

Monitoring, Assessment and Tiered Aquatic Life Use Criteria for Maine Wetlands



New Hampshire Department of
Environmental Services
Wetlands Water Quality Standards
Subcommittee Meeting
October 18, 2012

Jeanne L. DiFranco
Maine Department of Environmental Protection
Biological Monitoring Program

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

Protecting Maine's Air, Land and Water

Maine DEP Biological Monitoring Program

- Resides within State water quality assessment program
- Integrated approach for rivers, streams and freshwater wetlands
- Determines if water bodies are attaining aquatic life criteria
- Provides data and technical support to other programs



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

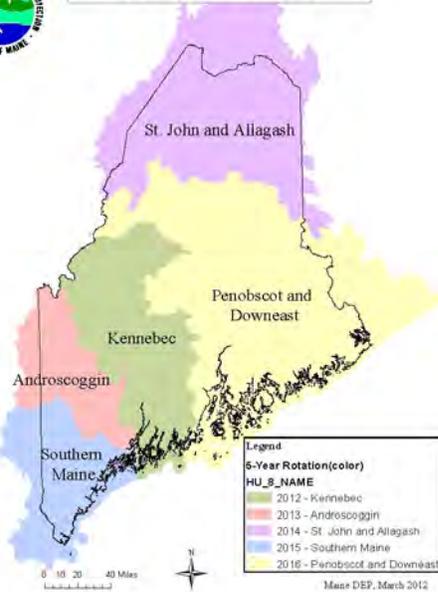
www.maine.gov/dep

Annual Monitoring

- Rotating basin schedule
- Lacustrine and riverine fringe
- Emergent and aquatic bed vegetation
- Water depth < 1 meter in area sampled



DEP Biological Monitoring Program Rotating Basin Schedule



MAINE DEPARTMENT OF
ENVIRONMENTAL PROTECTION

Aquatic Macroinvertebrates Three 1 meter D-net sweeps



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Wetland Algae

Phytoplankton and Epiphytes



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Water Chemistry



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Site Characterization



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Human Disturbance Score

(Field-based stressor assessment)



- Hydrologic modifications
- Vegetative modifications
- Evidence of chemical pollutants
- Impervious surface in watershed
- Other potential non-point sources



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Using Monitoring Results

- Monitor ambient condition, identify threats
- Develop/support biological criteria
- Inform permit decisions (discharges, hydropower, wetland/stream alterations, etc.)
- Integrated watershed assessments
- Evaluate mitigation success
- Support TMDL development
- Target conservation and restoration efforts
- Support wetland education and outreach activities

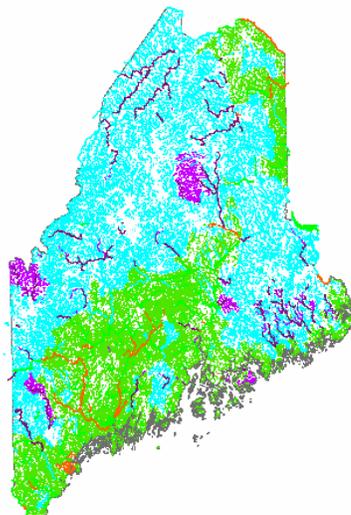


MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Maine's Water Classification Law

- State legislature established management classes (AA, A, B, & C) and goals (**designated uses**) for fresh surface waters.
- Lakes and estuarine/marine waters have separate classes (not displayed).
- Wetlands assume class of associated water body
- Each class has water quality criteria, including **aquatic life criteria** (biomonitoring program focus)



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Wetland Biocriteria Development

- Narrative biocriteria for fresh surface waters based on **tiered aquatic life goals**
- Need consistent approach to apply aquatic life criteria to wetlands (to facilitate use of data by other programs)
- Need to compare assessment results from various assemblages (invertebrates, algae), sampling methods and resource/habitat types for watershed-level assessments



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Narrative Tiered Aquatic Life Criteria

- Lakes and ponds**
- GPA** Habitat natural. Stable or decreasing trophic state free of culturally induced algal blooms.
- Other fresh surface waters (rivers, streams, wetlands)**
- AA** Habitat natural and free flowing. 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.



