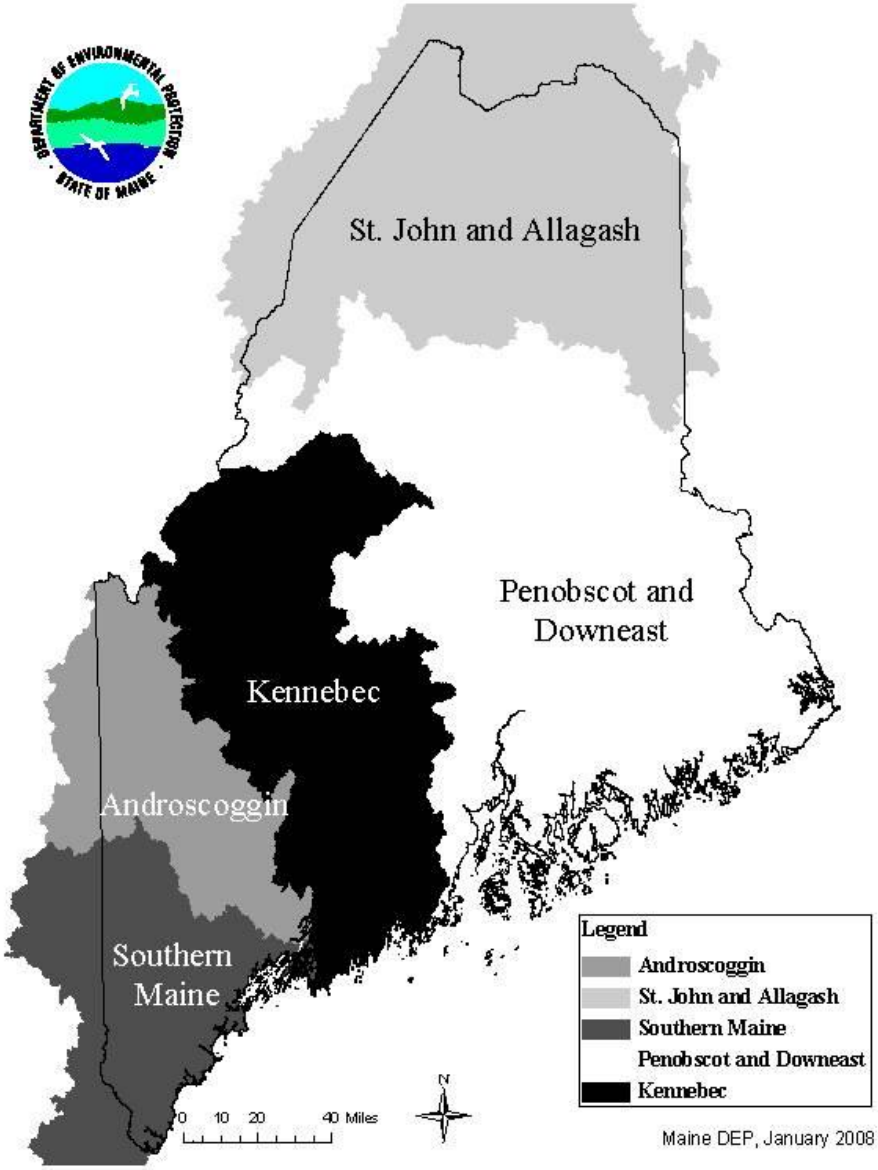
B Habitat unimpaired. Must support all indigenous aquatic species. No detrimental changes to resident biological community.

C Must support all indigenous fish species and maintain structure and function of resident biological community.

GPA **Lakes and Ponds** (and associated wetlands)
One class, equivalent to Class A)

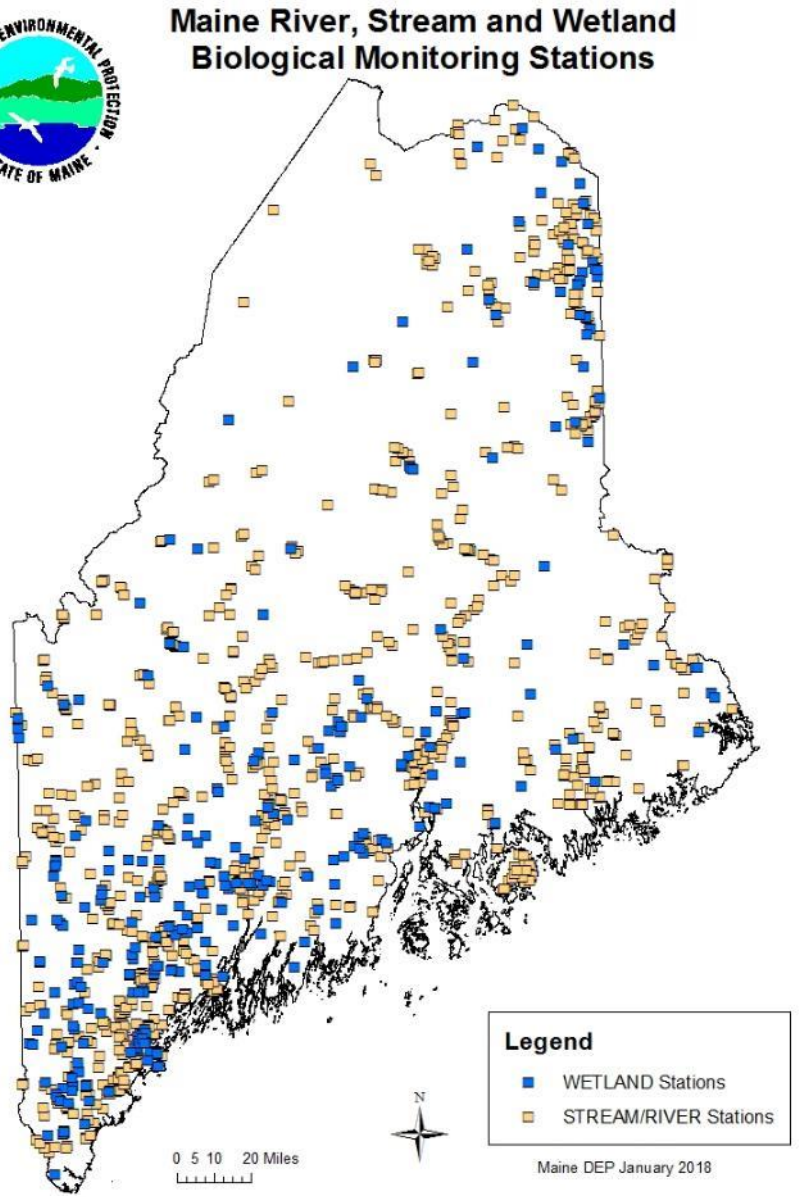
Sampling design

Rotating basin schedule to cover the entire State



Sampling design

- Rotating basin schedule to cover the entire State
- ~1200+ stream stations
- ~350+ wetland stations
- Monitoring frequency:
  - Annually
  - Every 5 years
  - As needed



Habitats monitored






- Wadeable streams, large rivers, emergent/aquatic bed wetlands, shallow lakes and ponds

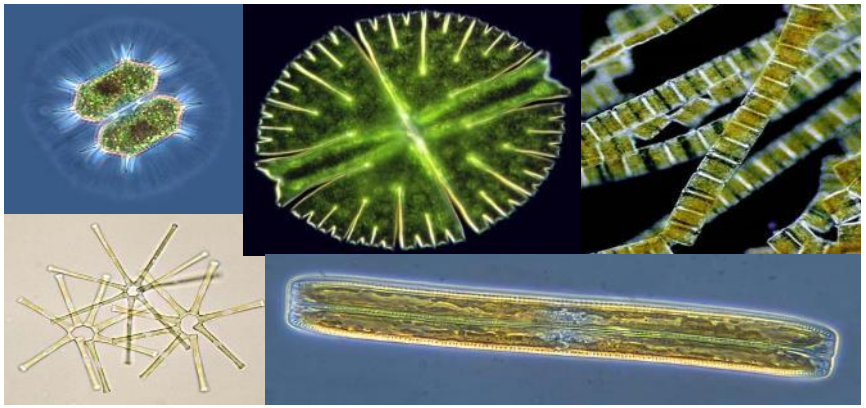
Biological assemblages monitored

‘Stream’ method (hard substrate):

