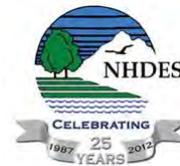
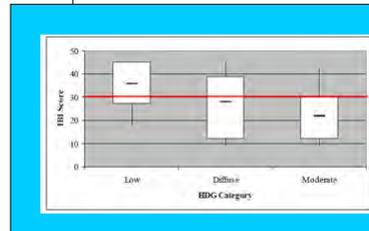


Biological Index Development: Start to Finish



What is a biological index?

A simple and informative representation of the condition of the biological community.

A biological index summarizes results of the numbers, types, and condition of organisms in a particular environmental setting (streams, lake, wetlands).

Indices can reported narratively or numerically.

Index outcomes are compared a “thresholds” to determine the overall health of a biological community.

Why use biological indices?

Types and numbers of invertebrates

Order:	Family:	Final ID:	Individ.:
MEGALOPTER	CORYDALIDAE	Nigronia	4
PLECOPTERA	PERLIDAE	Acronuria	12
PLECOPTERA	TAENIOPTERYGIDAE	Taeniopteryx	212
EPHEMEROPT	HEPTAGENIIDAE	Stenonema	56
EPHEMEROPT	HEPTAGENIIDAE	Stenacron	4
EPHEMEROPT	EPHEMERELLIDAE	Serratella	120
TRICHOPTERA	RHYACOPHILIDAE	Rhyacophila	4
TRICHOPTERA	POLYCENTROPIDAE	Polycentropus	16
BASOMMATOP	PHYSIDAE	Physidae	4
TRICHOPTERA	POLYCENTROPIDAE	Nyctiophylax	4
TRICHOPTERA	POLYCENTROPIDAE	Neureclipsis	12
TRICHOPTERA	HELICOPSYCHIDAE	Helicopsyche	24
ODONATA	AESHNIDAE	Bayeria	4
TRICHOPTERA	HYDROPSYCHIDAE	Cheumatopsyche	280
DIPTERA	CHIRONOMIDAE	Chironomidae	572
TRICHOPTERA	LEPTOCERIDAE	Oecetis	4
ODONATA	GOMPHIDAE	Gomphidae	4
TRICHOPTERA	LEPTOCERIDAE	Mystadodes	8

Condition based on direct evaluation ?

Biological indices are:

- a means of communicating overall condition
- comprised of the most responsive multiple measures of community "health"
- a direct measure of ecological structure and function of biological communities
- a reflection of the impact by env. stressors over time

Condition based on biological index

75 points out of 100;
threshold = 65

Biological indices are used to interpret narrative criteria

NH DES Administrative Rule Env-Wq 1700 – water quality criteria

Env-Wq 1703.19 Biological and Aquatic Community Integrity.

(a) The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(b) Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Biologic index – the measures of condition

Bio-criteria – the threshold which the measures of condition are compared against

Based on outcomes, biological community is assessed as meeting or not meeting criteria (impairment determination)

Status of biological indices and associated criteria for NH waterbodies

Stream and Rivers:

Wadeable streams only (1 - 4th order) - fish (coldwater, transitional water), macroinvertebrates

Lakes:

None at this point, small pilot project this summer using macroinvertebrates

Wetlands:

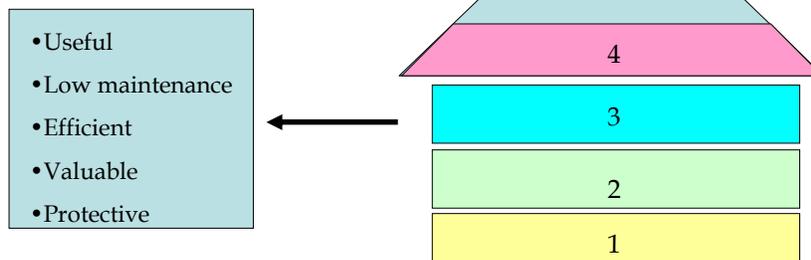
None at this point, testing rapid field protocols