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Advantages of Tiered Criteria

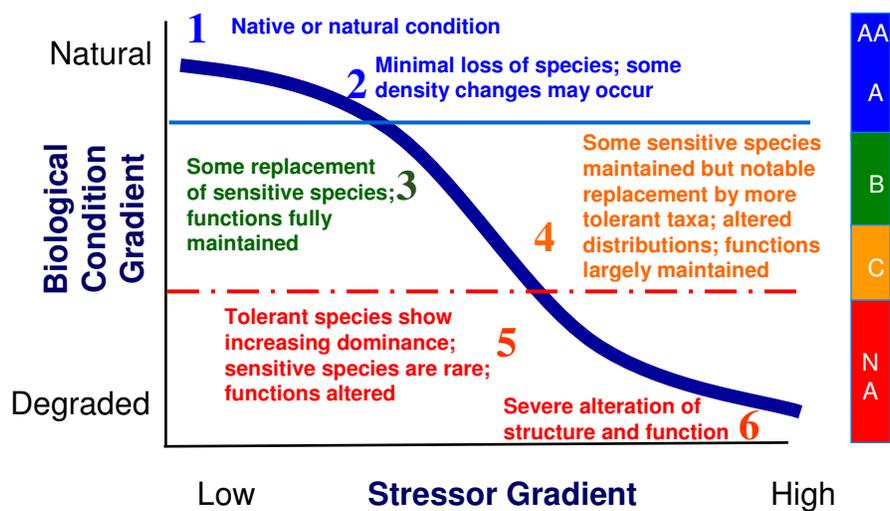
- Provide greater protection for high value resources (vs. single criterion)
- Enhance ability to detect and respond to incremental changes in biological condition



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Biological Condition Gradient (BCG) and Tiered Aquatic Life Use (TALU)



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Reference Site Criteria

51 reference sites selected using objective criteria:

- Watershed land use 95% or greater “natural” (forest or wetland)
- Total DEP Human Disturbance Score 10 or less; no single category score above 5
- Specific conductance <100 uS/cm (only 8 of 51 sites exceeded 50 uS/cm)



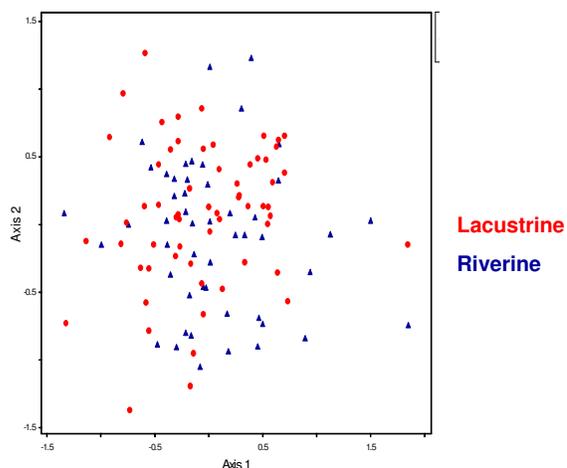
MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Reference Site Ordination

Non-metric multi-dimensional scaling (NMS, PCORD 5)

- No patterns in invertebrate communities due to wetland type detected (riverine vs. lacustrine)
- No significant patterns related to ecoregions
- Supports decision to proceed with a single model



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

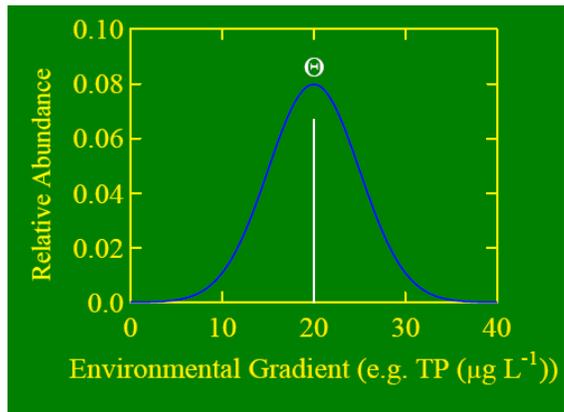
www.maine.gov/dep

Taxa Optima

Predict “preferred” environmental conditions for each taxon

Calculated weighted average taxa optima for environmental stressors (C2):

