

# **DEVELOPMENT OF A FISH ASSEMBLAGE ASSESSMENT INDEX FOR NON-WADEBALE RIVERS IN MAINE & NEW ENGLAND: 2002 - 2007**

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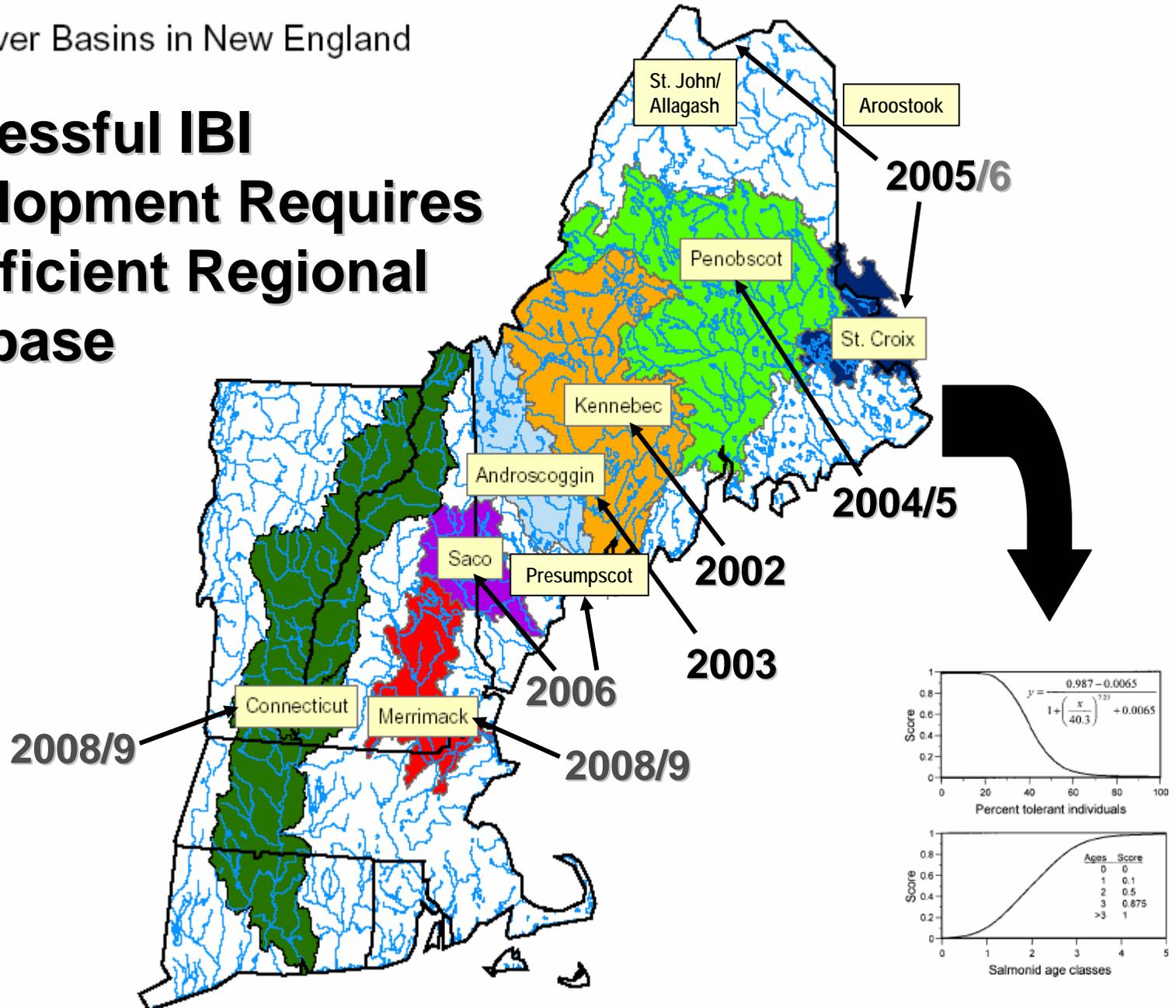
# Maine Rivers Fish Assemblage Assessment

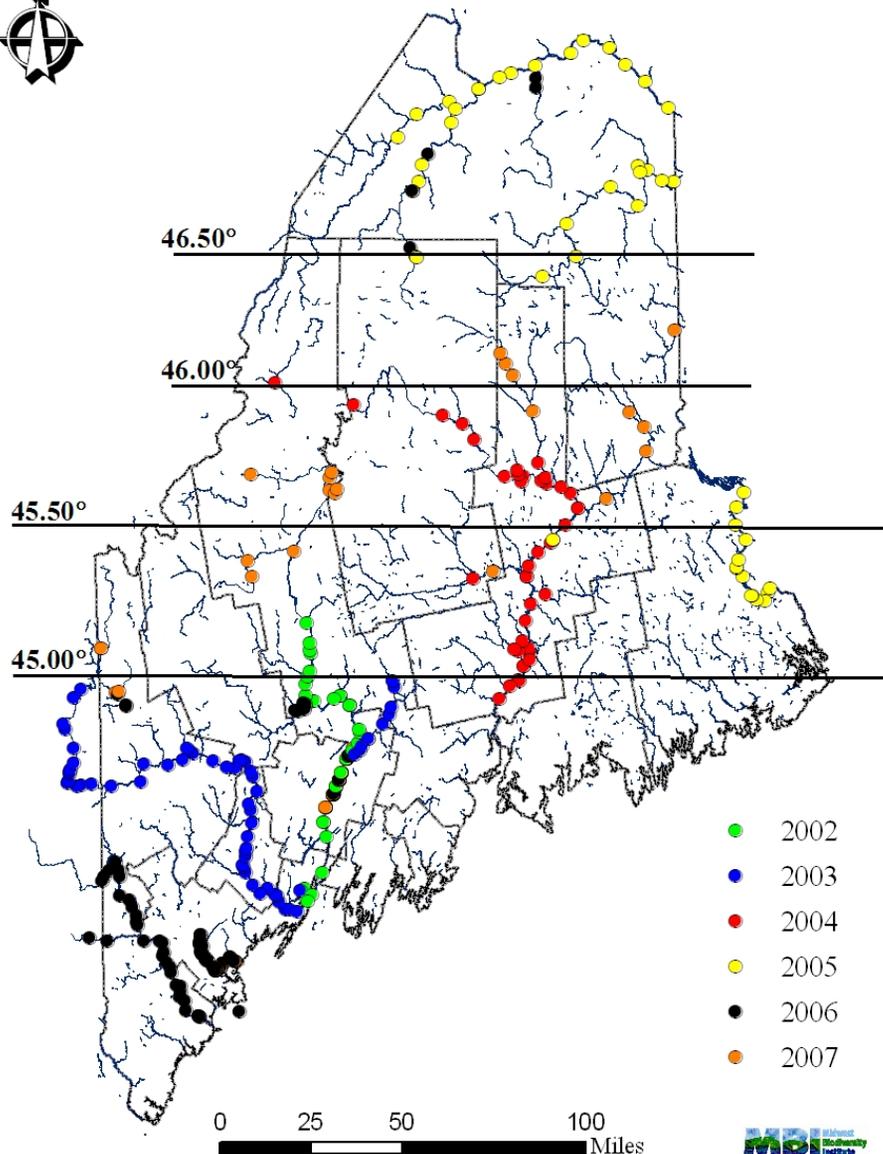
- Initiated in 2002 – initial sampling in Kennebec R.; Androscoggin R. & Sebasticook R. in 2003; Penobscot R. in 2004
- The study scope includes:
  - *Cold water assemblages*
  - *Warm water assemblages*
  - *Freshwater tidal assemblages*
- Boat electrofishing; development of standard methods in 2002 and 2003
- IBI - collect fish assemblage data for metric & index development
- Test of EPA Biological Condition Gradient; application to flow altered rivers and depauperate fish faunas
- Document presence of alien species



Major River Basins in New England

# Successful IBI Development Requires a Sufficient Regional Database





## Kennebec River (2002-6)

- Wyman Dam to Merrymeeting Bay (30 sites, 2 test areas)
- Follow-up Waterville to Augusta (2002-6)

## Androscoggin River (2003)

- Errol, NH to Merrymeeting Bay (51 sites)

## Sebecooc River (2003)

- Douglas Pond to Winslow (9 sites)

## Penobscot River (2004)

- N. Br. To Hamden (40 sites); included W. Br., E. Br., 5 additional tributaries

## Northern Maine Rivers (2005-6)

- St. John (14 sites), Allagash (8 sites), Aroostook (10 sites), St. Croix (12 sites)

## Southern Maine Rivers (2006)

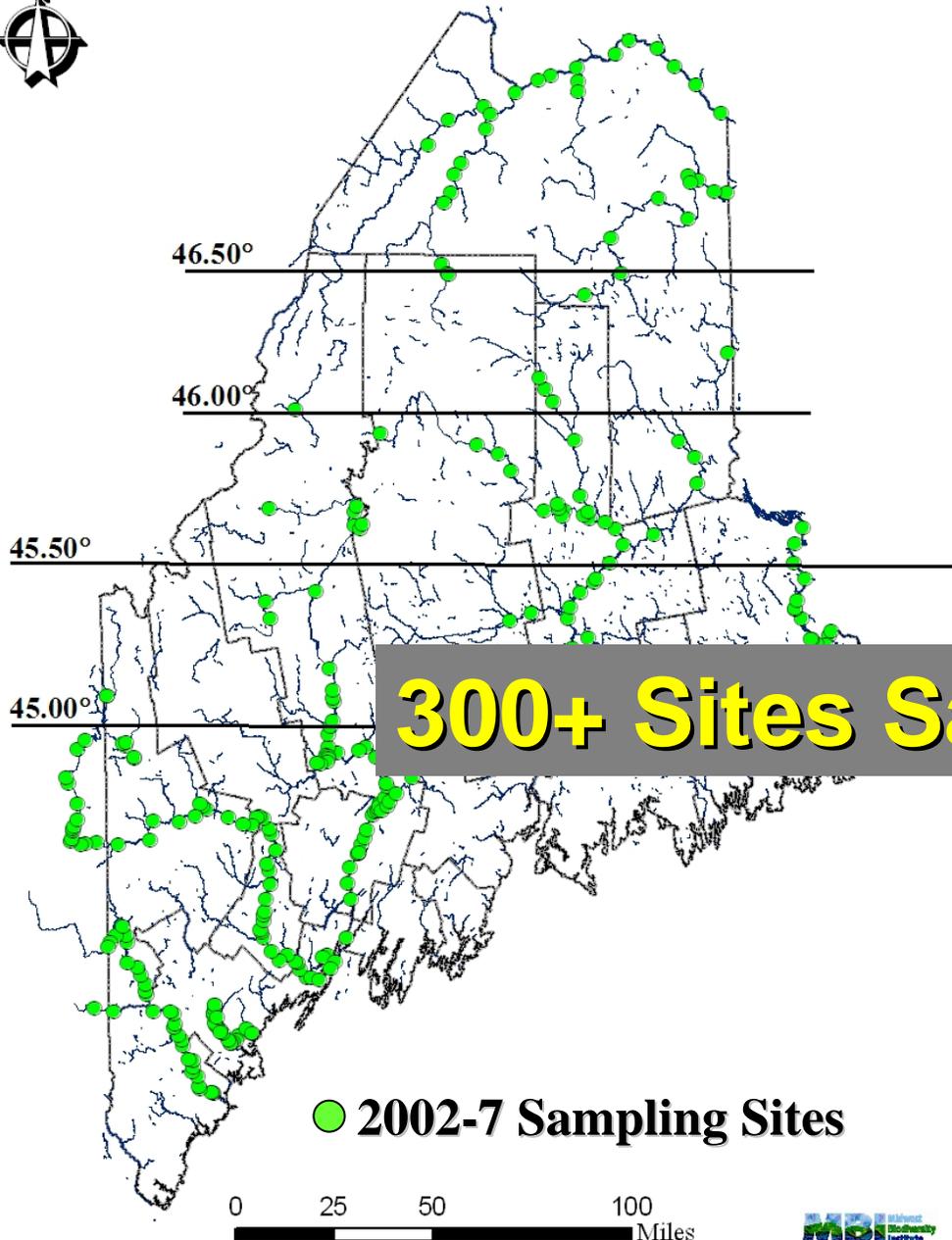
- Presumpscot R., Saco R. (32 sites)

## Miscellaneous Maine Rivers (2007)

- Mattawamkeag R., Rapid R., Moose R., Moosehead Outlets, Dead R., E. Br. Penobscot (22 sites)



# Maine Rivers Fish Assemblage Assessment: 2002-7

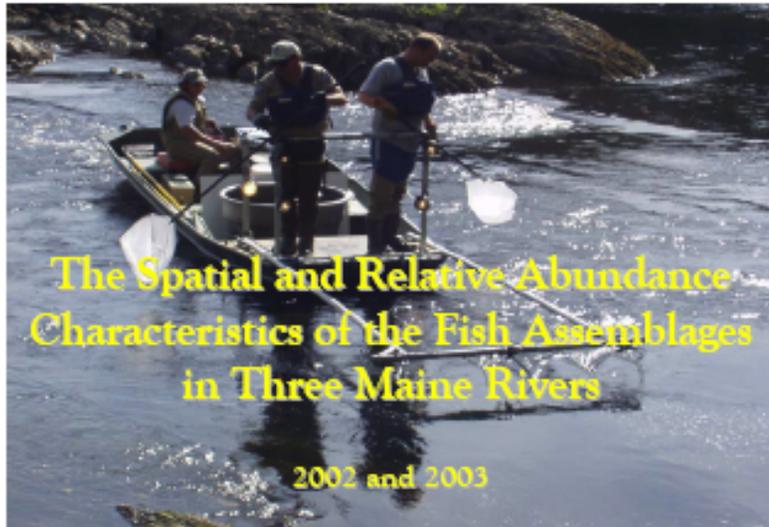




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## The Spatial and Relative Abundance Characteristics of the Fish Assemblages in Three Maine Rivers

2002 and 2003

**Kennebec River: Bingham, ME to Merrymeeting Bay**  
**Androscoggin River: Errol, NH to Merrymeeting Bay**  
**Sebasticook River: Pittsfield, ME to Winslow, ME**