For today, focus is on coldwater and transitional water fish assemblage indices

Anatomy of a biological index: The multi-metric approach

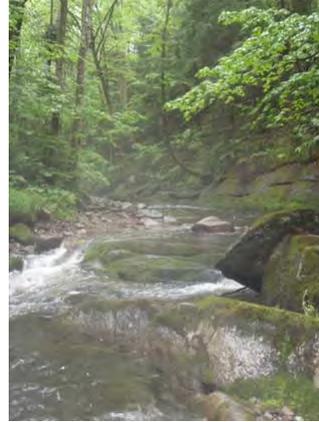
- 1) Identification of "reference" locations - baseline for building foundation of index
- 2) Classification system - a way to reduce natural variability community composition that is attributable to environmental differences
- 3) Identification of metrics most responsive to disturbance
- 4) Development of scoring system
- 5) Selection of "threshold"
- 6) Validation testing

A well constructed index is:



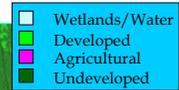
Reference Condition = Minimally Disturbed

- Serves as cornerstone for documenting “natural” biological condition
- Must represent range of all community “types” (warm vs. cold water)
- Selected based on abiotic factors (i.e. level of development)
- Cannot account for regional or historic impacts; best available current condition



Defining the Reference Condition

Quantitative
Evaluation



Visual
Verification



Example:

Coldwater Fish Index – Human Disturbance Gradient

APPENDIX A. Human disturbance gradient (HDG) variables, associated scoring criteria, and applicable spatial scale.

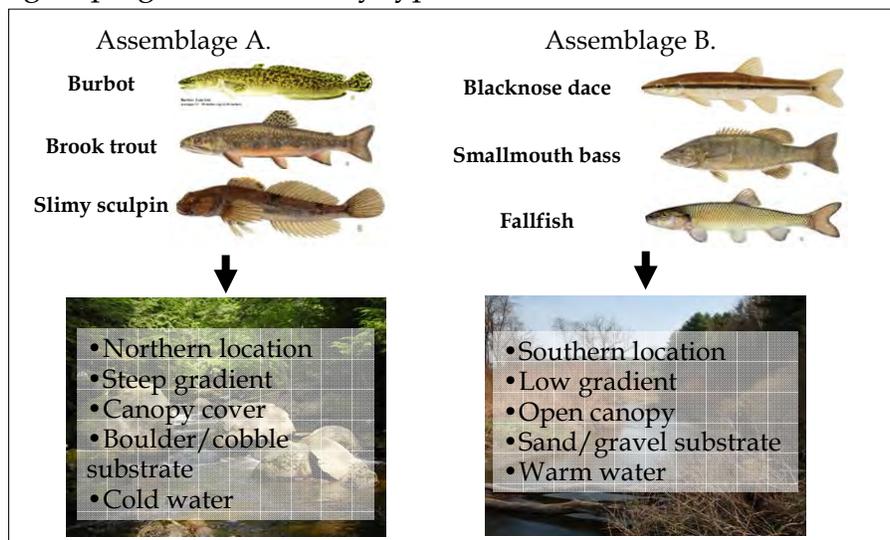
Variable	Category (density) ²	Score	Assessment Scale ⁴	
			Biomon shed	1-mile radius
GWHI	0	0		
	-2	1		x
	-5	2		
RCRA	-2	0		
	-5	1		x
	-7	2		
Aukyards	0	0		
	-1	1		x
	-3	2		
# dams	0	0		
	Y = 10 acres	1		x
	Y = 50 acres	2		
# waterways	0	0		
	-1	1		x
	-3	2		
NPDES	0	0		
	-1	1		x
	-2	2		
Road Density	-2	0		
	-1	1		x
	-4	2		
Impounde ²	0	0		
	-02	1	x	
	-05	2		
NHLC Developed (%) ²	-2	0		
	-4	1		x
	-8	2		
NHLC Ag (%) ²	-4	0		
	-8	1		x
	-8	2		

10 variables –
cumulative score ≤ 3
satisfies minimal
impact

Identification of 27
reference sites (also
ID impacted sites)