- total phosphorus
- conductivity
- human disturbance score
- % impervious surface (1000m buffer)
- % human alteration (1000m buffer)



Courtesy Jan Stevenson



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Maine Tolerance Values for Wetland Invertebrates

- Tolerance values for individual taxa calculated using species optima. Resulting tolerance values scaled from 1-100.
- Three categories determined for taxa tolerance metrics:
 - Sensitive taxa: *values* ≤ 22.0
 - Intermediate taxa: *values* $22.1 - 42.9$
 - Eurytopic taxa*: *values* ≥ 43.0

*Taxa that occur across a wide range of environmental conditions



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Sensitive Taxa Tolerance Values

Name	Group	Maine Tolerance Value	Name	Group	Maine Tolerance Value
Agrypnia	CADDISFLY	1.0	Polycentropus	CADDISFLY	15.4
Xenochironomus	FLY: MIDGE	1.5	Larsia	FLY: MIDGE	15.6
Aulodrilus	TUBIFICID WORM	3.8	Nigronia	DOBSONFLY	15.7
Neolimnochares	MITE	3.9	Oecetis	CADDISFLY	16.3
Slavina	WORM	4.2	Siphonurus	MAYFLY	17.0
Sisyra	SISYRID	5.8	Crangonyx	AMPHIPOD	17.2
Zavrelimyia	FLY: MIDGE	6.4	Lauterborniella	FLY: MIDGE	17.4
Cryptotendipes	FLY: MIDGE	7.1	Hygrotus	BEETLE	17.6
Petrophila	MOTH	7.9	Alluaudomyia	FLY: BITING MIDGE	18.0
Boyeria	DRAGONFLY/DAMSEFLY	8.0	Stylaria	WORM	18.0
Tribelos	FLY: MIDGE	9.3	Labrundinia	FLY: MIDGE	18.1
Dubiraphia	BEETLE	10.4	Mystacides	CADDISFLY	18.2
Limnochares	MITE	10.5	Coenagrion	DRAGONFLY/DAMSEFLY	18.5
Neureclipsis	CADDISFLY	10.5	Amnicola	SNAIL	18.7
Parakiefferiella	FLY: MIDGE	10.9	Cloeon	MAYFLY	19.1
Nilothauma	FLY: MIDGE	11.0	Trienodes	CADDISFLY	19.3
Nehalennia	DRAGONFLY/DAMSEFLY	11.3	Guttipelopia	FLY: MIDGE	19.4
Pagastiella	FLY: MIDGE	11.8	Arthroplea	MAYFLY	19.5
Gyrinus	BEETLE	11.9	Omisus	FLY: MIDGE	20.7
Culex	FLY: MOSQUITO	12.1	Chrysops	FLY: HORSE AND DEER	20.7
Vejdovskyella	WORM	13.7	Paratendipes	FLY: MIDGE	20.8
Nanocladius	FLY: MIDGE	14.1	Scirtes	BEETLE	20.9
Ischnura	DRAGONFLY/DAMSEFLY	14.6	Procloeon	MAYFLY	21.0
Hydrodroma	MITE	14.8	Zavrelliella	FLY: MIDGE	21.8
Banksiola	CADDISFLY	14.9	Orthocladius	FLY: MIDGE	22.0
Libellula	DRAGONFLY/DAMSEFLY	15.0	Oxyethira	CADDISFLY	22.0
			Psectrocladius	FLY: MIDGE	22.0