Technical Report MBI/12-05-1



## 2005 Maine Rivers Fish Assemblage Assessment:

### I. Northern Maine Rivers Results

Allagash River: Churchill Lake to Allagash

Aroostook River: Oxbow to Ft. Fairfield

St. Croix River: Vanceboro to Calais

St. John River: Black River to Maine/New Brunswick border

### II. Maine Rivers Fish Species Distribution Atlas

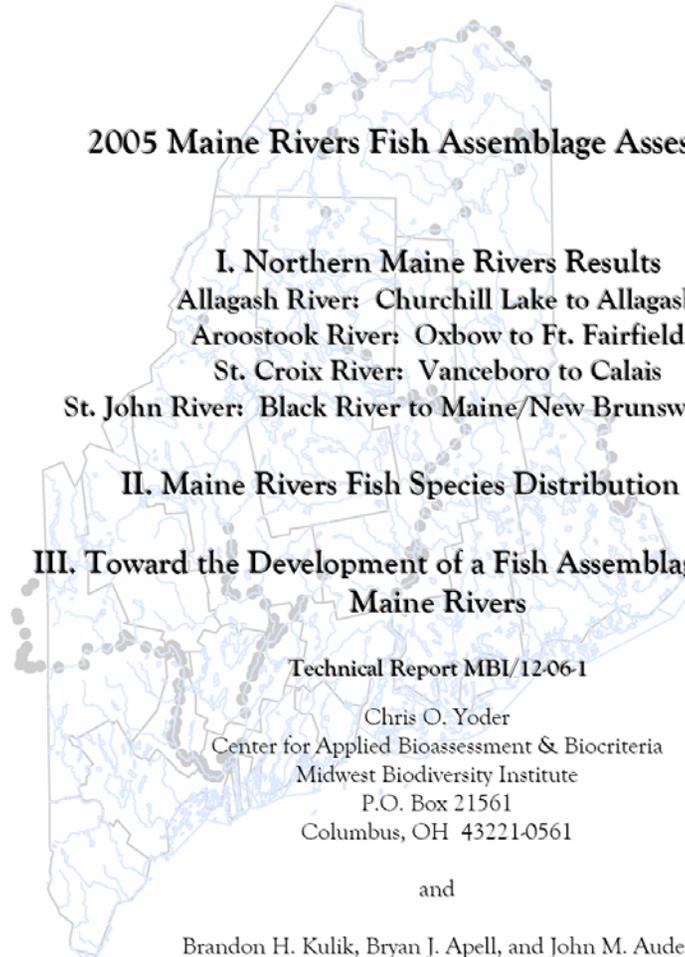
### III. Toward the Development of a Fish Assemblage Index for Maine Rivers

Technical Report MBI/12-06-1

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# Why Knowledge of the Fish Assemblage is Important

## *Current Issues:*

- **Limited Knowledge of Extant Fauna** – limited mostly to managed species (especially trout and salmon); need to document relative abundance of co-occurring native and alien species and their respective influence.
- **Naturally Depauperate Fauna** – cold water, coastal drainages – “how will these respond?”
- **Assess Potential Conflicts with High Profile Restoration Goals** – do non-native species pose an unintentional deterrent?

# Sampling Methods

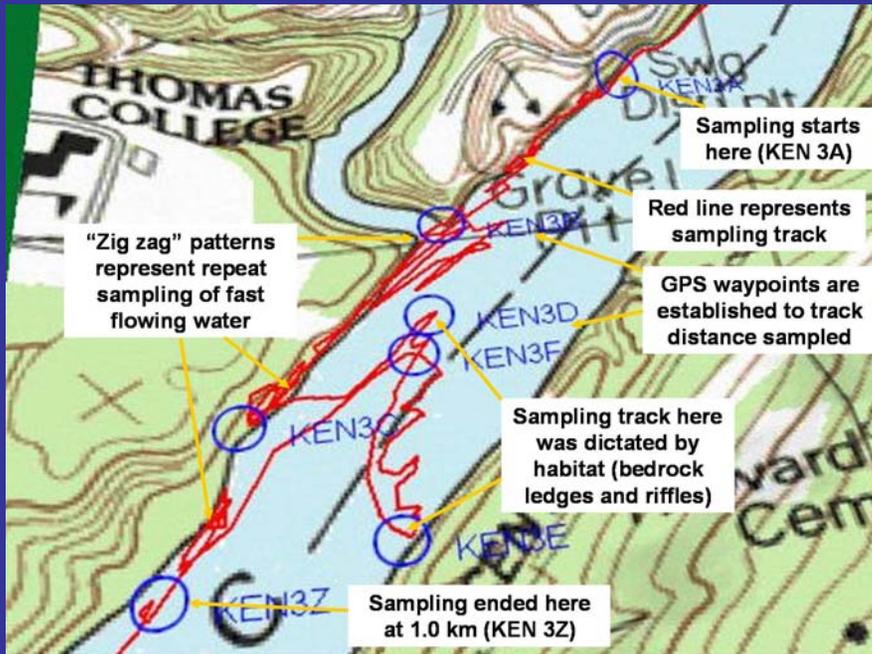
An aerial photograph of a river with a rocky bed. A small boat is positioned in the middle of the river, with a long metal frame extending across the water. Two people are on the boat, one appears to be operating the equipment. The water is dark and turbulent, with white foam from rapids visible on the right side. The surrounding landscape is rugged with large rocks and some sparse vegetation.

## Standardized Approach:

- Pulsed D.C. boat electrofishing – effort indexed to distance
- Electrode array customized for Maine river conditions
- Intensive survey design – mainstem & non-wadeable tribs.
- Field water quality and habitat data
- July – September index period



- Sampling guided by a QAPP
- Standardized sampling to yield comparable data
- All representative habitat types within each site



- Geo-referenced sample site location and sample track
- Fish are identified to species, enumerated, and weighed
- DELT anomalies recorded

# Access & Logistics



After launching and sampling the boat is retrieved or navigates downstream to the next sampling site and/or access point.



# Sampling Procedure

Boat driver

Two netters collect all fish sighted

1.0 km distance includes all nearshore habitats

Sampling boat moves in a general downstream direction, but is maneuvered within the site to produce a thorough sampling of each site

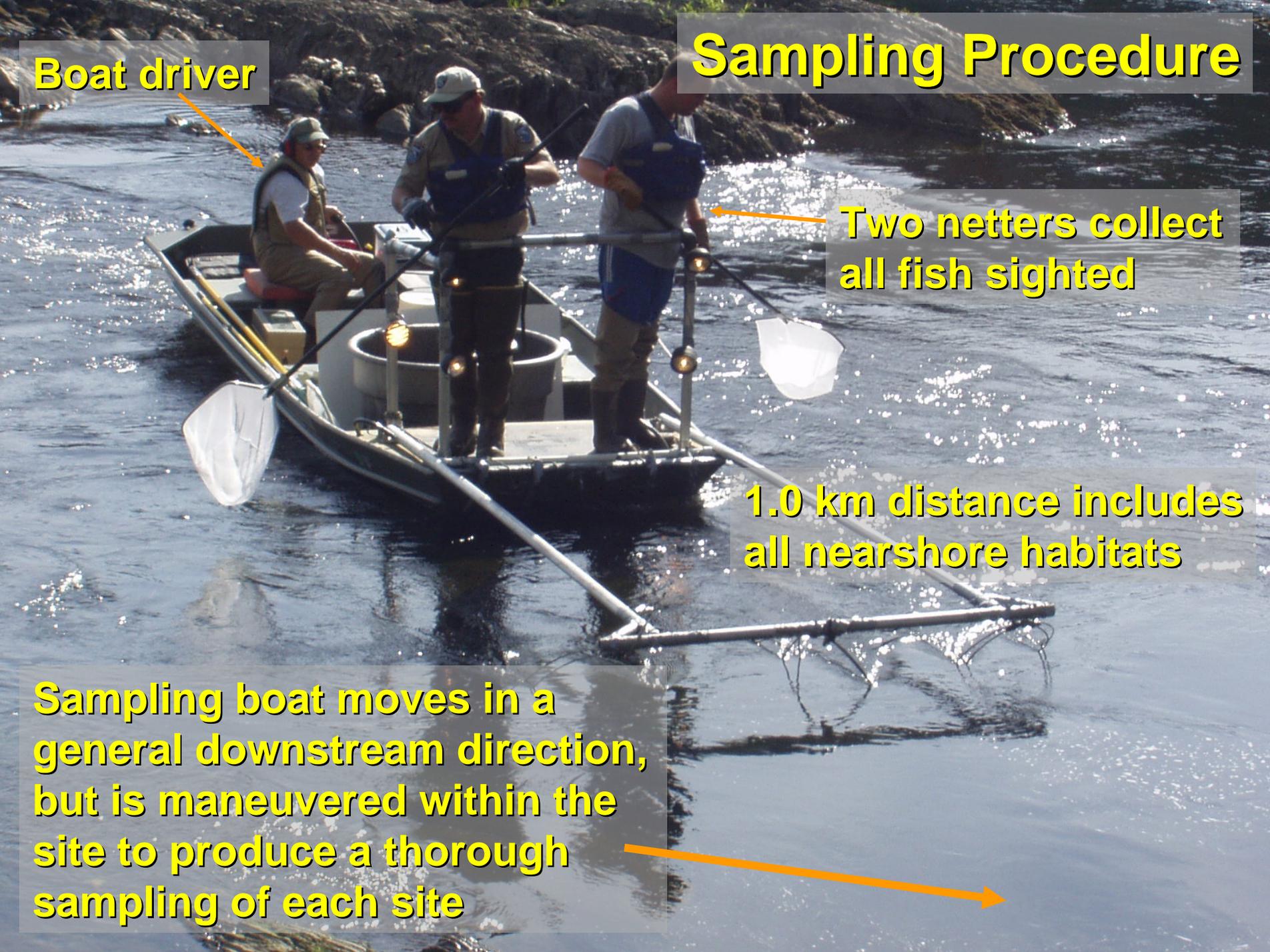


Table 1. Key characteristics of a boat electrofishing protocol applicable to Maine and New England large river habitats.

Category/Attribute	Riverine Wadeable <sup>a</sup> (Low-Mod. Cond. <sup>b</sup> )	Riverine High Gradient (Low Cond.)	Riverine Mod. Gradient (Low Cond.)	Riverine Low Gradient (Mod. Cond.)	Impounded (Mod. Cond.)	Impounded (Mod. Cond.)	Tidal (High Cond.)
1. Drainage Area	<500 mi <sup>2</sup>	<500 mi <sup>2</sup>	>500-1000 mi <sup>2</sup>	>1000 mi <sup>2</sup>	NA	NA	NA
2. Platform	Georator <sup>c</sup> (bank set/towboat)	14' raft <sup>d</sup> or 12' johnboat	16' johnboat or 16' raft <sup>e</sup>	16' johnboat	16' johnboat	16' johnboat	16' johnboat
3. Crew Size	3 persons (2 netters)	2 persons (1 netter)	3 persons (2 netters)	3 persons (2 netters)	3 persons (2 netters)	3 persons (2 netters)	3 persons (2 netters)
4. Electrofishing Unit	GPP 2.5, 5.0 <sup>e</sup> or equivalent	GPP 2.5, 5.0 or equivalent	GPP 5.0 or equivalent	GPP 5.0 or equivalent	GPP 5.0 or equivalent	GPP 5.0 or equivalent	GPP 5.0 or
5. Power Source	2500-5000 Watt Alternator	5000 Watt Alternator	5000 Watt Alternator	5000 Watt Alternator	5000 Watt Alternator	5000 Watt Alternator	5000 Watt Alternator
6. Unit Settings <sup>f</sup>  (% of Low or High Range)	High 120 Hz  NA	High 120 Hz 2-4 Amperes (100%)	High 120 Hz 2-4 Amperes (100%)	Low or High 120 Hz 4-8 Amperes (60-100%)	High 120 Hz 2-4 Amperes (100%)	Low or High 120 Hz 4-8 Amperes (60-100%)	Low 120 Hz >8-15 Amperes (50-80%)
7. Anodes <sup>g</sup>	Net Ring	2 gangs	3 gangs	3 gangs	3 gangs	3 gangs	2 gangs
8. Cathodes	rat tail	6'	8'	8'	8'	8'	8'

<sup>a</sup> Wadeable defined as sites where a raft or boat mounted apparatus cannot be used due to shallowness of depth – accessibility is not a criterion.

<sup>b</sup> Typical relative conductivity ranges: Low (15-40  $\mu\text{s}/\text{m}^2$ ); Moderate (40 – 200  $\mu\text{s}/\text{m}^2$ ); High (>200  $\mu\text{s}/\text{m}^2$ ).

<sup>c</sup> Employs a primary net ring as the anode that is operated by the primary netter backed by an assist netter - the unit is either bank set or towed on a small skiff (towboat).

<sup>d</sup> This platform was extensively tested in 2005.

<sup>e</sup> This platform has not been tested in Maine, but it has worked well elsewhere and in similar conditions.

<sup>f</sup> This does not constitute an endorsement of a particular brand or product name and is for methodological identification only.

<sup>g</sup> Unit settings are selected to produce the highest voltage and amperage output; these are what typically worked in each conductivity range and habitat type.