- Macroinvertebrates
- Algae

‘Wetland’ method (soft substrate streams and lake/pond margins):

- Macroinvertebrates
- Algae
- Aquatic macrophytes



Sampling methods

‘Streams’ (hard substrate habitat):

Artificial substrates (rock bags, baskets, cones) – river/stream bugs

Rock or wood scrapings – river/stream algae

‘Wetlands’ (soft substrate/macrophyte habitat):

Plant clippings and water grabs – wetland algae

D-net sweeps – wetland bugs

Wetland Sampling Habitat

Areas of emergent, floating or submerged aquatic vegetation

(≤ 1 meter deep)

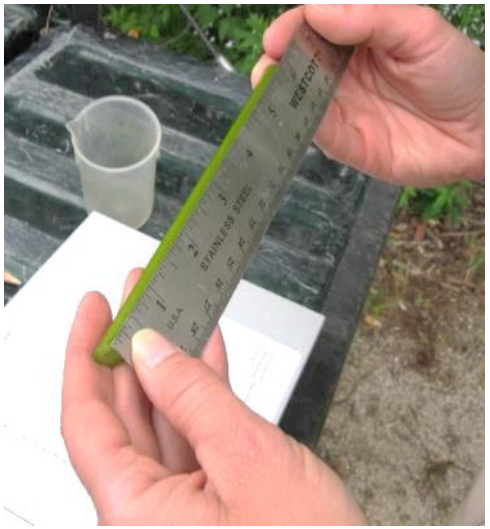
Includes shallow vegetated areas in and along slow-moving rivers and streams, ponds and lakes

Aquatic Macroinvertebrates

Three 1 meter D-net sweeps

Wetland Epiphytic Algae

Clip 5 p**lant stems at each of** 3 replicate sites,

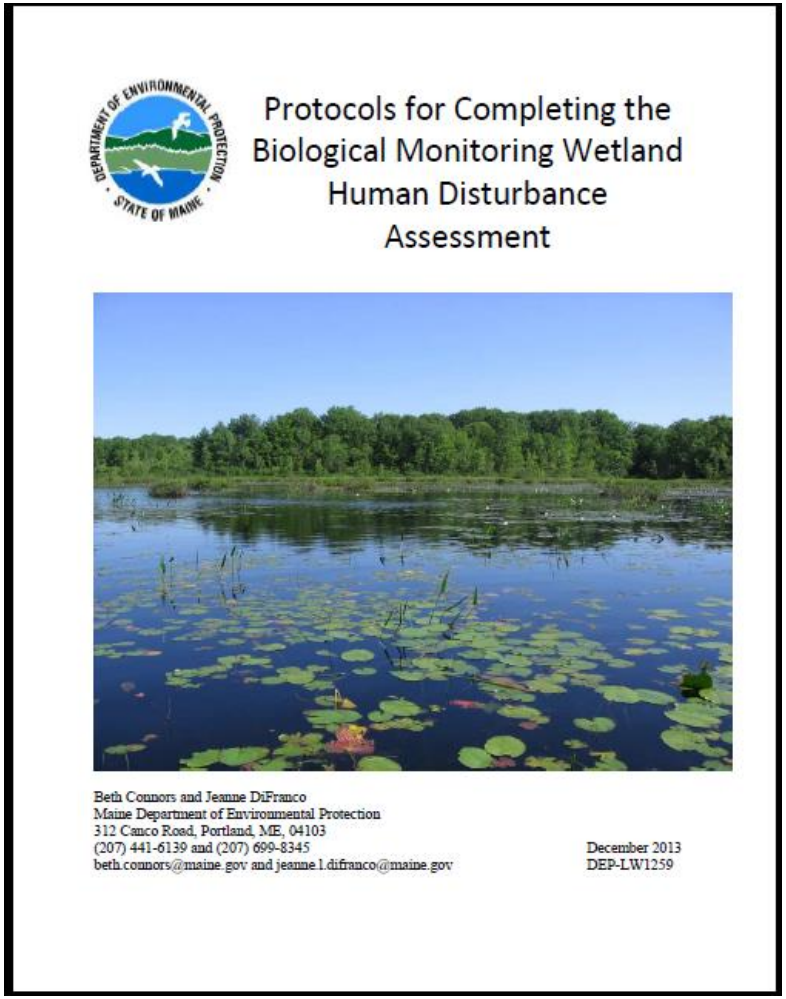


Water Quality

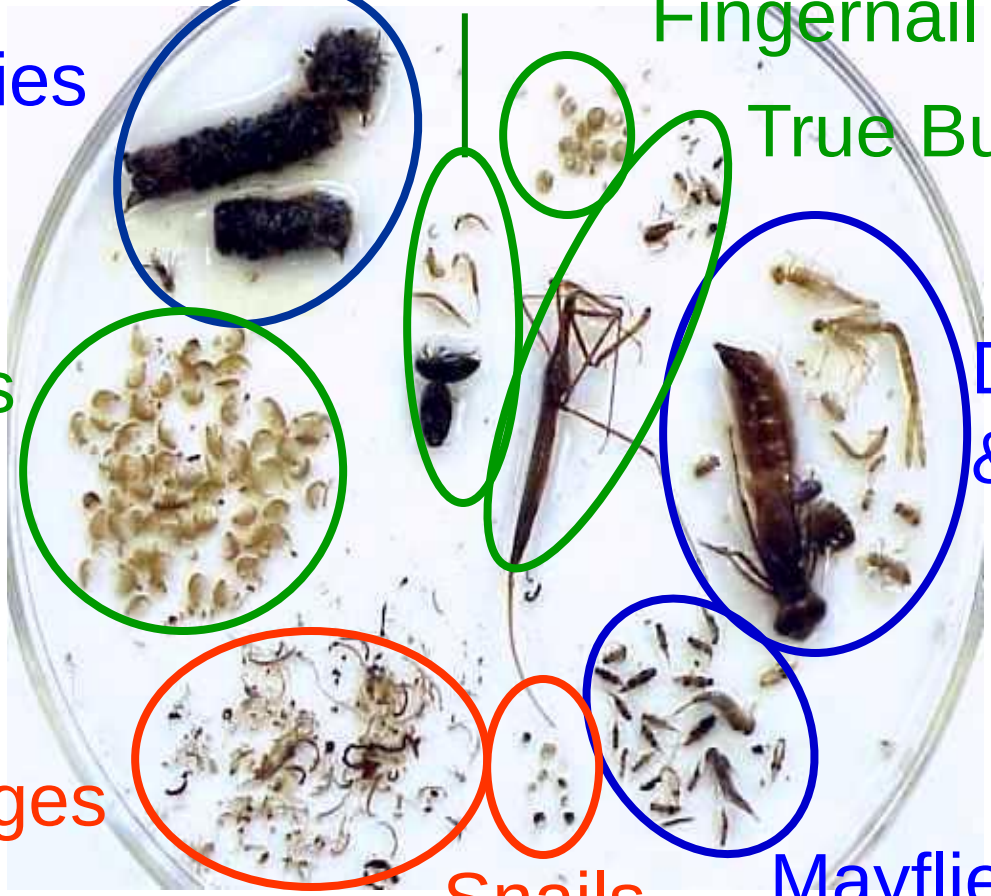
Wetland Human Disturbance Assessment

Field-based rapid stressor assessment:

- Hydrologic modifications
- Vegetative modifications
- Evidence of chemical pollutants
- Watershed characterization



Healthy wetland



Color Code
Sensitive
Intermediate
Tolerant

Unhealthy wetland

Other

Midges and Worms

Color Code
Sensitive
Intermediate
Tolerant

Predictive Statistical Models

- Help DEP biologists decide if wetlands meet narrative biological criteria
- Predict aquatic life class attained (AA/A, B, C) using biological monitoring data
- Separate models for different habitats and assembleges
  - Stream macroinvertebrates (already in Biocriteria rule)
  - Stream algae
  - Wetland macroinvertebrates
  - Wetland algae
- Model results will become numeric biological criteria once implemented in rules