Serves as basis for
establishing “expected
condition” - types and
relative abundances
absent disturbance

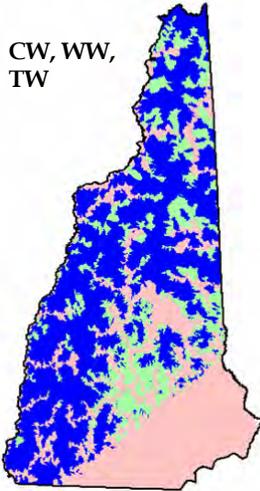
Classification: A system for defining major natural groupings of community types



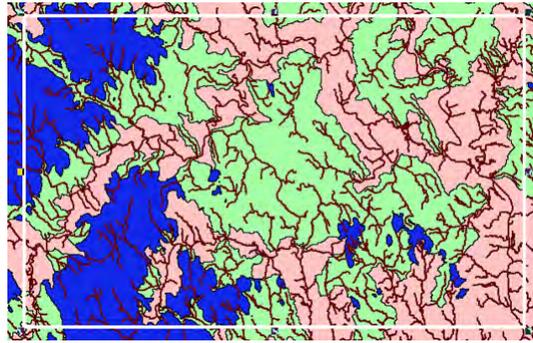
Cowardin (other) provides a natural classification for wetlands, but do flora / fauna naturally differ within a single “type”?

Classification of major NH fish assemblages (Coldwater - CW, Transitional water - TW, Warmwater- WW)

Statewide Results



Detailed Results



● CW ● TW ● WW

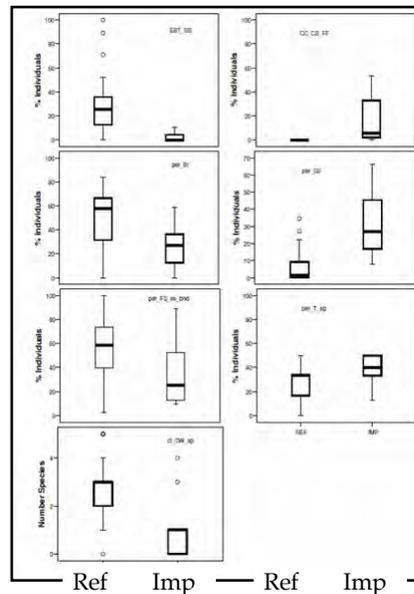
Areas define where a specific index is applied

Metric Identification: measures of condition

Example: Transitional water fish assemblage

1. Reference and Impact sites separated
2. Identified and tested 72 metrics
3. Broke metrics into several categories
4. Applied evaluation system that tests metric performance
5. Selected metrics with most separation between reference and impact sites

Metric Category	# Candidate metrics	# Retained for testing	%
Non-native	4	0	0.0
Composition / Indicator taxa	18	7	38.9
Reproduction	4	0	0.0
Trophic	8	3	37.5
Richness	2	0	0.0
Streamflow preference	17	4	23.5
Thermal preference	9	6	66.7
Tolerance	10	8	80.0
TOTAL	72	28	38.9



Scoring System: A way to translate taxonomic / ecological information into consistent understandable scale

Example: Transitional water fish assemblage index

Additive; range 8 - 40

Metric	Score		
	1	3	5
% sculpin and brook trout	<5	5 - 20	>20
% benthic insectivores	<20	20 - 40	>40
% flow specialist (less BND)	<40	40 - 60	>60
# coldwater specialists	0	1	≥2
% CC+CS+FF	>20	2 - 20	≤2
% generalist feeders	>30	10 - 30	≤10
% tolerant individuals	≥50	33 - 50	<33
Brook trout age class	No YOY	Only YOY	YOY + Adult

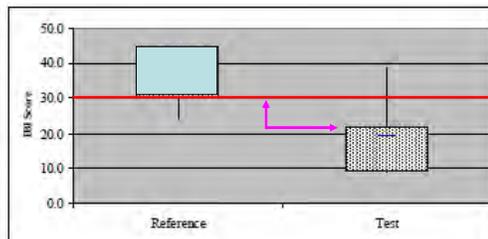
Threshold identification

(b) Difference from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function

Must define what is “non-detrimental difference”

Usually done by observing range of scores from reference and impact sites, then choosing a cutoff.