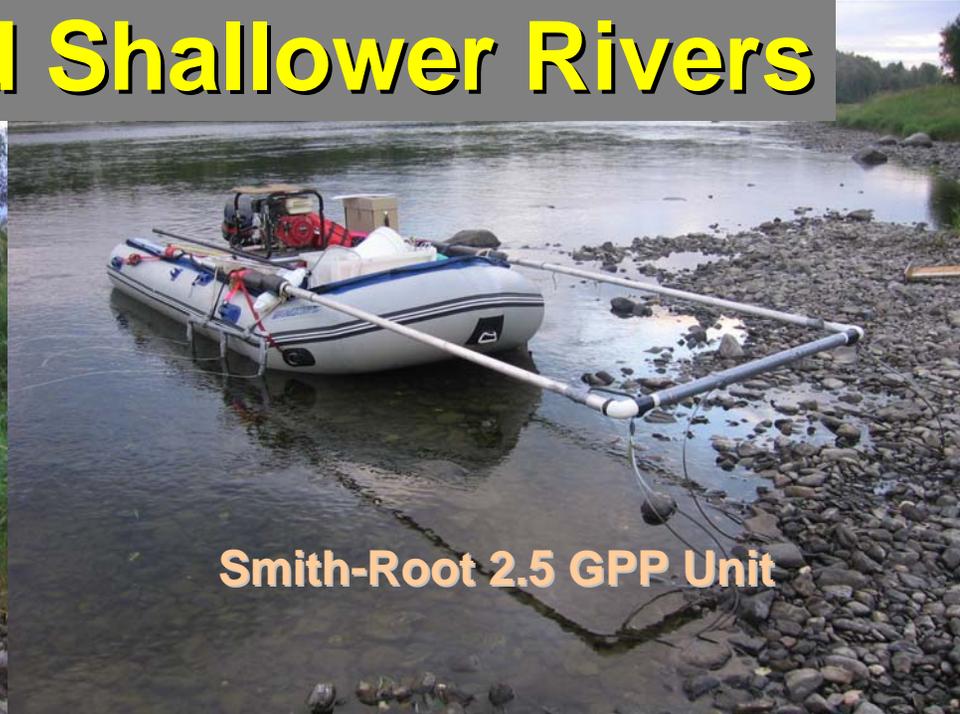
<sup>h</sup> Anodes consist of gangs or multiple strands of wire as described under Equipment Specifications.



# Developed in 2005 to Access Medium Sized and Shallower Rivers



Launching & Retrieving



Smith-Root 2.5 GPP Unit

Figure 4. Qualitative habitat evaluation index (QHEI) field sheet.

# Midwest Biodiversity Institute

# MBI

Qualitative Habitat Evaluation Index Field Sheet QHEI Score:

River Code: \_\_\_\_\_ RM: \_\_\_\_\_ Stream: \_\_\_\_\_

Date: \_\_\_\_\_ Location: \_\_\_\_\_

Scorers Full Name: \_\_\_\_\_ Affiliation: \_\_\_\_\_

1) SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present)

TYPE	POOL RIFFLE	POOL RIFFLE	SUBSTRATE ORIGIN	SUBSTRATE QUALITY	
<input type="checkbox"/> <input type="checkbox"/> -BLDR /SLBS [10] _____	<input type="checkbox"/> <input type="checkbox"/> -GRAVEL [7] _____	Check ONE (OR 2 & AVERAGE)		Check ONE (OR 2 & AVERAGE)	
<input type="checkbox"/> <input type="checkbox"/> -BOULDER [9] _____	<input type="checkbox"/> <input type="checkbox"/> -SAND [6] _____	<input type="checkbox"/> -LIMESTONE [1] _____	SILT:	<input type="checkbox"/> - SILT HEAVY [-2]	Substrate <div style="border: 1px solid black; width: 40px; height: 40px; margin: 0 auto;"></div> Max 20
<input type="checkbox"/> <input type="checkbox"/> -COBBLE [8] _____	<input type="checkbox"/> <input type="checkbox"/> -BEDROCK [5] _____	<input type="checkbox"/> -TILLS [1] _____	<input type="checkbox"/> -WETLANDS [0] _____	<input type="checkbox"/> -SILT MODERATE [-1]	
<input type="checkbox"/> <input type="checkbox"/> -HARDPAN [4] _____	<input type="checkbox"/> <input type="checkbox"/> -DETRITUS [3] _____	<input type="checkbox"/> -HARDPAN [0] _____	<input type="checkbox"/> -SANDSTONE [0] _____	<input type="checkbox"/> -SILT NORMAL [0]	
<input type="checkbox"/> <input type="checkbox"/> -MUCK [2] _____	<input type="checkbox"/> <input type="checkbox"/> -ARTIFICIAL [0] _____	<input type="checkbox"/> -RIP/RAP [0] _____	EMBEDDED	<input type="checkbox"/> -SILT FREE [1]	
<input type="checkbox"/> <input type="checkbox"/> -SILT [2] _____	NOTE: Ignore Sludge Originating From Point Sources	<input type="checkbox"/> -LACUSTRINE [0] _____	NESS:	<input type="checkbox"/> -EXTENSIVE [-2]	
NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >)	<input type="checkbox"/> 4 or More [2]	<input type="checkbox"/> -SHALE [-1] _____	<input type="checkbox"/> -COAL FINES [-2] _____	<input type="checkbox"/> -MODERATE [-1]	
		<input type="checkbox"/> 3 or Less [0]		<input type="checkbox"/> -NORMAL [0]	
				<input type="checkbox"/> -NONE [1]	

COMMENTS: \_\_\_\_\_

2) INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions)

(Structure)	TYPE: Score All That Occur	AMOUNT: (Check ONLY One or check 2 and AVERAGE)	
<input type="checkbox"/> UNDERCUT BANKS [1]	<input type="checkbox"/> POOLS > 70 cm [2]	<input type="checkbox"/> - EXTENSIVE > 75% [11]	Cover <div style="border: 1px solid black; width: 40px; height: 40px; margin: 0 auto;"></div> Max 20
<input type="checkbox"/> OVERHANGING VEGETATION [1]	<input type="checkbox"/> ROOTWADS [1]	<input type="checkbox"/> - MODERATE 25-75% [7]	
<input type="checkbox"/> SHALLOWS (IN SLOW WATER) [1]	<input type="checkbox"/> BOULDERS [1]	<input type="checkbox"/> - SPARSE 5-25% [3]	
<input type="checkbox"/> ROOTMATS [1]	COMMENTS: _____	<input type="checkbox"/> - NEARLY ABSENT < 5% [1]	

3) CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE )

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS/OTHER	
<input type="checkbox"/> - HIGH [4]	<input type="checkbox"/> - EXCELLENT [7]	<input type="checkbox"/> - NONE [6]	<input type="checkbox"/> - HIGH [3]	<input type="checkbox"/> - SNAGGING	Channel <div style="border: 1px solid black; width: 40px; height: 40px; margin: 0 auto;"></div> Max 20
<input type="checkbox"/> - MODERATE [3]	<input type="checkbox"/> - GOOD [5]	<input type="checkbox"/> - RECOVERED [4]	<input type="checkbox"/> - MODERATE [2]	<input type="checkbox"/> - RELOCATION	
<input type="checkbox"/> - LOW [2]	<input type="checkbox"/> - FAIR [3]	<input type="checkbox"/> - RECOVERING [3]	<input type="checkbox"/> - LOW [1]	<input type="checkbox"/> - CANOPY REMOVAL	
<input type="checkbox"/> - NONE [1]	<input type="checkbox"/> - POOR [1]	<input type="checkbox"/> - RECENT OR NO RECOVERY [1]		<input type="checkbox"/> - DREDGING	
				<input type="checkbox"/> - ONE SIDE CHANNEL MODIFICATIONS	

COMMENTS: \_\_\_\_\_

# Project Status

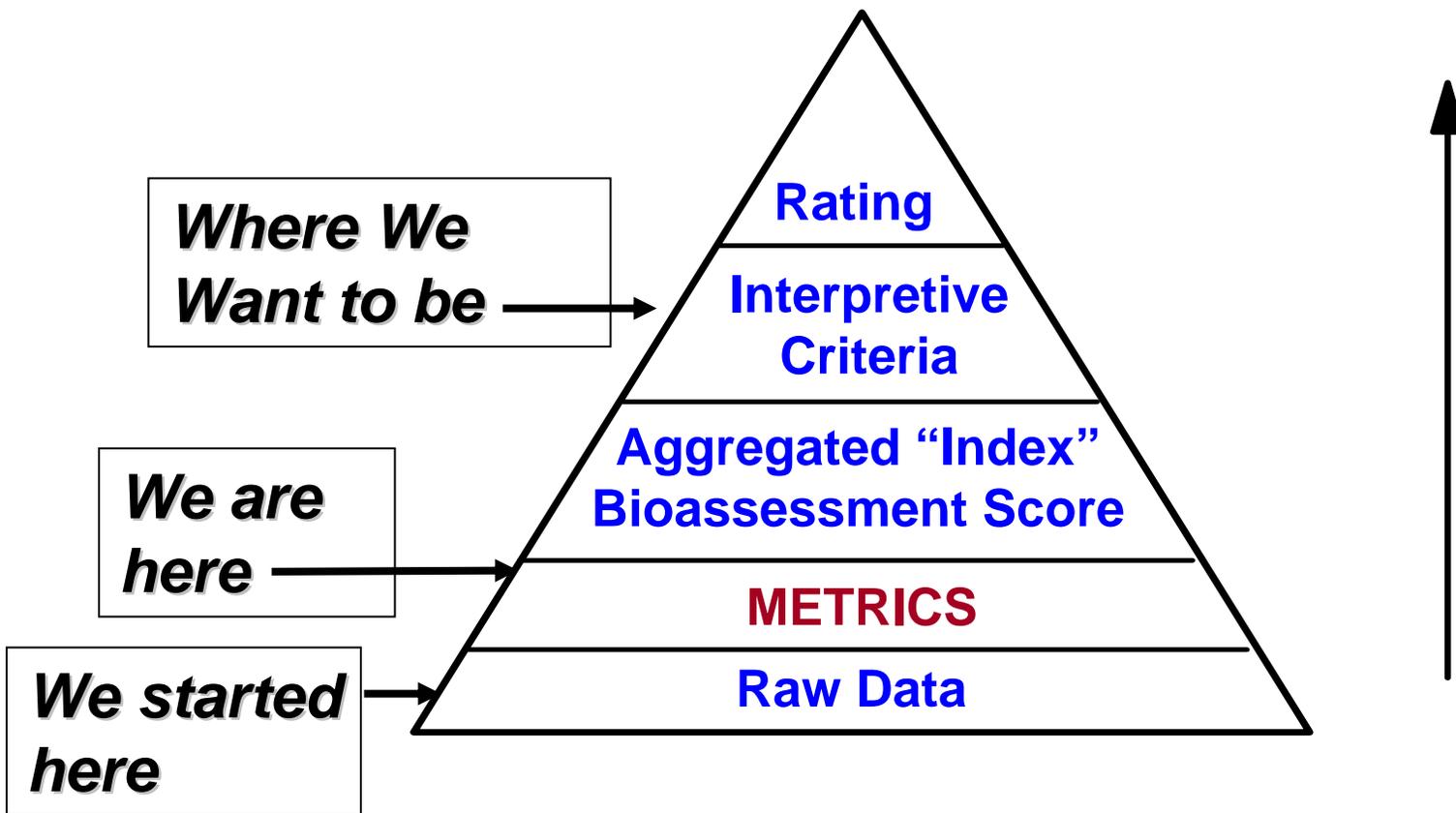
## Development of standardized field methods:

- Single-gear approach – 16' boat & 14' raft
- Yields relative abundance data - #s, biomass
- Logistics and remote access procedures
- Gradient of large river habitat “types”

## Data Analysis (2007-8):

- Distribution & abundance of key species
- Analysis of core stressors – habitat, T (°C)
- Autecology of each species – pre-IBI
- Multivariate analysis – expose gradients

# Data Manipulation Hierarchy of Field Collected Biological Samples



# Relative Abundance Data

## Species List

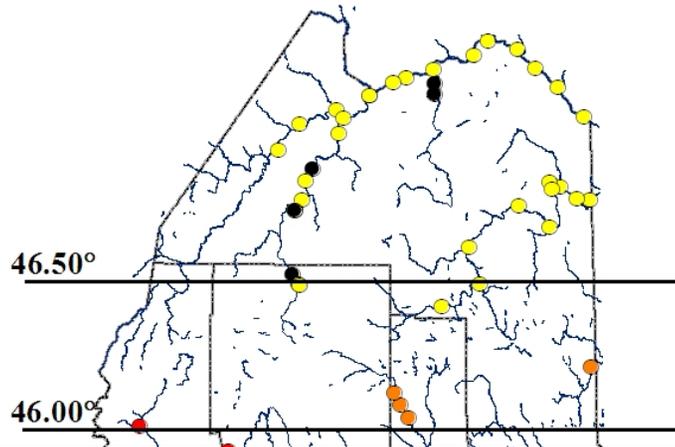
Page 1

River Code: <b>50-001</b>	Stream: <b>Kennebec River (ust. Edwards Dam)</b>	River Segment Totals
Mile Range: <b>59.20</b>		Date Range: 08/08/2002
Thru: <b>75.00</b>		Thru: 08/15/2002
Dist Fished: 12.50 km	Basin:	No of Passes: 20
		Sampler Type: A