Advantages of DEP's Biological Monitoring and Assessment Approach

- Focus is on integrity of biological communities compared to reference ("natural") conditions
- Standard sampling, analysis and assessment protocols produce quantitative data and objective results
- Results expressed in relation to statutory tiered criteria for assigned water quality class (AA/A, B, C)
- Class attainment results comparable among different water body types and taxa groups
- Tiered criteria allow us to detect incremental changes in resource condition, identify improving/declining trends
- Applicable to other wetland types and taxa groups

How We Use Wetland Biomonitoring Data

- Evaluate ambient condition, diagnose stressors
- Evaluate impacts from nonpoint sources, permitted activities, violations of water quality/natural resource laws
- Inform permit decisions and management strategies (discharges, water levels, habitat alterations)
- Diagnose stressors
  - Nutrients
  - Toxics
  - Hydrologic alterations

How We Use Wetland Biomonitoring Data

Evaluate restoration projects:

- Dam removals
- Mitigation sites

Sedgeunkedunk Stream (dam removal project)

Evaluate health of wetlands on public lands:

- State parks and Wildlife Management Areas
- National Wildlife Reserves
- Other conservation lands

New Dam Road (wetland mitigation site)

How We Use Wetland Biomonitoring Data

Evaluate health of wetlands on public lands:

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- National Wildlife Reserves
- Other conservation lands

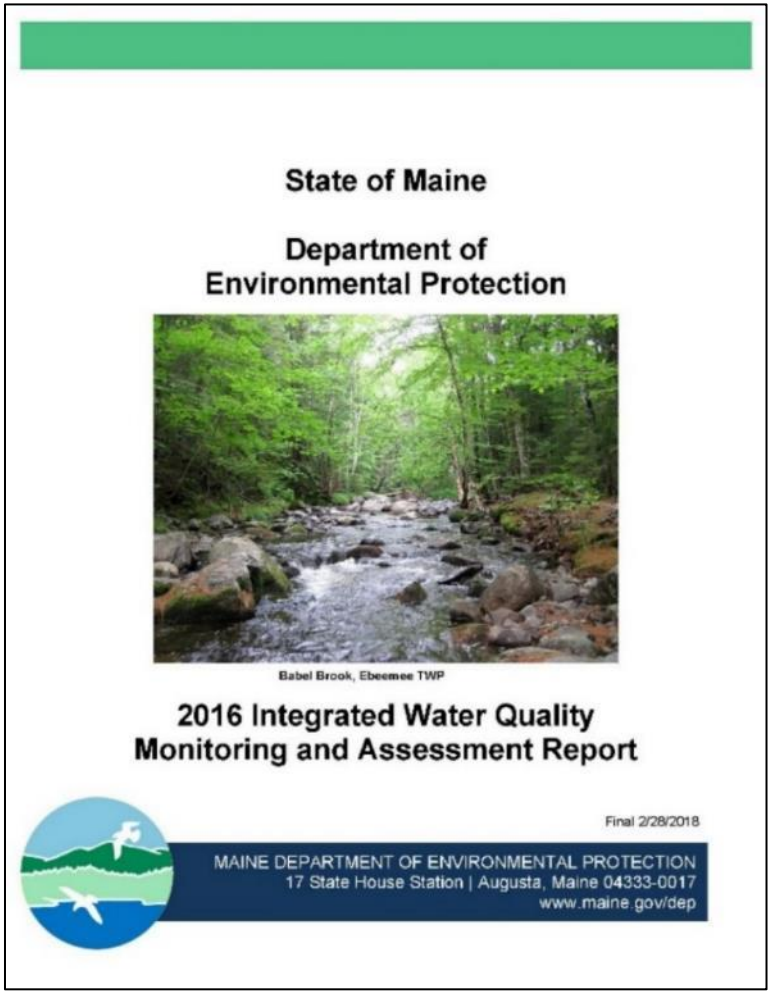
Mercer Bog Wildlife Management Area

Sunkhaze Stream National Wildlife Reserve

How We Use Wetland Biomonitoring Data

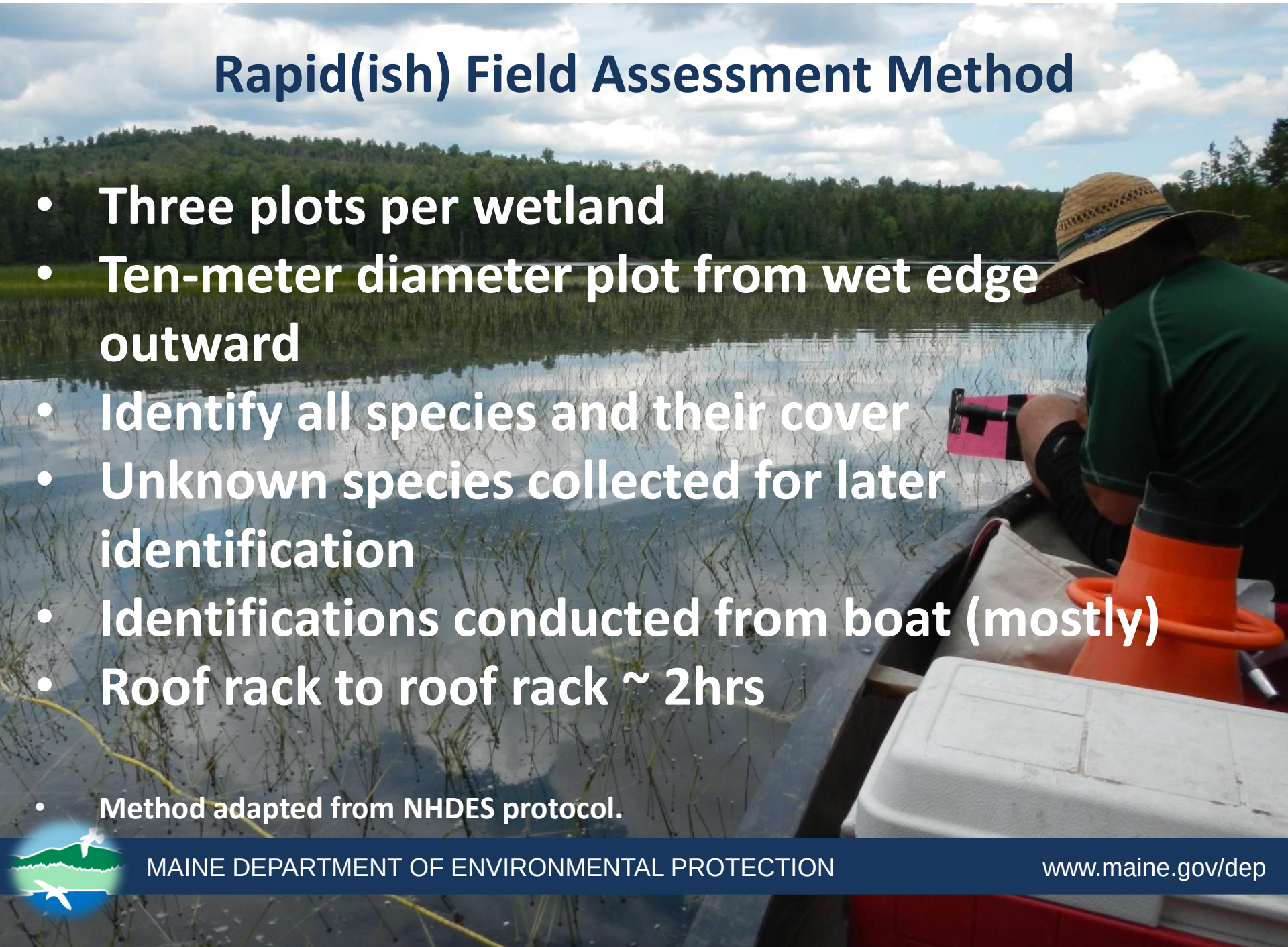
- Report to EPA on wetland condition in biannual Integrated Water Quality Monitoring and Assessment Report