Intermediate Taxa Tolerance Values	Name	Group	Maine Tolerance Value	Name	Group	Maine Tolerance Value
	Caenis	MAYFLY		22.1	Baetis	MAYFLY
Cladotanytarsus	FLY: MIDGE		22.2	Clinotanypus	FLY: MIDGE	30.3
Microtendipes	FLY: MIDGE		22.3	Dasyhelea	FLY: BITING MIDGE	30.6
Eylais	MITE		23.0	Stenelmis	BEETLE	30.7
Eurylophella	MAYFLY		23.2	Hydrachna	MITE	30.8
Dineutus	BEETLE		23.2	Cryptochironomus	FLY: MIDGE	31.3
Ablabesmyia	FLY: MIDGE		23.6	Coptotomus	BEETLE	32.0
Arrenurus	MITE		23.8	Lestes	DRAGONFLY/DAMSEFLY	32.6
Ceraclaea	CADDISFLY		23.9	Valvata	SNAIL	33.4
Polypedilum	FLY: MIDGE		24.2	Promenetus	SNAIL	33.4
Hyatella	AMPHIPOD		24.5	Tanytus	FLY: MIDGE	33.5
Limnephilus	CADDISFLY		24.6	Physella	SNAIL	34.0
Thienemanniella	FLY: MIDGE		24.7	Chauliodes	DOBSONFLY	34.4
Leucorrhinia	DRAGONFLY/DAMSEFLY		24.7	Agabus	BEETLE	34.5
Pelocoris	TRUE BUG		24.7	Lumbriculus	WORM	35.0
Unionicola	MITE		24.8	Neoplea	TRUE BUG	35.5
Sphaerium	MUSSEL/CLAM		24.8	Stempellinella	FLY: MIDGE	35.7
Musculium	MUSSEL/CLAM		24.8	Erpobdella	LEECH	36.4
Chaoborus	FLY: PHANTOM MIDGE		25.0	Limnesia	MITE	37.0
Procladius	FLY: MIDGE		25.1	Sympetrum	DRAGONFLY/DAMSEFLY	37.0
Donacia	BEETLE		25.1	Rhyncholimnochares	MITE	37.1
Dixella	FLY: DIXID MIDGE		25.4	Pachydiplax	DRAGONFLY/DAMSEFLY	37.1
Tanytarsus	FLY: MIDGE		25.7	Gyraulus	SNAIL	37.2
Hydryphantes	MITE		25.8	Dero	WORM	37.9
Enallagma	DRAGONFLY/DAMSEFLY		26.2	Corynoneura	FLY: MIDGE	40.1
Limnophyes	FLY: MIDGE		26.5	Gammarus	AMPHIPOD	40.3
Ferrissia	SNAIL		26.7	Callibaetis	MAYFLY	40.5
Bezzia/palpomyia	FLY: BITING MIDGE		26.9	Ilybius	BEETLE	40.7
Piona	MITE		27.2	Neurocordulia	DRAGONFLY/DAMSEFLY	41.3
Graphoderus	BEETLE		27.4	Belostoma	TRUE BUG	41.7
Chironomus	FLY: MIDGE		27.4	Culicoides	FLY: BITING MIDGE	42.1
Cladopelma	FLY: MIDGE		27.9	Mansonia	FLY: MOSQUITO	42.2
Aeshna	DRAGONFLY/DAMSEFLY		27.9	Ranatra	TRUE BUG	42.3
Parachironomus	FLY: MIDGE		28.6	Stagnicola	SNAIL	42.8
Probezzia	FLY: BITING MIDGE		28.6	Helisoma	SNAIL	42.8
Dicrotendipes	FLY: MIDGE		28.8	Hydroporus	BEETLE	42.9
Paramerina	FLY: MIDGE		29.3	Matus	BEETLE	42.9

Eurytopic Taxa Tolerance Values

Name	Group	Maine Tolerance Value	Name	Group	Maine Tolerance Value
Anopheles	FLY: MOSQUITO	43.0	Monopelopia	FLY: MIDGE	60.4
Cricotopus	FLY: MIDGE	43.0	Mesovelgia	TRUE BUG	60.6
Glyptotendipes	FLY: MIDGE	43.0	Rheotanytarsus	FLY: MIDGE	61.6
Helobdella	LEECH	43.0	Tropisternus	BEETLE	61.8
Nais	WORM	43.0	Deronectes	BEETLE	63.4
Paratanytarsus	FLY: MIDGE	43.0	Laccophilus	BEETLE	63.7
Natarsia	FLY: MIDGE	43.6	Haliplus	BEETLE	67.1
Phylocentropus	CADDISFLY	43.8	Ceratopogon	FLY: BITING MIDGE	71.5
Phaenopsectra	FLY: MIDGE	44.2	Acricotopus	FLY: MIDGE	75.0
Pseudochironomus	FLY: MIDGE	47.7	Einfeldia	FLY: MIDGE	76.1
Ancyronyx	BEETLE	49.2	Lymnaea	SNAIL	83.3
Endochironomus	FLY: MIDGE	50.2	Limnodrilus	TUBIFICID WORM	83.9
Caecidotea	ISOPOD	51.9	Haemonais	WORM	86.1
Pseudocloeon	MAYFLY	52.8	Berosus	BEETLE	87.9
Tipula	FLY: CRANE	53.8	Cipangopaludina	SNAIL	88.2
Glossiphonia	LEECH	55.3	Hydrophilus	BEETLE	94.0
Fossaria	SNAIL	56.1	Odontomyia	FLY: AQUATIC SOLDIER	94.2
Peltodytes	BEETLE	56.2	Psectrotanypus	FLY: MIDGE	95.6
Hydaticus	BEETLE	56.9	Micropsectra	FLY: MIDGE	98.1