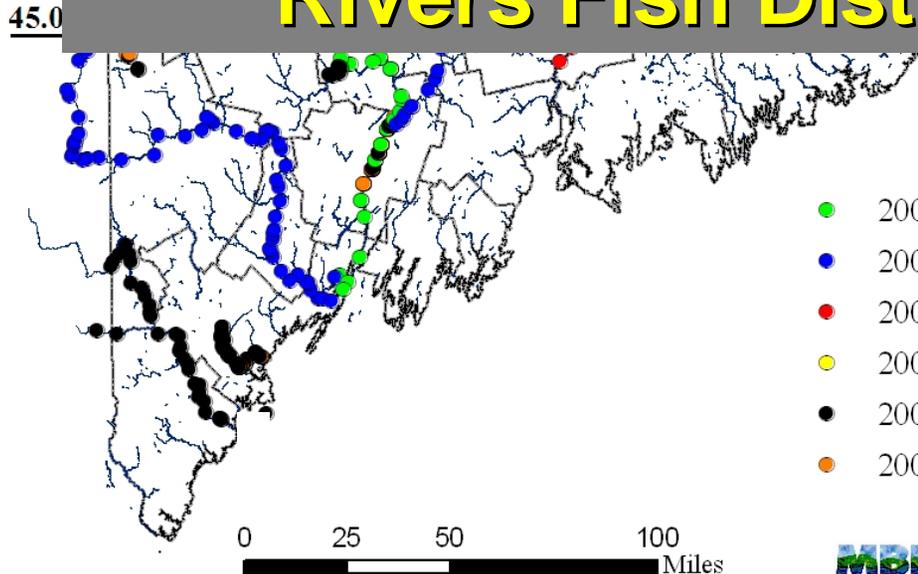
Species Name / ODNr status	IBI Grp	Feed Guild	Breed Guild Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Brown Trout	E	P	N I	18	1.45	0.39	0.11	0.68	83.61
Rainbow Trout	E	P	N I	41	3.35	0.89	0.27	1.58	79.88
Landlocked Salmon		C	I	95	7.65	2.03	0.51	3.01	66.51
Lake Trout X Brook Trout				3	0.25	0.07	0.03	0.20	135.00
White Sucker	W	O	S T	463	36.60	9.73	8.82	52.20	231.76
Blacknose Dace	N	G	S T	86	6.80	1.81	0.01	0.06	1.57
Creek Chub	N	G	N T	15	1.15	0.31	0.01	0.04	5.07
Common Shiner	N	I	S	945	72.40	19.24	0.56	3.30	7.71
Fallfish		G		217	16.90	4.49	0.09	0.55	5.44
Lake Chub		O		12	1.00	0.27	0.01	0.06	10.50
American Eel [T]		C	M	105	8.55	2.27	3.44	20.33	404.41
Eastern Banded Killifish	E	I	M T	1,193	91.05	24.20	0.21	1.26	2.34
Burbot [S]		C	S	25	2.00	0.53	0.20	1.18	99.24
Smallmouth Bass	F	C	C M	950	73.70	19.59	1.88	11.15	25.49
Pumpkinseed Sunfish	S	I	C P	28	2.30	0.61	0.03	0.19	13.68
Redbreast Sunfish	S	I	C	15	1.15	0.31	0.00	0.03	4.33
Yellow Perch		C	M	510	41.05	10.91	0.67	3.99	16.30
Slimy Sculpin		I	I	97	8.05	2.14	0.03	0.19	4.08
Three-spine Stickleback		I		12	0.90	0.24	0.00	0.00	0.67
<i>Stream Total</i>				4,830	376.30		16.90		
<i>Number of Species</i>				18					
<i>Number of Hybrids</i>				1					



# Maine Rivers Fish Assemblage Assessment: 2002-7



**Key First Task – Know Current  
Distribution of Fish Species: Maine  
Rivers Fish Distribution Atlas**



- 2002
- 2003
- 2004
- 2005
- 2006
- 2007



# Cold Water Species: Salmon and Trout



**Landlocked salmon  
(Intracontinental Introduced)**



**Rainbow trout  
(Intercontinental Introduced)**



**Brook trout  
(Indigenous Native)**

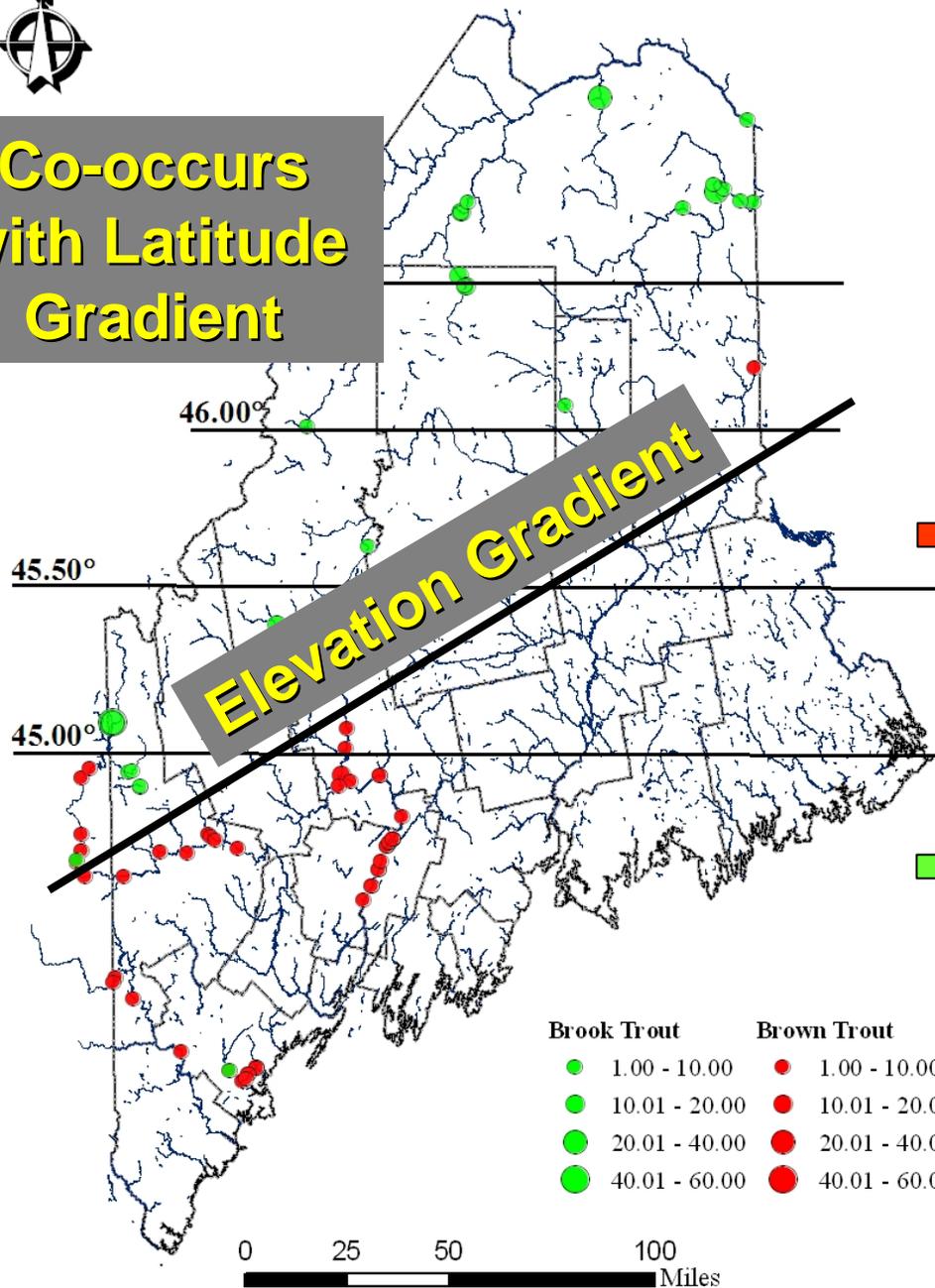


**Brown trout  
(Intercontinental Introduced)**



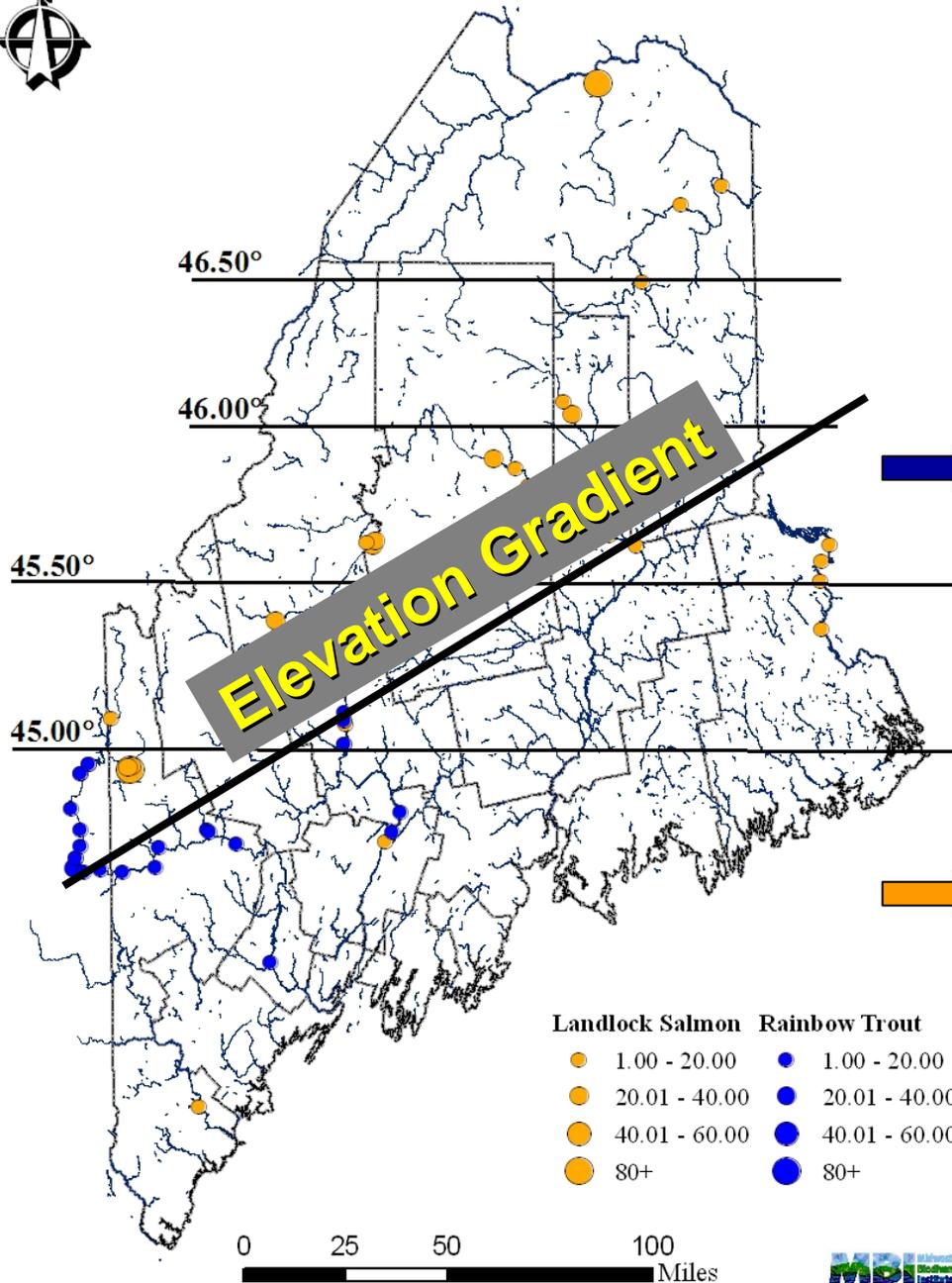
**Co-occurs  
with Latitude  
Gradient**