- Provide data to support TMDLs



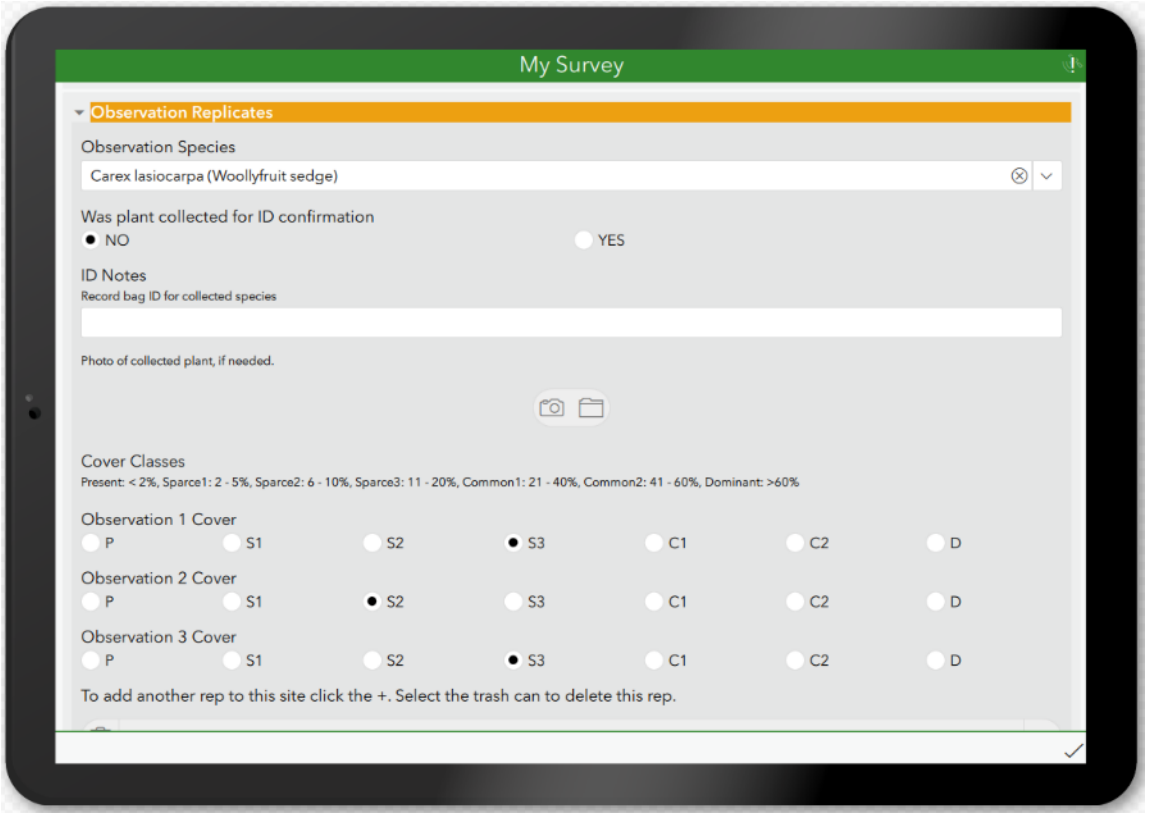
Macrophyte assessments

Rapid(ish) Field Assessment Method



- Three plots per wetland
- Ten-meter diameter plot from wet edge outward
- Identify all species and their cover
- Unknown species collected for later identification
- Identifications conducted from boat (mostly)
- Roof rack to roof rack ~ 2hrs

- Method adapted from NHDES protocol.



Data Recorded:

- Species ID.
- Percent Cover

  Classes

  Present: < 2%,
  Sparce1: 2 - 5%,
  Sparce2: 6 - 10%,
  Sparce3: 11 - 20%,
  Common1: 21 - 40%,
  Common2: 41 - 60%,
  Dominant: >60%

  midpoints used in calculations

Paired to Seasonal Wetland Monitoring Data:

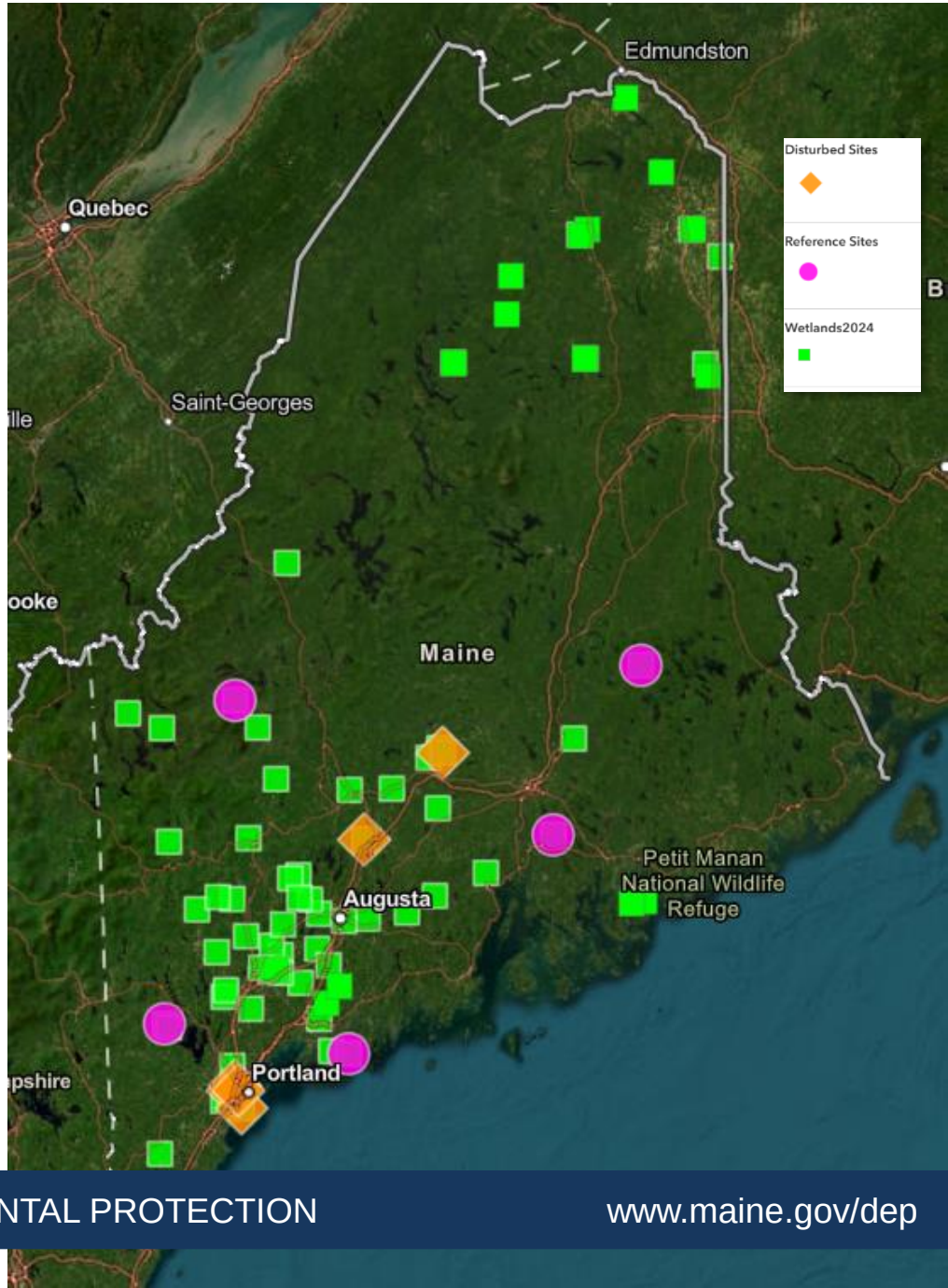
- Wetland Human Disturbance Assessment
- Water Chemistry
- Watershed Landcover Assessment