Maine Tolerance Index (MTI) for Wetland Invertebrates

- Weighted average community level biotic index
- Similar to Hillsenhoff Biotic Index used for stream assessments
- Based on data from Maine wetlands



Environmental Inference Models

- Constructed models to infer site-specific environmental stressor values for:
 - conductivity
 - total phosphorus
 - % impervious surface
 - % human alteration
 - DEP human disturbance score
- Help diagnose stressors and determine relative importance of multiple stressors

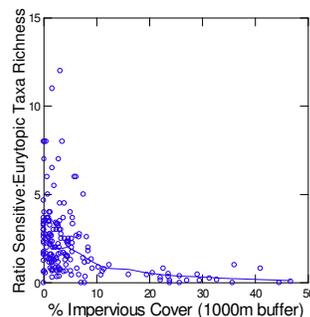
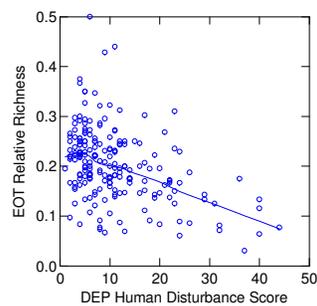


MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Metric and Threshold Development

Tested over 100 biological attributes for predictable response to disturbance gradient



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

A Priori Class and BCG Tier Determinations

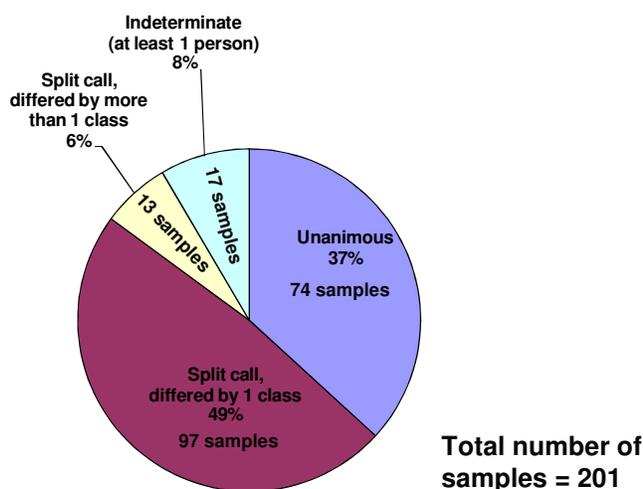
- DEP biologists assigned Maine water quality class attainment (A, B, C, NA) and BCG tiers for 201 macroinvertebrate samples
- Initial calls done “blind” by individual team members using only biological data (site names, physical/chemical data not revealed)
- Narrative aquatic life use criteria, invertebrate metrics, taxa tolerance values, inference models and BCG used to inform *a priori* class determinations (biologists’ calls)
- Compiled results for each team member and resolved differences by consensus



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Summary of DEP Biologists Agreement on Individual Class Attainment Calls



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Class Attainment Predictive Model

- Linear Discriminant Model to predict aquatic life use attainment of new macroinvertebrate samples
- Expert judgment incorporated via biologists' initial determinations (used in model building)
- LDM model will serve as basis for wetland-specific numeric biocriteria



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Wetland Macroinvertebrate Provisional Linear Discriminant Model Variables