# Maine Rivers Fish Assemblage Assessment: 2002-7





# Maine Rivers Fish Assemblage Assessment: 2002-7



# Cold Water Species: Non-Salmonids (Indigenous Natives)



**Common white sucker  
(adult life stage)**



**Slimy sculpin**



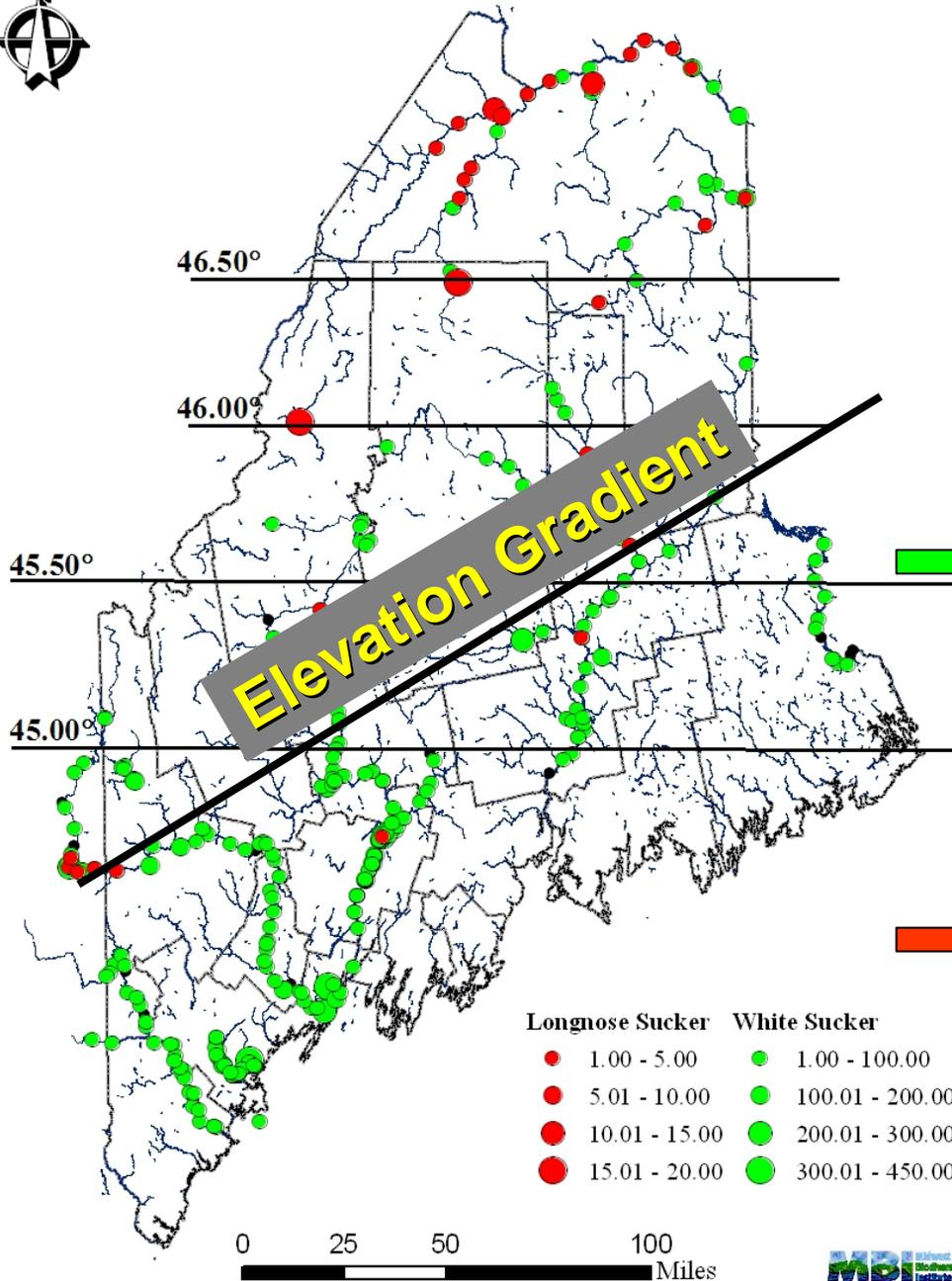
**Lake chub**



**Burbot**

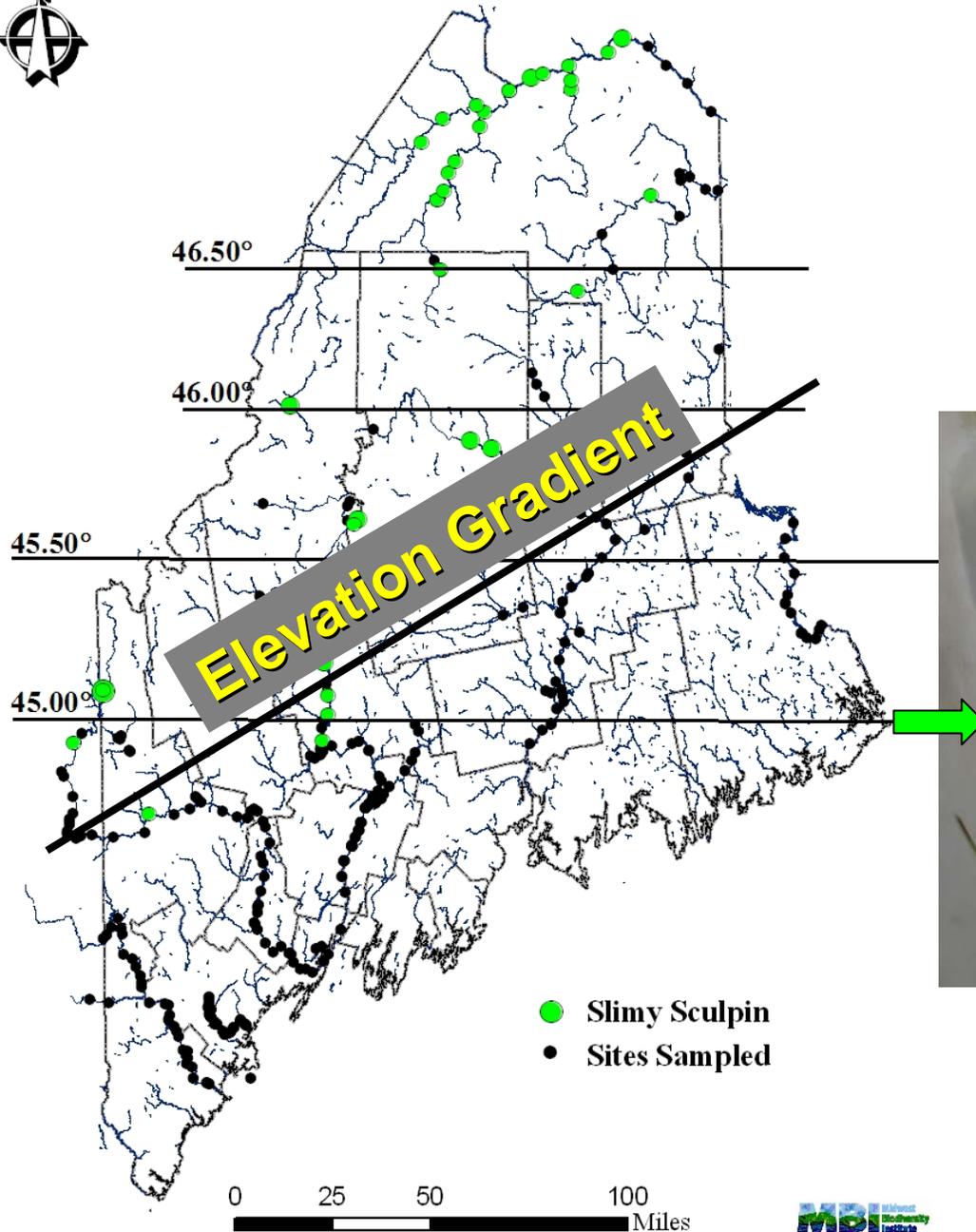


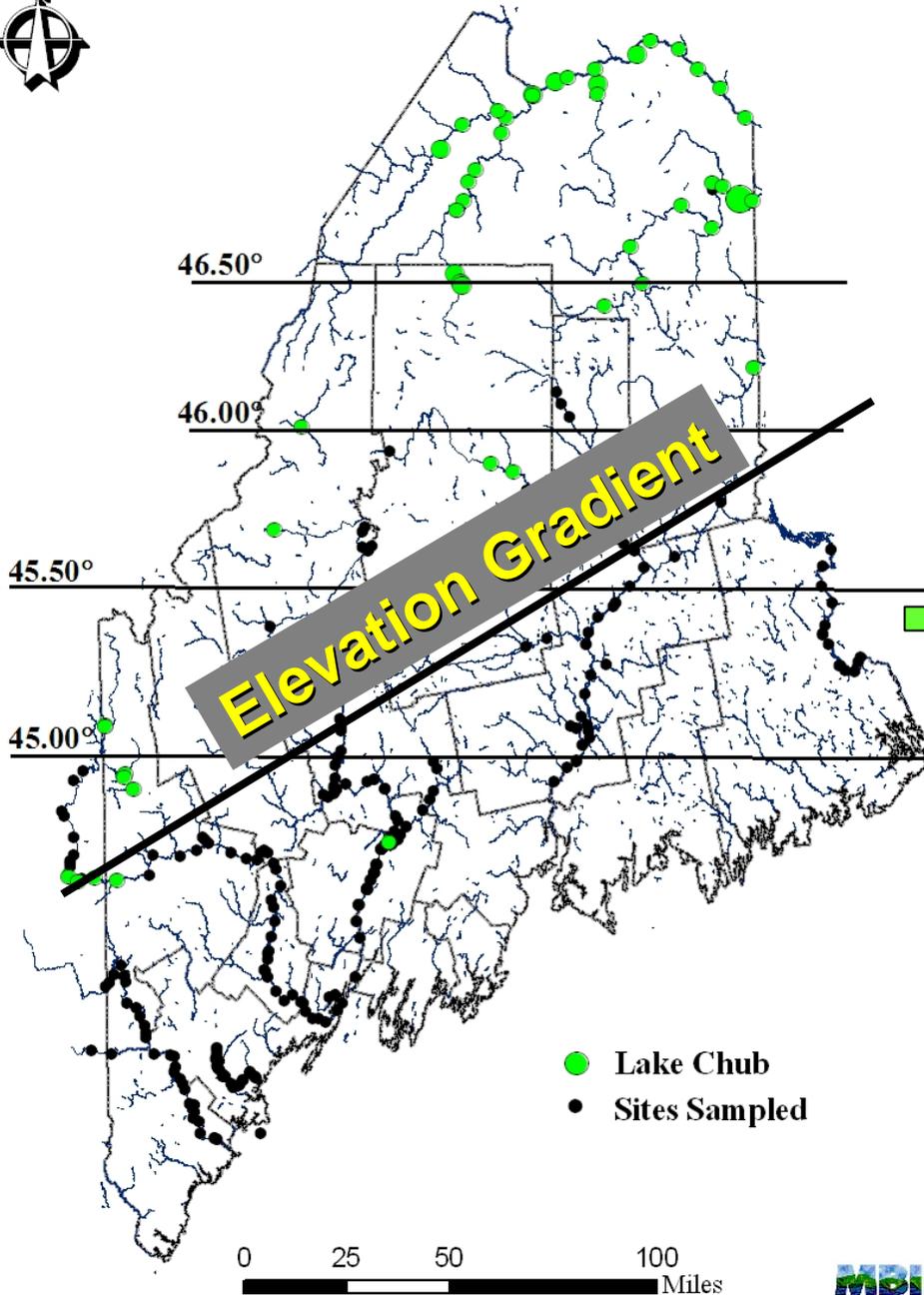
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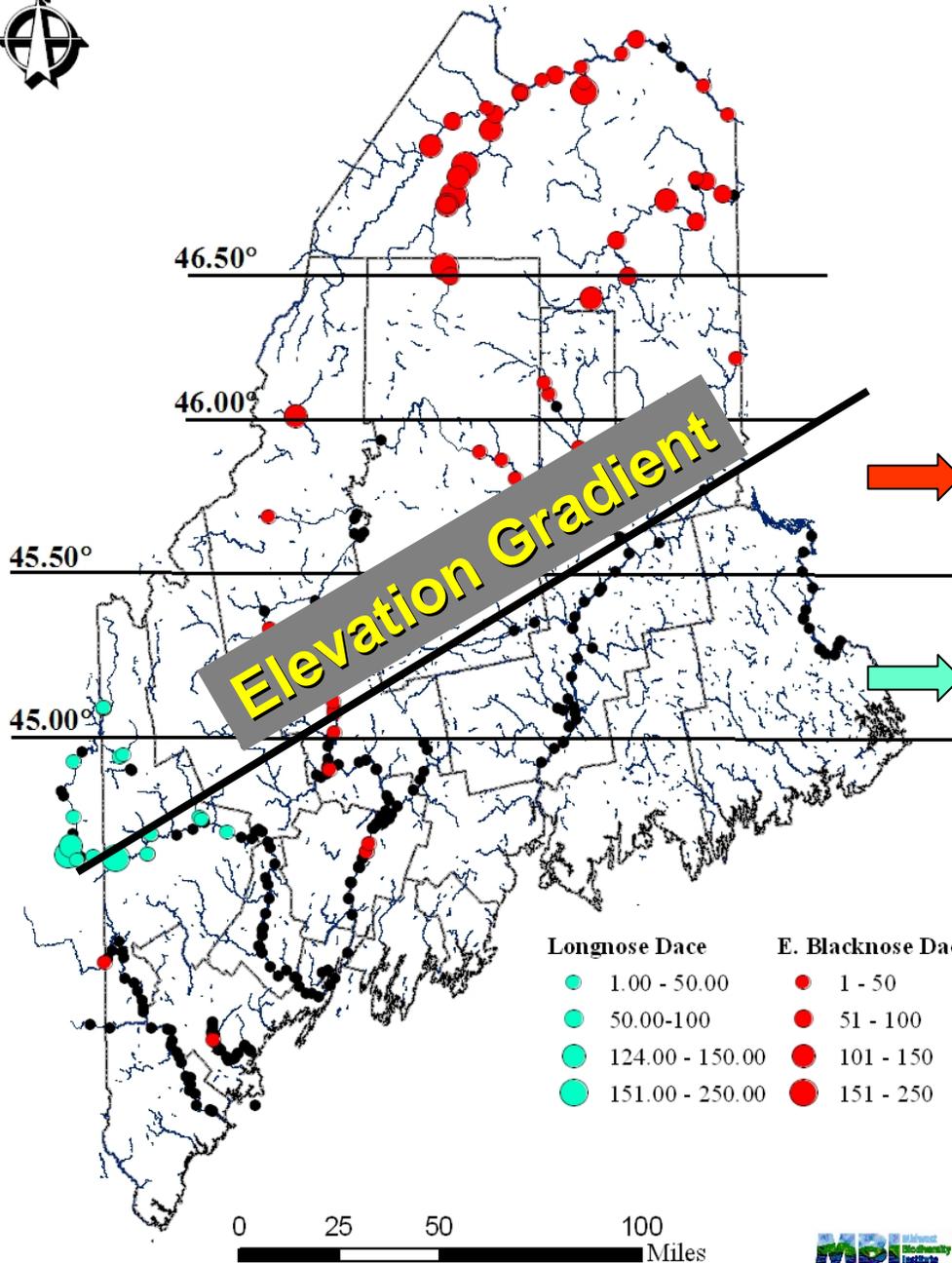


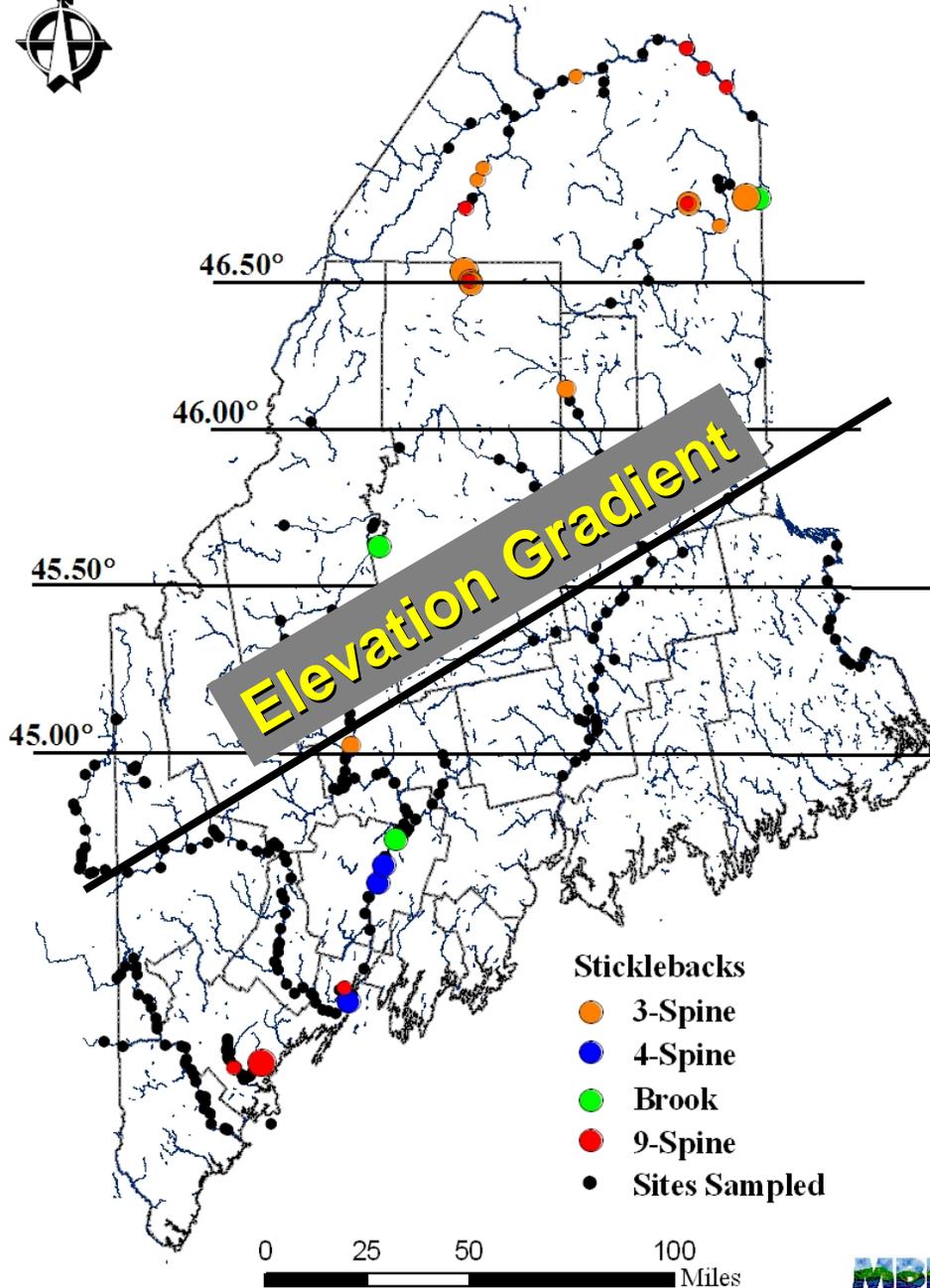
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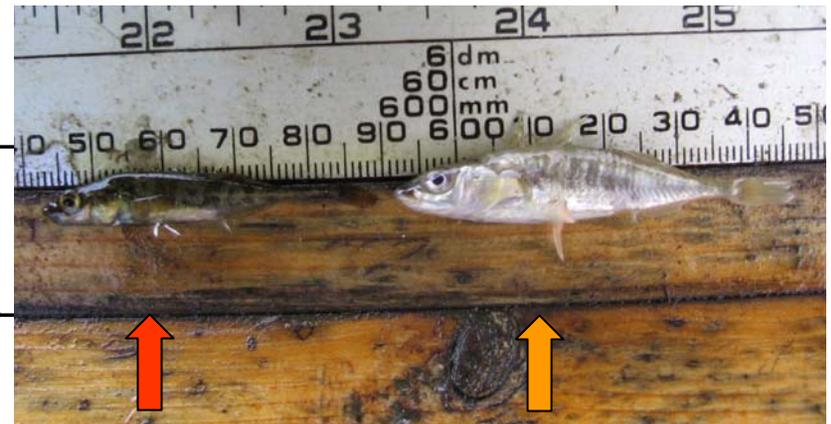