Sites 2017 – 2024

77 Sites Surveyed

5 Reference Sites

6 Highly Disturbed Sites



Reference Criteria: Biomonitoring Method

Criteria	Value
Total Wetland Human Disturbance Score (WHDS)	<= 10
Individual WHDS Scores	< 5
Total Phosphorus	< 100 ug/L
Specific Conductance	< 100 uS/cm
Watershed Percent Natural	> 95%
Sites Selected	5

Reference Sites: *Morse Pond W-348, Northwest River W-331, Hothole Brook - W-288, Stratton Brook W-169, and Passadumkeag River W-149.*

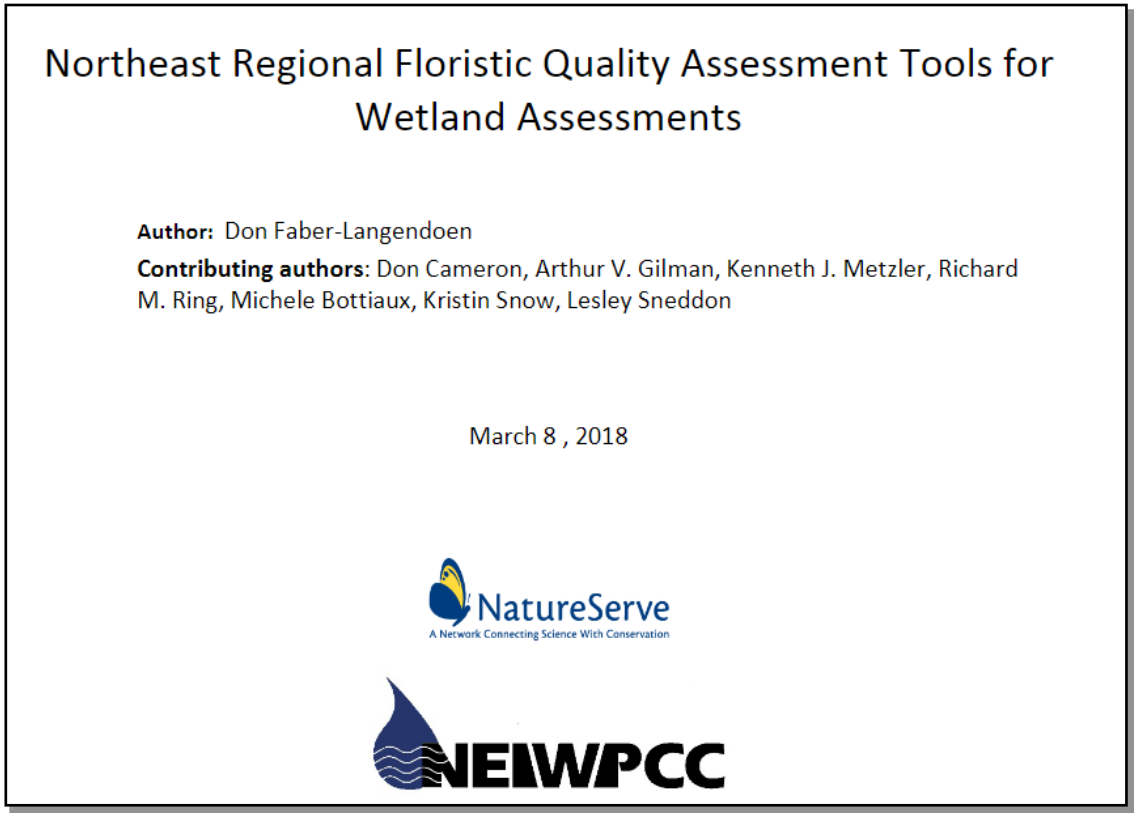
Disturbance Criteria: 90th Percentile Based

STRESSOR	Value
Total Human Disturbance Score	>= 30
Hydrologic Modification Score	>= 7
Watershed Modification Score	>= 15
Total Phosphorus (ug/L)	>= 280
Specific Conductance (uS/cm)	>= 270
Landcover metrics	
All Development	>= 15%
Tilled Agriculture	>= 1.7%
Impervious surfaces	>= 9.5%
Total Natural Area	< 70% (10th percentile)

Highly Disturbed Sites: Alder Stream W-247, Fish Brook W-243, Capisic Pond W-224, Home Depot Wetland W-182, Highland Avenue (MTA) W-174, Tributary to Nason's Brook W-173

Floristic Quality Assessment - https://universalfqa.org/

Species were assigned a Coefficient of Conservatism (C score) based upon each species tolerance to disturbance. Swink and Wilhelm, 1994



Northeast Regional Floristic Quality Assessment Tools for Wetland Assessments

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Contributing authors: Don Cameron, Arthur V. Gilman, Kenneth J. Metzler, Richard M. Ring, Michele Bottiaux, Kristin Snow, Lesley Sneddon

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Coefficient of Conservatism (C score) :

Developed shortly after the National Environmental Policy Act as a method to evaluate properties worthy of conservation.

Developed COC score for each species from 0 – 10 based on response to disturbance and fidelity to specific communities.

Low end scores are species that dominate in damaged habitat.
High scores species restricted to natural areas.

When the COC scores for plants found in an area are averaged, they give you a measure for detecting remnant populations and measuring the level of impact from human disturbance.

Remnant Populations defined as “populations with an extended persistence despite a negative growth rate”, Ericksson et al. He suggested further that “the common ability of plants to develop remnant populations is a contributing factor to ecosystem stability. Remnant populations are important for the capacity of ecosystems to cope with the present-day impact caused by human society, and their occurrence should be recognized…” Ericksson, 2008.


7
7
7
4
Mean CoC = 6.25
Floristic Quality Index = 3.125
Mean C / sqrt Richness
Mean Cover Weighted CoC = 5.4
CoC * cover / Total Cover

Metric Development: Site Metrics

ME_C_SCORE	Mean Statewide C Score
MEAN_ECOREGIONAL_C	Mean Ecoregion C Score
NATIVEC	Mean C Score for Native Species
WETNESS	Mean Wetness Coefficient for All Species
NATIVEWETNESS	For Native Species
COVERWEIGHTEDC	Sum of Each Species C Score multiplied by Cover Then Divided by Total Site Cover
NATIVECOVERWEIGHTEDC	For Native Species
RICHNESS	Number of Species
NATIVE_RICHNESS	For Native Species
COVERWEIGHTEDFQI	Cover-weighted Mean C for All Species Multiplied by Square Root of Richness
COVERWEIGHTEDNATIVEFQI	For Native Species
TOTALFQI	Mean C of All Species, Multiplied by Square Root of Richness
NATIVEFQI	For Native Species
ECOFQI	Mean Ecoregion C of All Species, Multiplied by Square Root of Richness
ADJUSTEDFQI	Mean C of Native Species Divided by 10, Multiplied by Square Root of Native Richness Divided by Richness, Multiplied by 100