Total abundance
Ephemeroptera abundance
Odonate relative abundance
Trichoptera relative abundance
Shredder taxa relative abundance
Non-insect relative richness
Sensitive taxa abundance
Sensitive taxa relative abundance
Sensitive taxa richness
Intermediate taxa relative abundance
Intermediate taxa richness
Ratio of sensitive to eurytopic taxa abundance



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

LDM Model Class Predictions Agreement with DEP Biologists' Determinations

(Number of samples; Values in red indicate samples misclassified by model)

	A	B	C	NA	Total in Class: Biologist Calls	Percent Correctly Classified by Model
A	64 agree	4	0	0	68	94%
B	3	27 agree	1	0	31	87%
C	0	3	24 agree	0	27	89%
NA	0	0	1	9 agree	10	90%
						91% Total

Jackknife re-sampling results: 85% of samples correctly classified (SYSTAT version 13)

In most cases, misclassified sites were borderline calls based on biologists' expert judgment



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

BPJ Adjustments Allowed

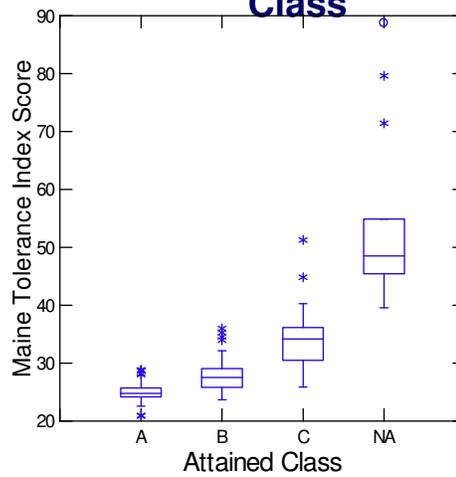
- Atypical habitat or site conditions
- Sample does not meet model criteria (total mean abundance ≥ 50 , total generic richness ≥ 15)
- If model class probability < 0.6 and > 0.4 , may raise or lower the class with compelling evidence



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

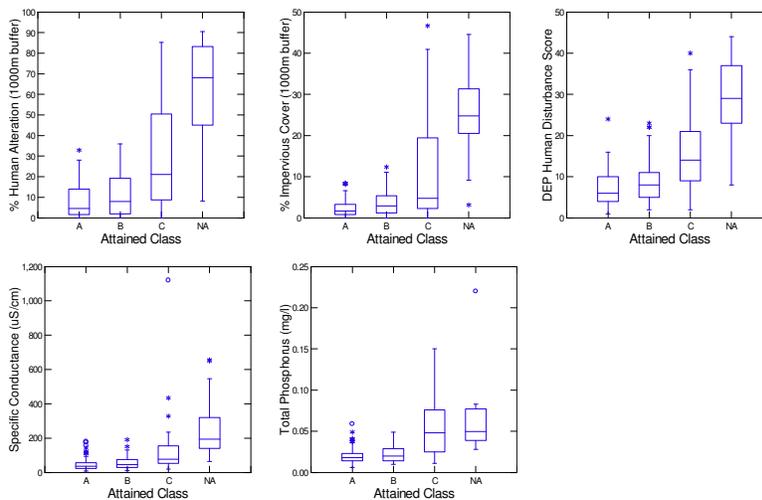
Maine Tolerance Index: Macroinvertebrate Community Values in Relation to Attained Class



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

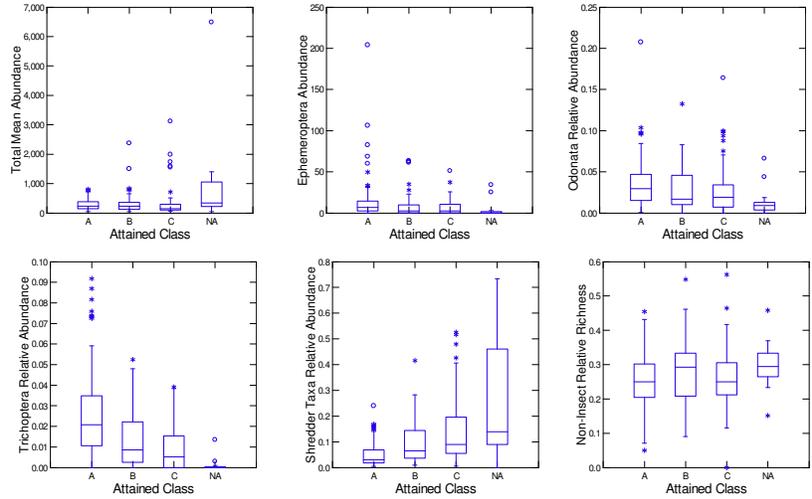
Environmental Stressor Indicators in Relation to Attained Class