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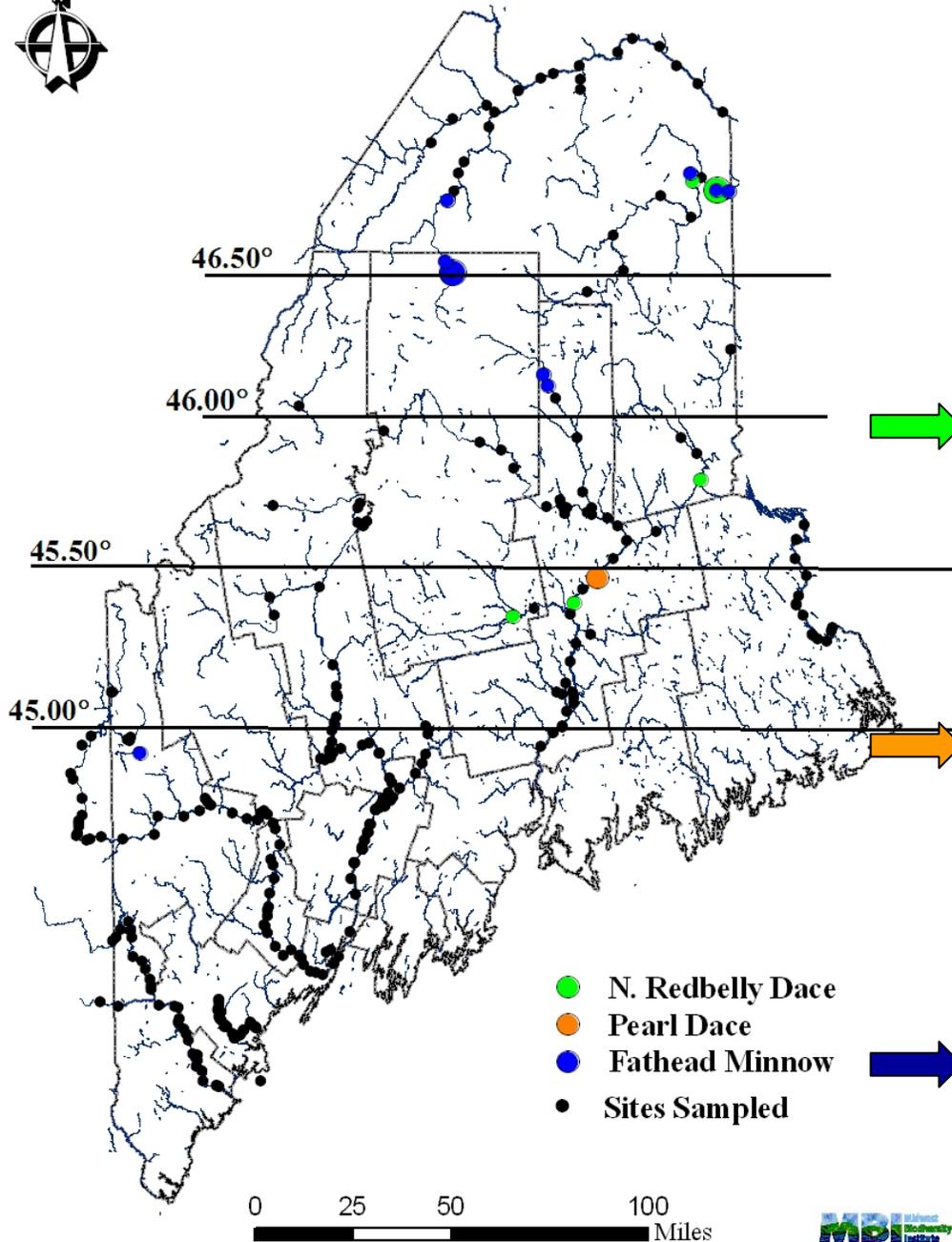


# Maine Rivers Fish Assemblage Assessment: 2002-7





# Maine Rivers Fish Assemblage Assessment: 2002-7



# Widely Distributed Species: Cyprinidae



**Fallfish  
(Indigenous Native)**



**Common shiner  
(Indigenous Native)**



**Creek chub**



**Fallfish**



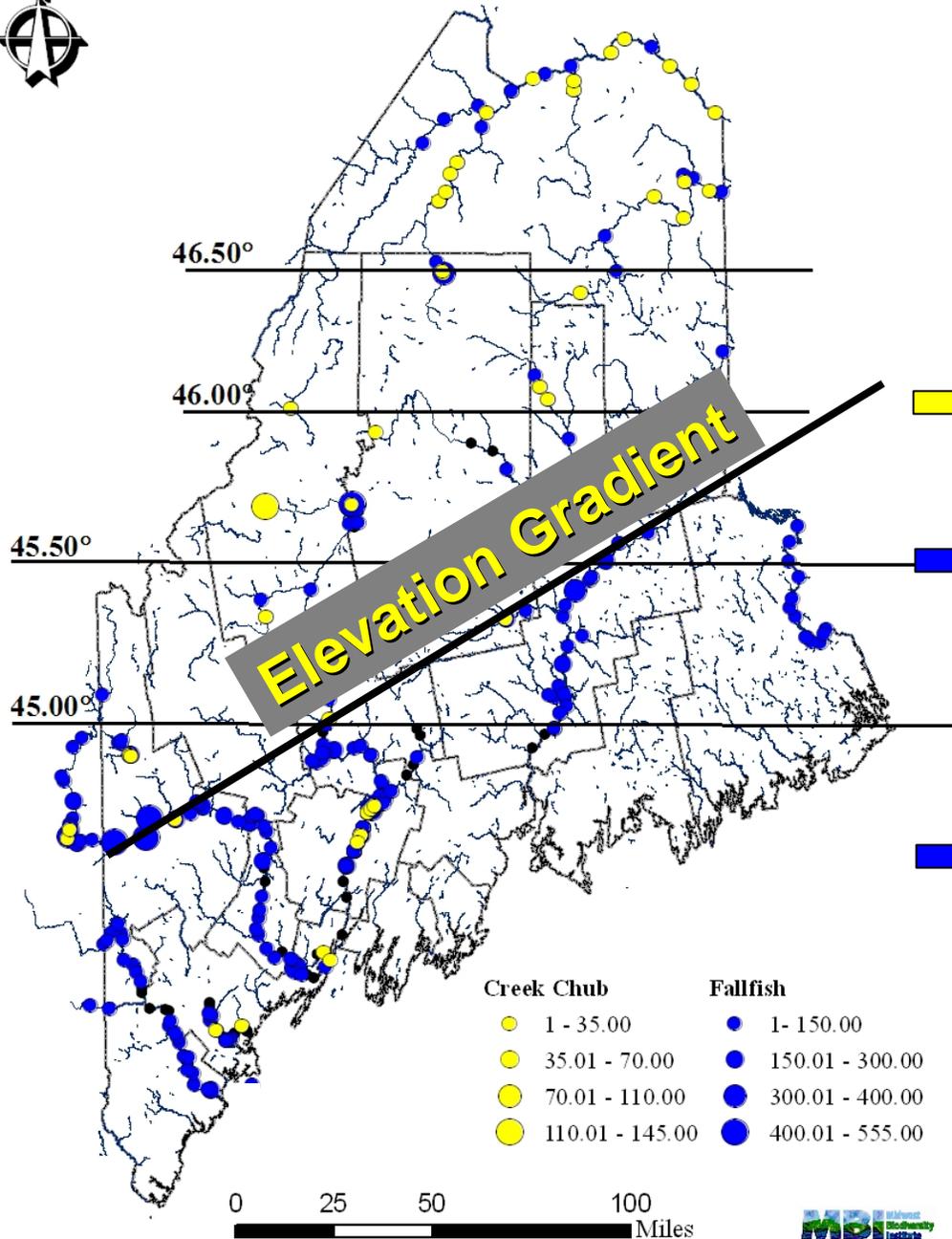
**Common shiner  
(All Indigenous Native)**