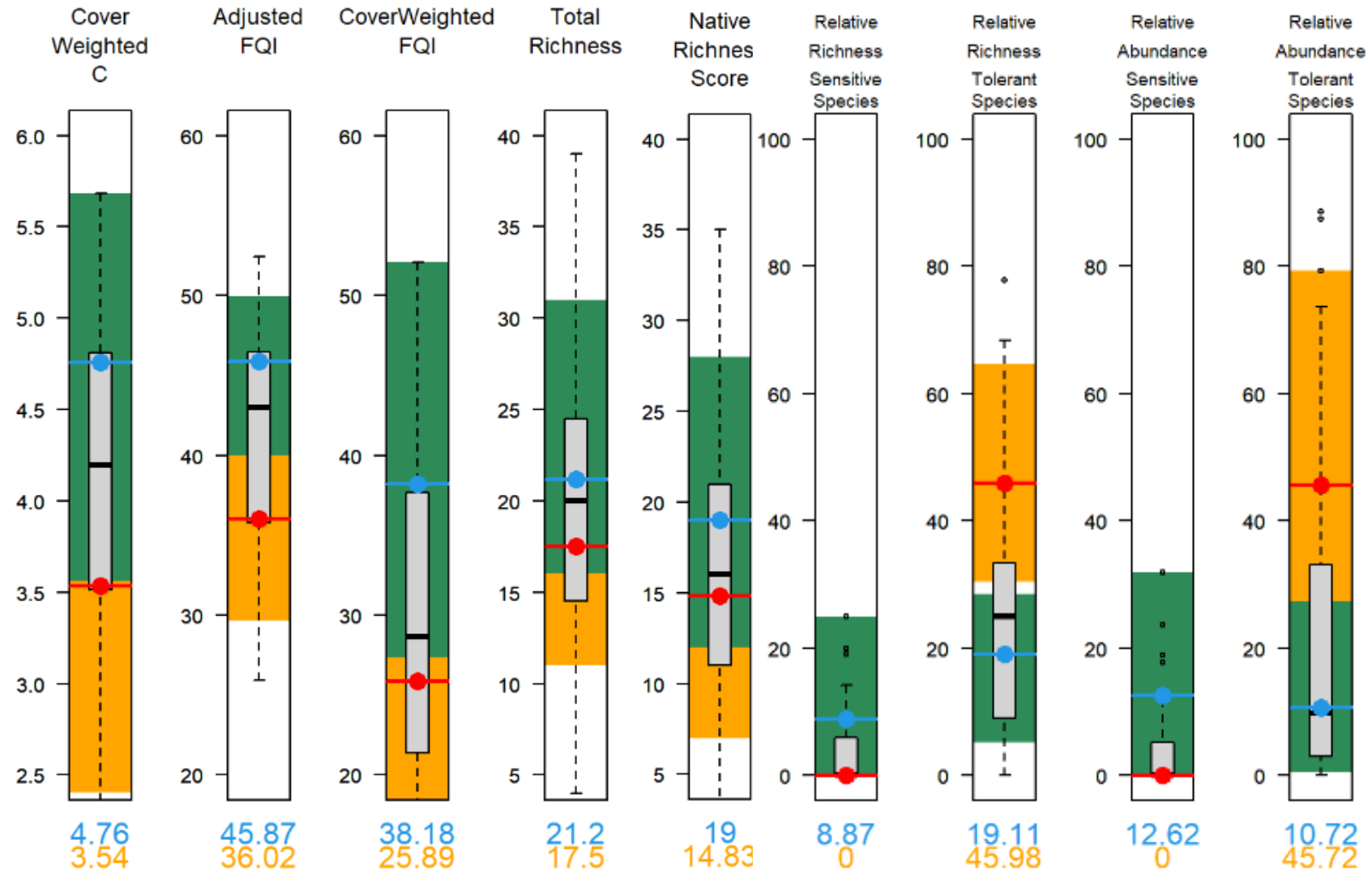
Metric Development: Trophic Metrics

Shannon Diversity Index
Relative Richness of Sensitive Species
Relative Richness of Tolerant Species
Relative Richness of Intermediate Species
Relative Abundance of Sensitive Species
Relative Abundance of Tolerant Species
Relative Abundance of Intermediate Species

Sensitive species defined as CoC > 7, Tolerant species defined as CoC < 3

Metric Testing:

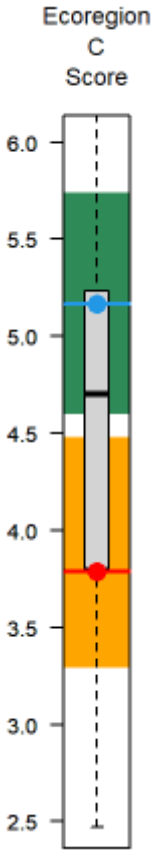
Metric Testing:



Metric Testing: Comparing ability to separate reference from disturbance

The metrics that performed best in separation of reference and disturbed sites was Mean C score

Simple comparison of means t-test and Mann-Whitney tests.



Metric	t	df	p-value	Ref Mean	Dist Mean
Mean C (ecoregion score)	4.6542	8.7581	0.001285	5.206	3.563
Adjusted FQI	5.1073	8.9517	0.0006497	49.106	38.042
FQI_ADJUSTED = 100*(NATIVE_MEAN_C / 10) * (sqrt(NATIVE_RICHNESS/RICHNESS)					
Richness	1.1397	8.47	0.2856	21.4	17.5

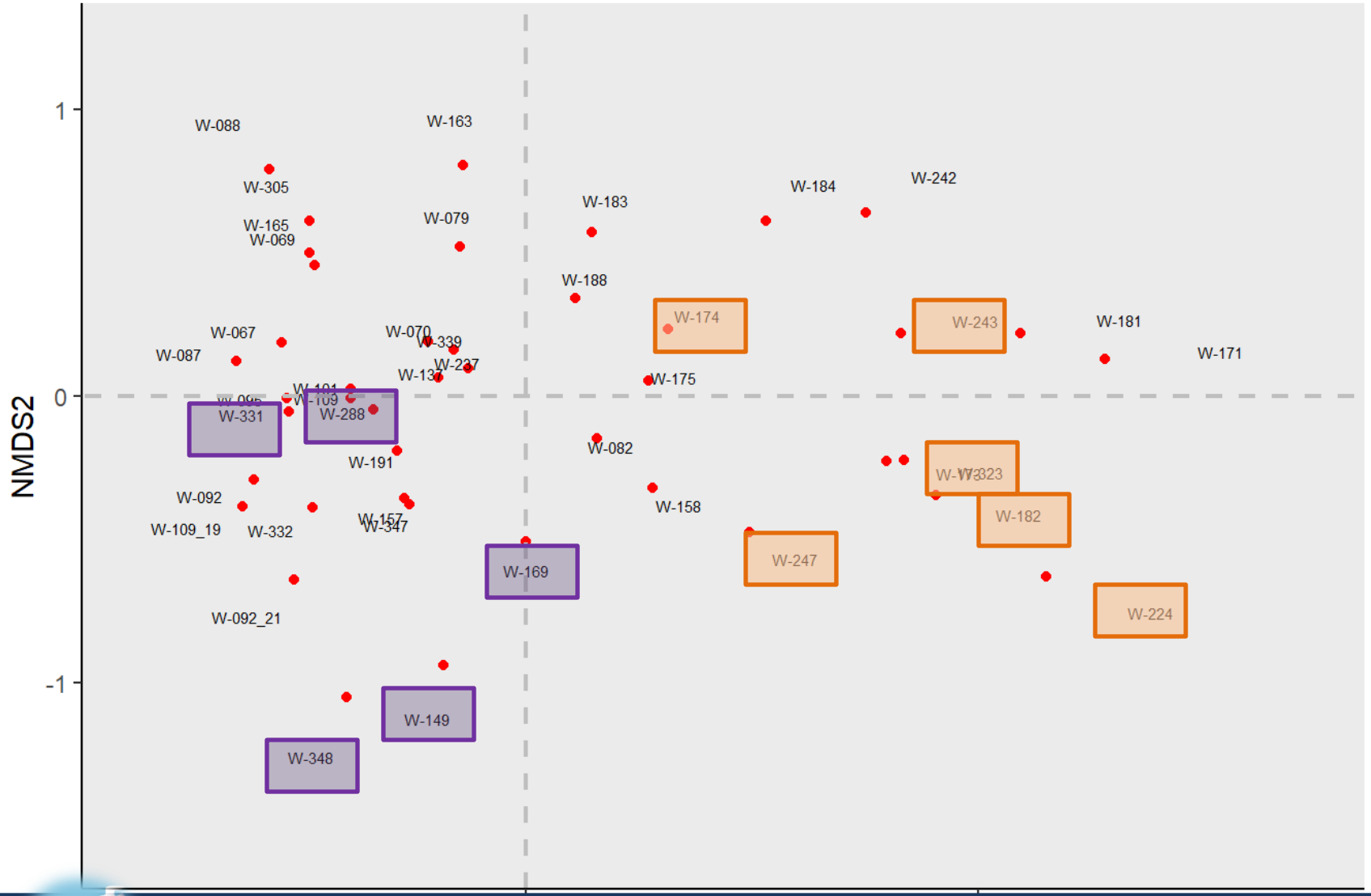
Applying CoCs: Mean Coefficient of Conservatism (Mean C)

Low scores reflect impacted communities
Trib to Long Creek W-171 CoC = 2.7
Home Depot W -182 CoC = 3.0

High scores show us our natural remnant communities.
Pearly Pond W -332 CoC = 6.0
Northwest River W-331 CoC = 5.82

Scores ranged from 2.7 to 6.0 with a mean of 4.56.
Wilhelm defined “Natural Area Quality” as Mean C > 4
And called these areas “unmitigable”.