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

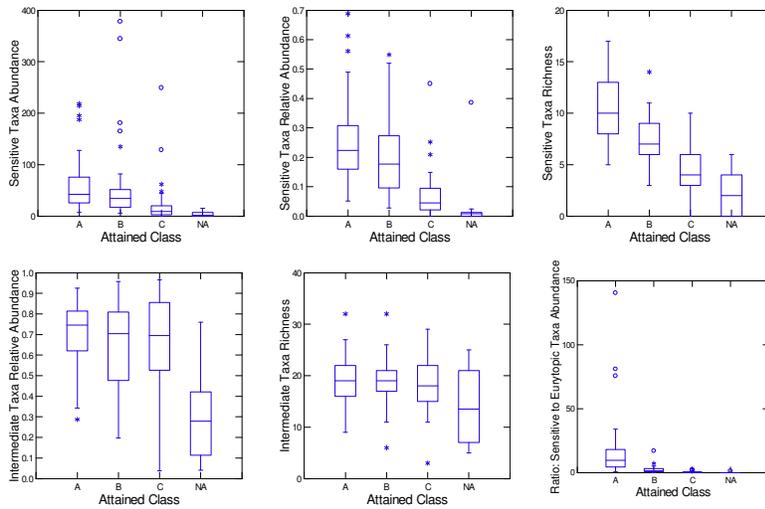
Model Variables in Relation to Attained Class



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Model Variables in Relation to Attained Class



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

Next Steps

- Test provisional macroinvertebrate model as new data are collected and refine if necessary
- Incorporate model into rules as wetland-specific aquatic life use criteria
- Complete analysis of wetland algae data and begin algae model development
- Pilot monitoring and assessment projects for other biological assemblages and wetland types (including forested wetlands)



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

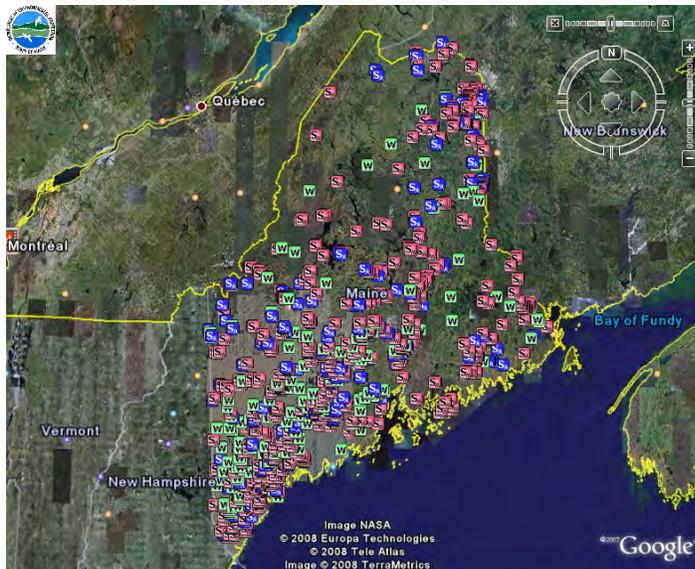
www.maine.gov/dep

Google Earth Biomonitoring Site

Site Locations
(wetlands,
rivers and
streams)

Physical,
chemical and
biological data

Photos and
reports



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

For more information...

**Visit the Maine DEP Biological
Monitoring Program web site at:**

**[www.maine.gov/dep/water/monitoring/
biomonitoring](http://www.maine.gov/dep/water/monitoring/biomonitoring)**



MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

www.maine.gov/dep