**Golden shiner  
(Indigenous Native)**



# Maine Rivers Fish Assemblage Assessment: 2002-7



# Warmwater Species



**Redbreast sunfish  
(Indigenous Native)**



**Pumpkinseed sunfish  
(Indigenous Native)**



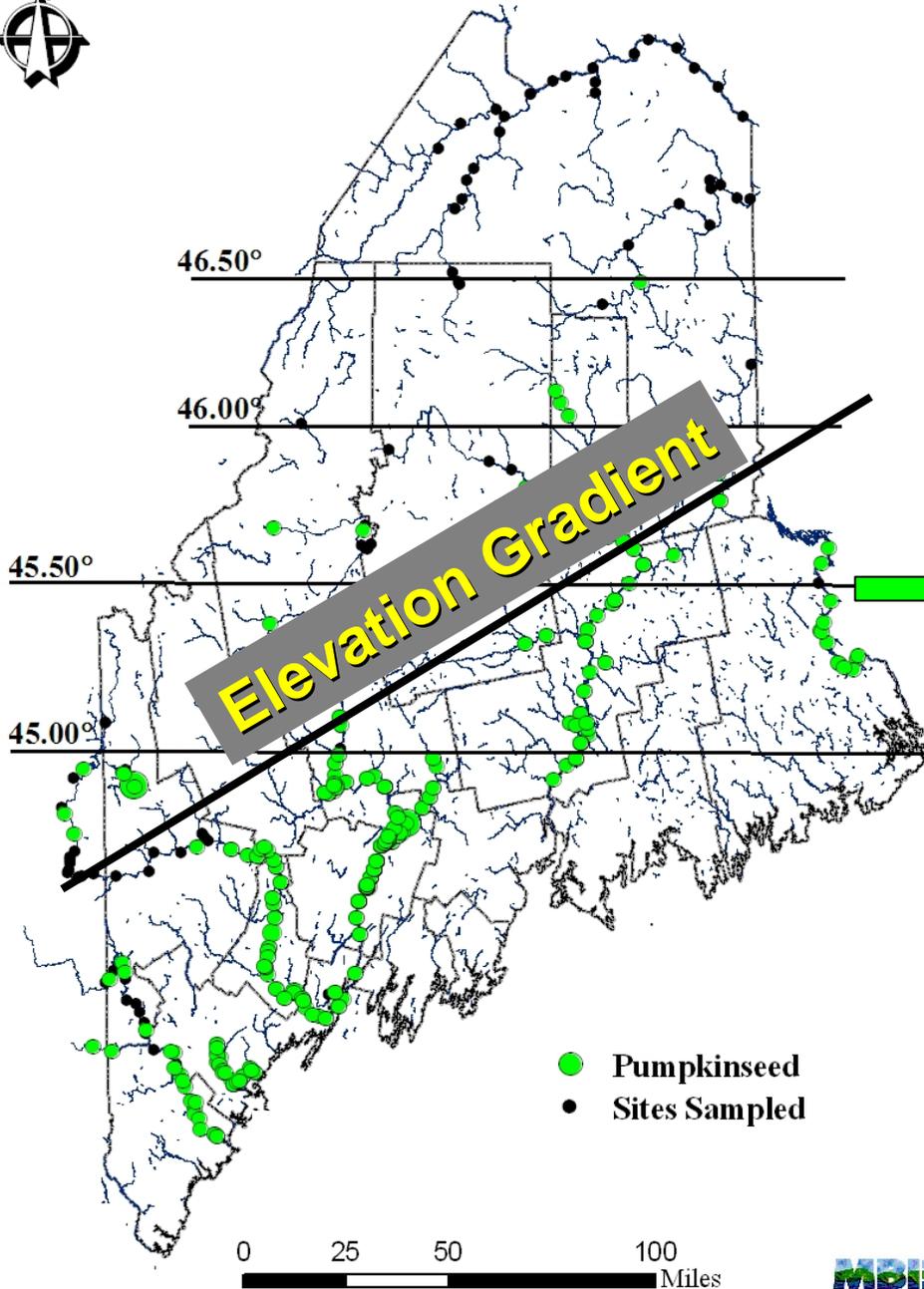
**Yellow perch  
(Indigenous Native)**



**Black crappie  
(Introduced)**

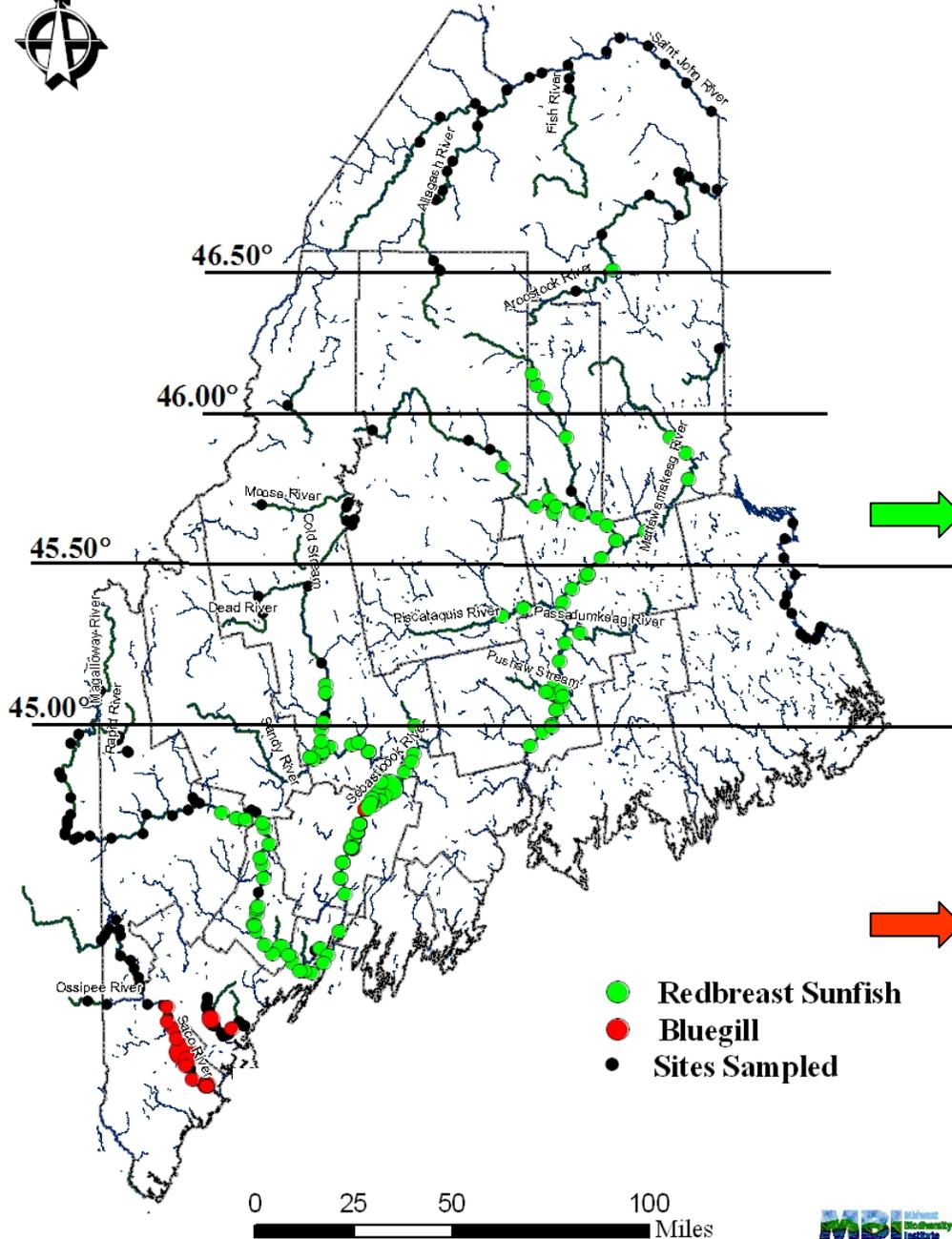


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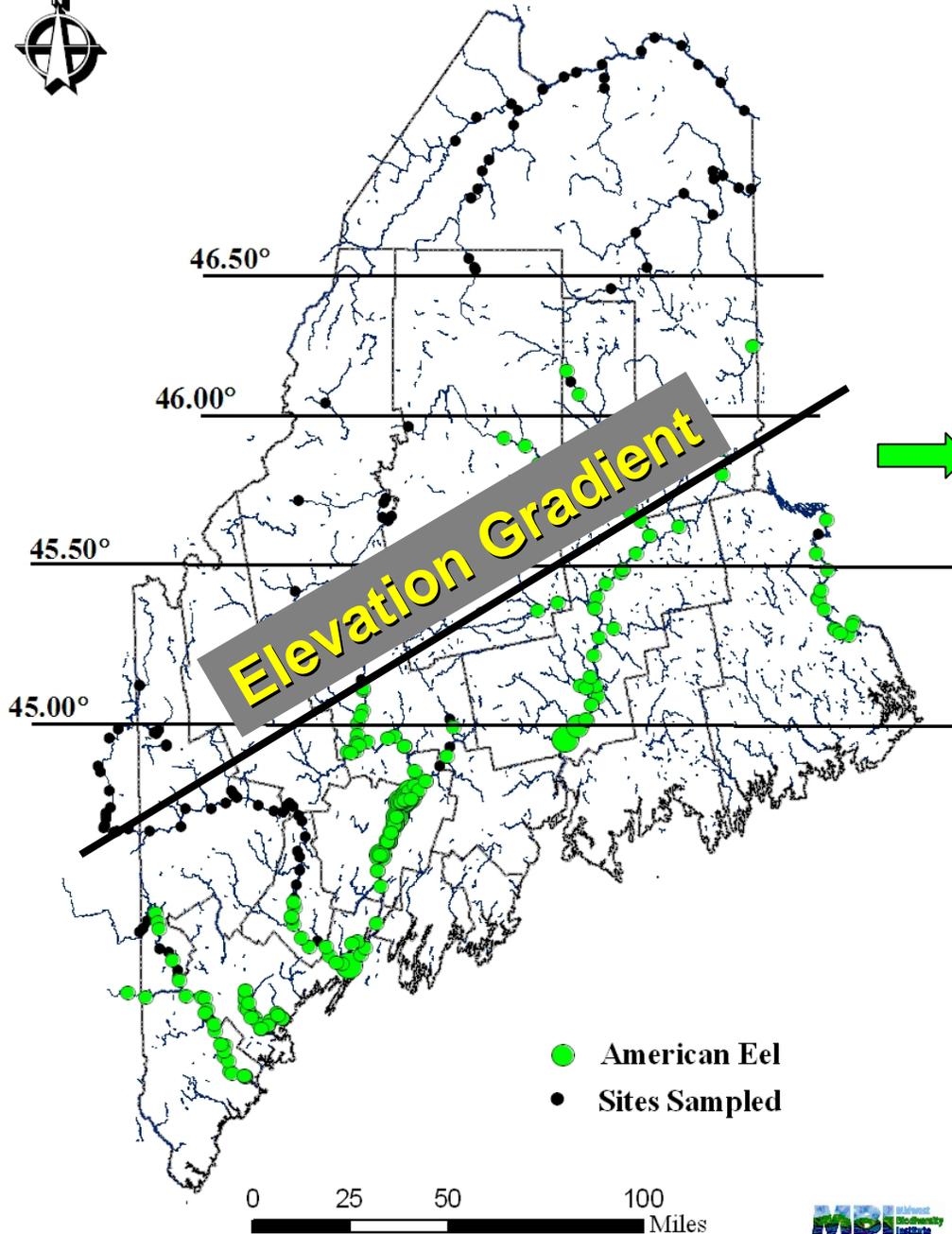
# Maine Rivers Fish Assemblage Assessment: 2002-7



# Native Species

American eel (Native Diadromous)



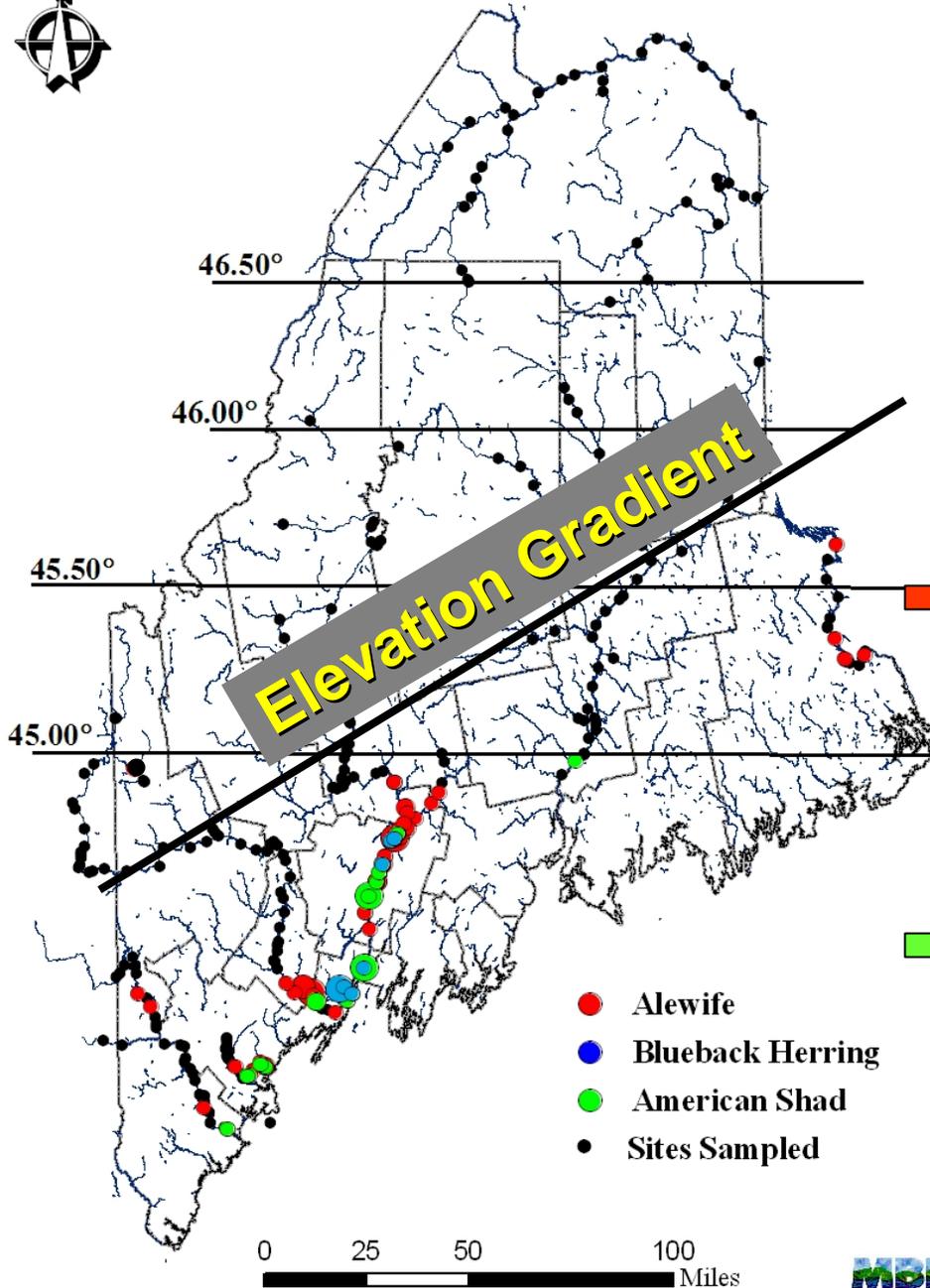


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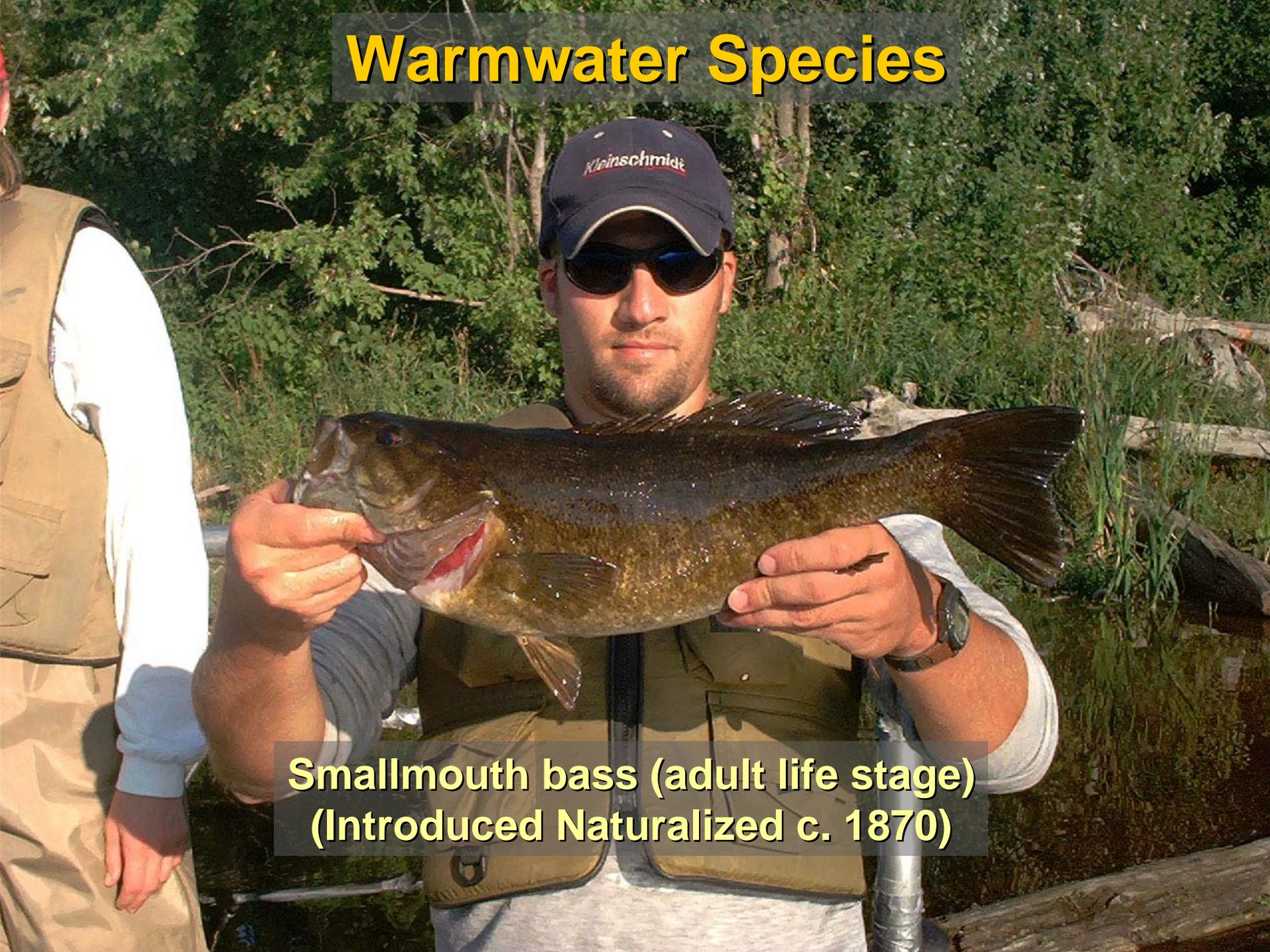