Ordination: Community Based



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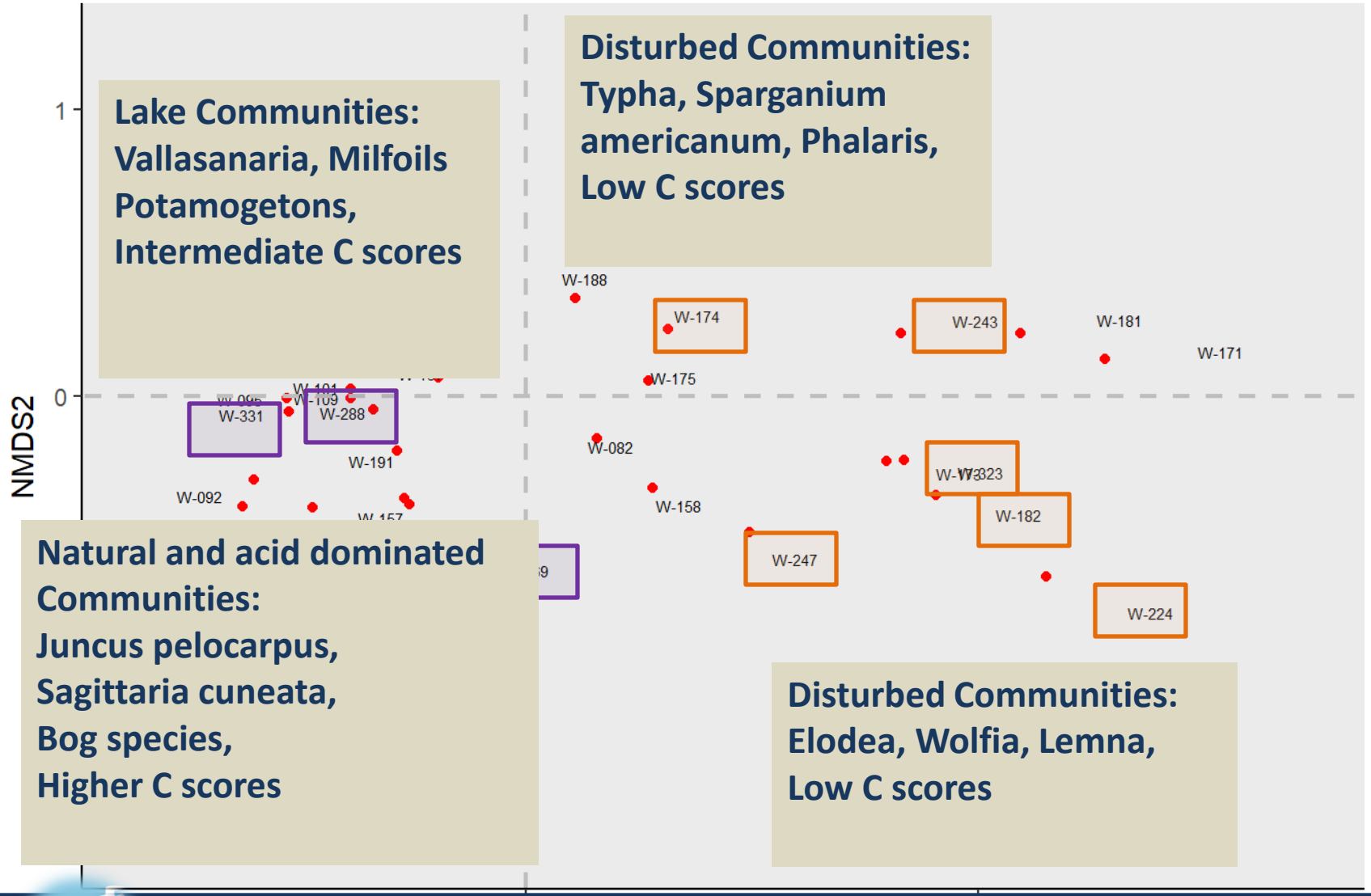
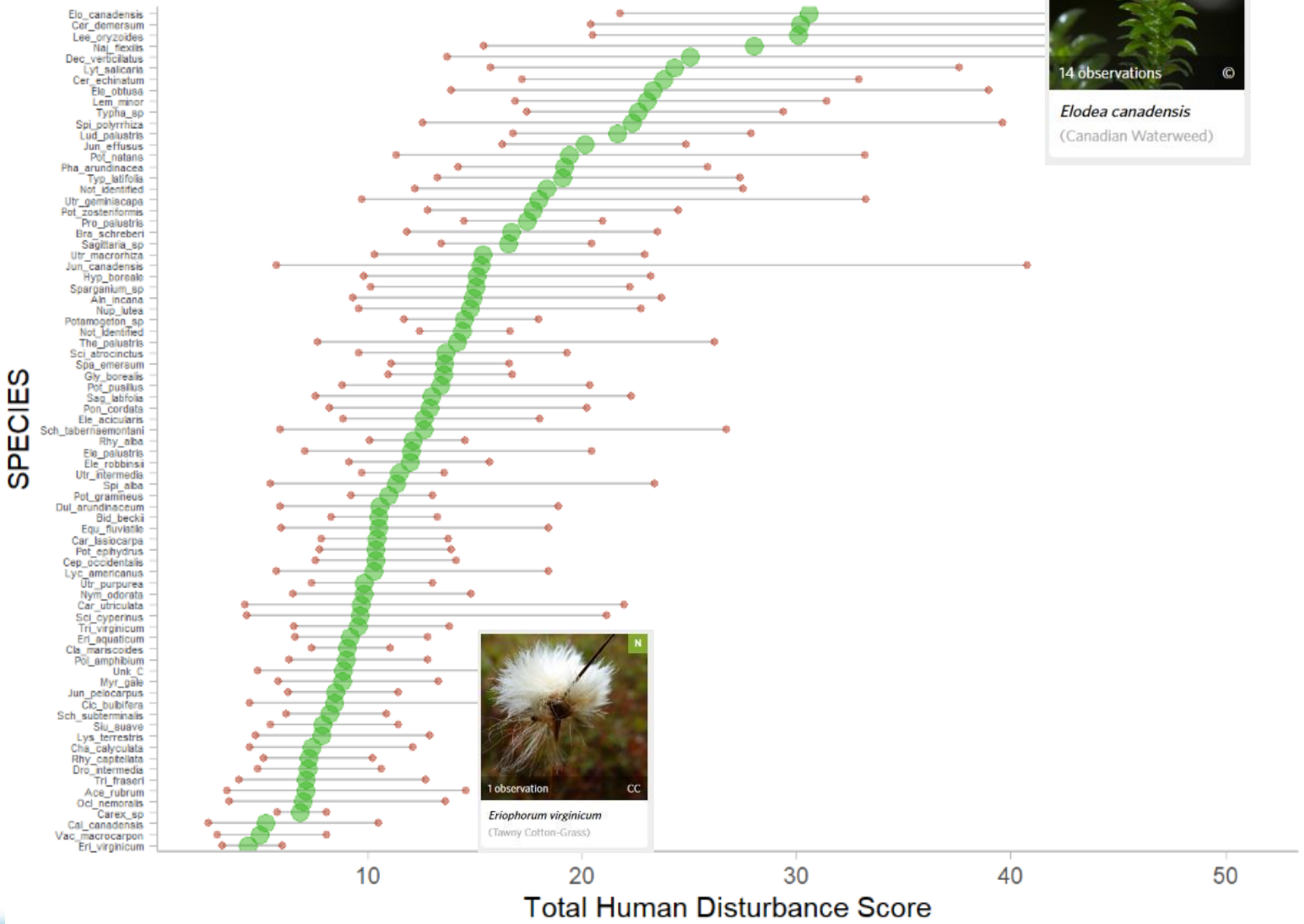