Site Type	Statistic	Result
Reference	95 th	45.0
	75 th	45.0
	mean	37.9
	25 th	30.0
	5 th	24.0
Test	95 th	38.9
	75 th	21.8
	mean	19.1
	25 th	9.0
	5 th	9.0



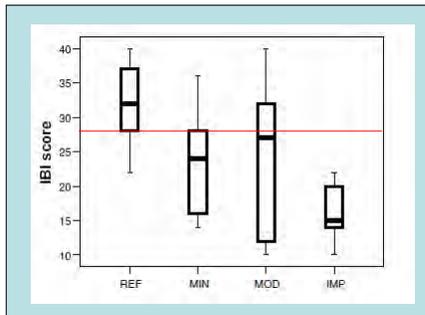
75% of reference sites have index score above 30

Good separation between reference and impact site index score



Validation Testing

- A measure of how well index performs
- Comparison of index scores across a range of impact classes
- Uses previously excluded data



Example: Transitional water index

- 36 sites excluded during development
- Threshold corresponds to calibration
- Min - mod impacted sites lower scores
- Highly impact site dramatically lower scores

Examples: Clay Brook



2. **New Hampshire Department of Environmental Services**
Stream Monitoring Report
 Station: 04-05 Clay Brook Project: 0754P

Assemblage type

Sample Details

Raw Data

Index Results

Fish Index = COLDWATER

3.

Raw Data	
Species	Number (YOY)
Slimy Sculpin	57
Longnose Dace	29
Blacknose Dace	63
Yellow Bullhead	3
Brook Trout	13 (5)

4.

Index Results		
Metric	Raw Result	Score
% Brook Trout	7.88	1.5
# Tolerant Taxa	2	1.5
% Carnivores	7.88	1.5
% Coldwater	42.4	1.5
% Generalists	1.82	7.5
EBT age class	Adult + YOY	7.5
Score / Threshold 21 / 30 → Fails to Meet		

Examples: Israel River

1. **Town: Jefferson**
Drainage area: 70.5 sq. mi.
Lat: 44.412; Long: 71.499



2. **New Hampshire Department of Environmental Services**
Stream Biomonitoring Report
 Station: 062-100 **Israel River** Project: 10/2007

Assemblage type

Sample Details

Raw Data

Index Results

FW Index: 33 **Stream of Health: Meets or Exceeds Criteria**
 FW Criteria: 32

Fish Index = Transitional water

3.

Raw Data	
Species	Number (YOY)
White Sucker	1
Longnose Dace	19
Blacknose Dace	60
Slimy Sculpin	3
Longnose Sucker	4
Brook Trout	11(0)

4.

Index Results		
Metric	Raw	Score
% Brook Trout	14.4	3
% CC, CS, FF	0.0	5
% Coldwater Taxa	60.0	5
% Tolerant Taxa	20.0	5
% BI	26.8	3
% Generalists	0.0	5
% Carnivore	11.34	3
EBT age class	Adult Only	1
% Fluvial Specialist (less BND)	34.0	3
Score / Threshold 33 / 28 → Meets		

Biological Indices To Date:

- Serve as the core indicator of Aquatic Life Use (ALU) for streams and rivers for water quality reports
- 100+ assessments completed in 2012 305(b) / 303(d) water quality report
- Utilized in 2008/09 to complete statewide probabilistic assessments of all state's streams and rivers
- Used in assessing impacts related stressors (nutrients, stormwater) by investigating stressor : response curves
- Utilized for fish and macroinvertebrates, but could include other "assemblage types" or non-biological attributes
- Are the most direct and cost effective measure of condition

What Indices Are Not:

- Short-term commitments
- Indicators of cause of impairment
- Snake oil

Getting the data requires time and patience

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