Stressors Driving Community Shifts:



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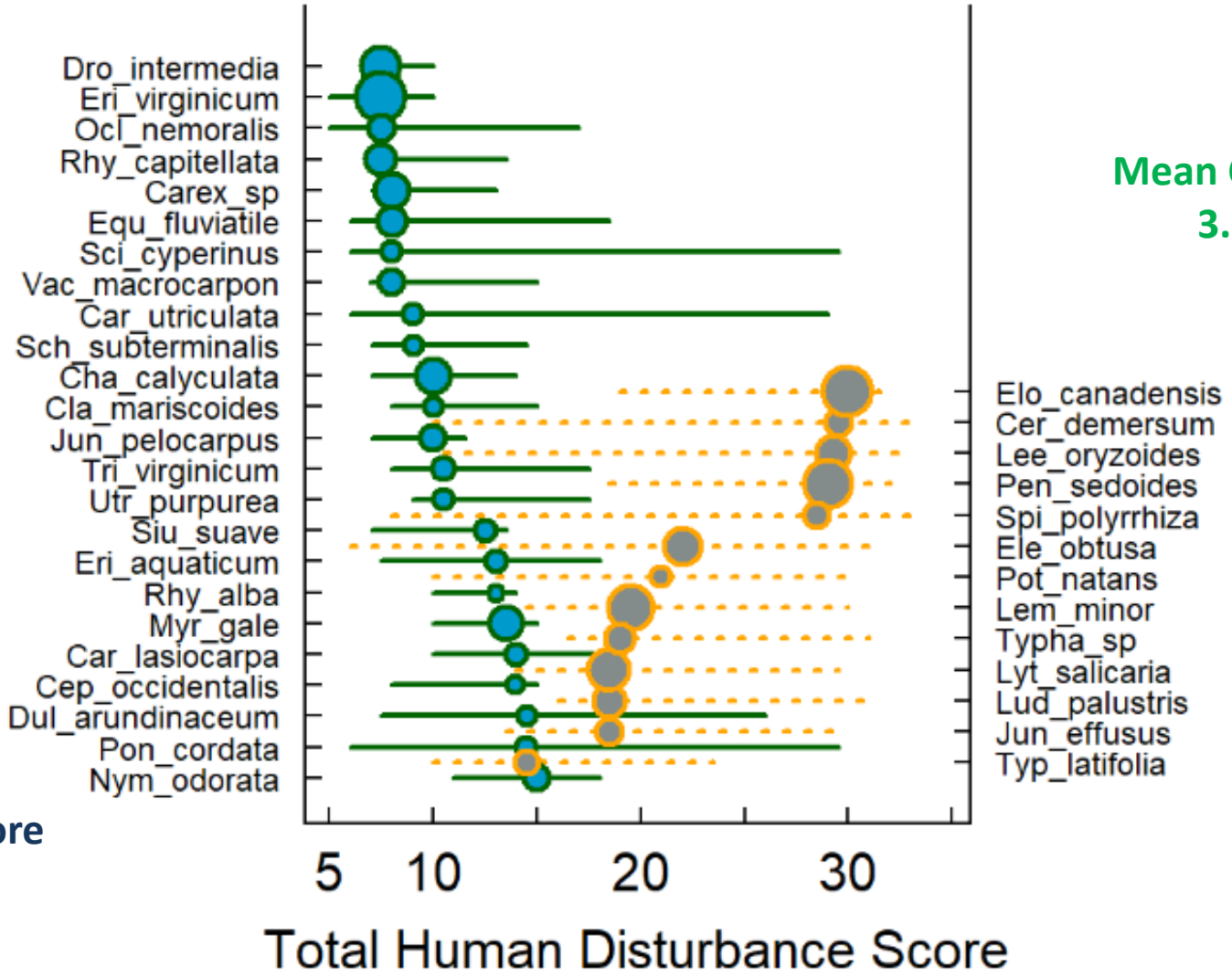
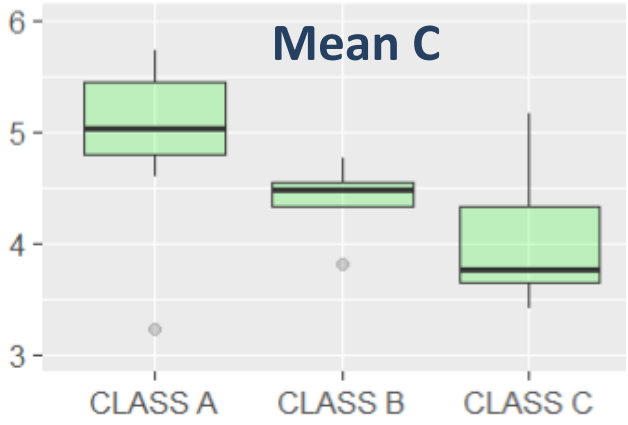


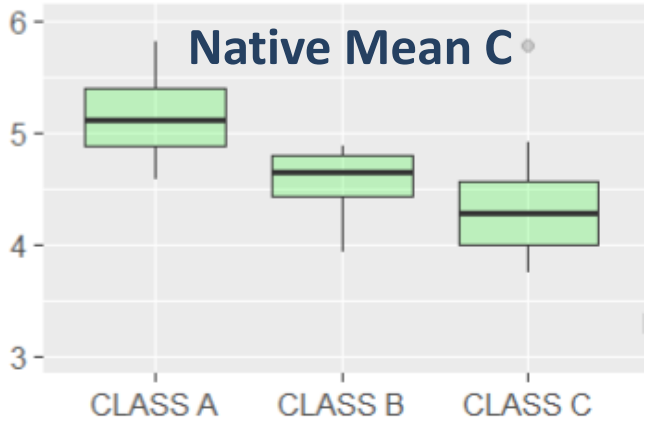
Mean C Score
3.07

Mean C Score
5.2

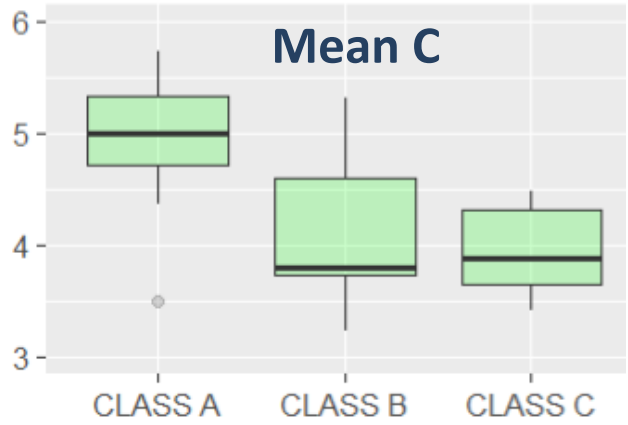
Comparison with results from other models.

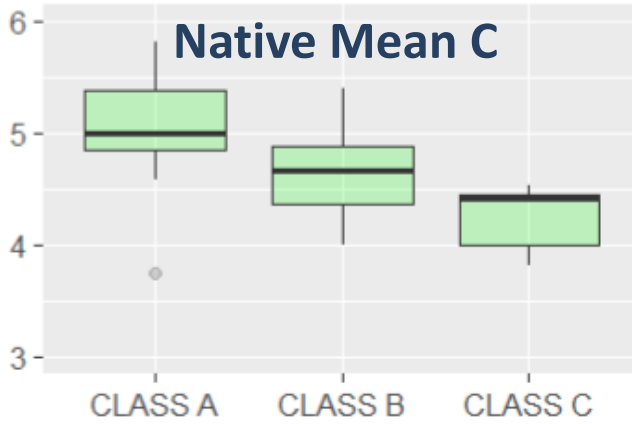
Macroinvertebrate Model Results





Epiphytic Algae Model Results





Next Steps?

Fill in data gaps: Forestry Areas, Ecoreserves etc…

Compare application across wetland types? Ordination shows possible grouping of some wetland types.

Look at application in under surveyed wetland classes.

Share methods with private and non-profit land managers. An affordable tool for the evaluation and management of wetlands.

Collaborate with neighboring states and regional efforts to compare results.

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