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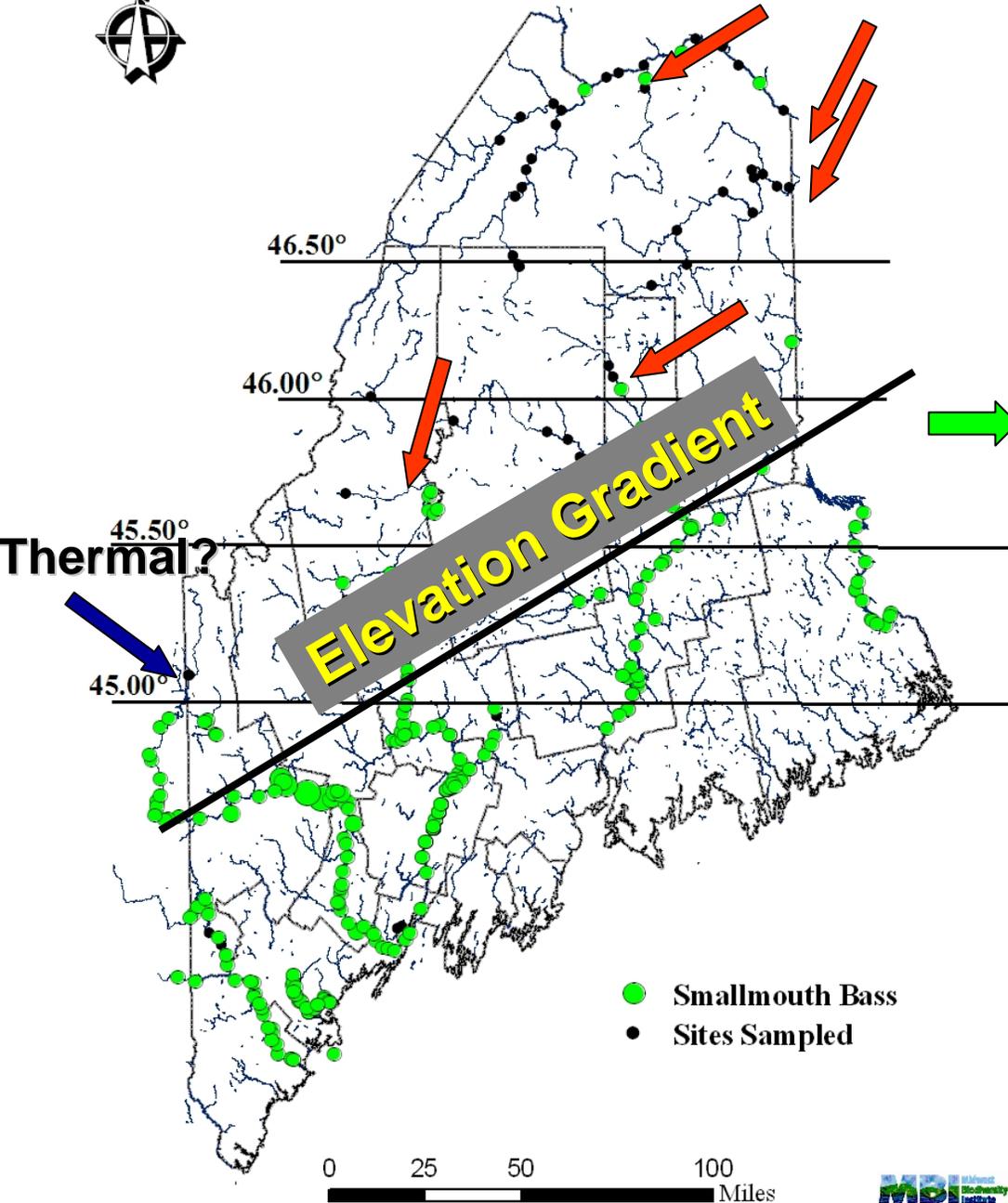
# Warmwater Species



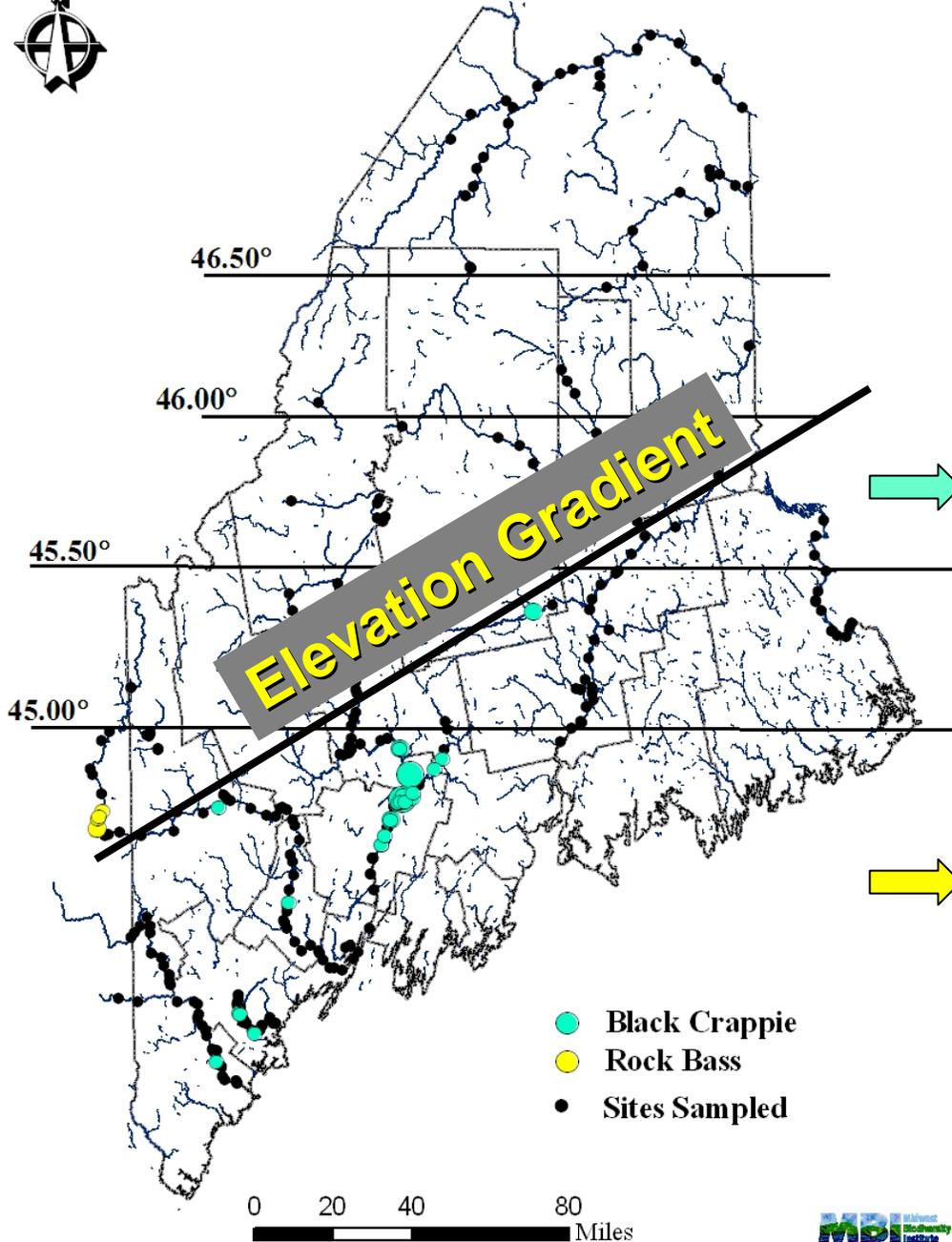
**Smallmouth bass (adult life stage)  
(Introduced Naturalized c. 1870)**



# Maine Rivers Fish Assemblage Assessment: 2002-7



← **Physical barriers**



# Maine Rivers Fish Assemblage Assessment: 2002-7



# **Definitions of Introduced Species Based on Origins (after Halliwell 2005)**

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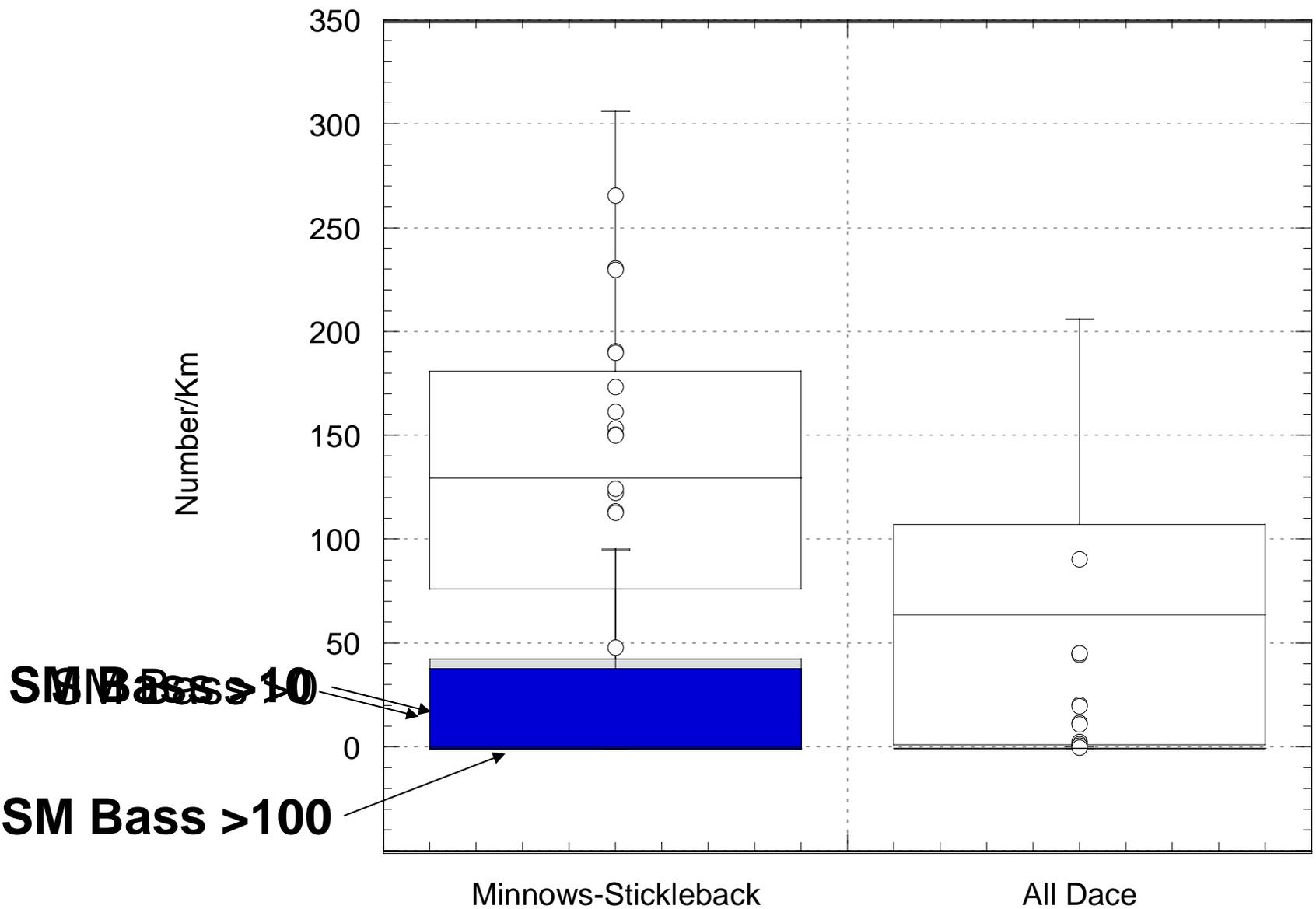
- **Intercontinental origin – usually referred to as “alien” species**
- **Intracontinental origin – species can become naturalized (e.g., smallmouth bass, rainbow trout)**
- **Intraregional origin – usually interstate or nearby New England transplants**
- **Managed introduced – deliberate stocking for recreational purposes**

# Assessing the Impact of Alien Species

## *Current Issues:*

- **Refined Designations of Non-native Species** – effects of each are not equal and some have become a permanent part of the resource.
- **Improved Understanding of Impacts** – impacts are different to cold and warmwater faunas; influence can be misinterpreted, especially with increases in overall species richness.

# Maine Fish Data: No Smallmouth Bass



# Maine Rivers 2007 Faunal Status

## Native Freshwater

- Brook trout (AI,Ar)
- Round whitefish (AI)
- White sucker (ALL)
- Longnose sucker (AI,Ar,SJ)
- Creek chubsucker (Sa)
- Fallfish (ALL)
- Common shiner (ALL)
- Blacknose shiner (AI)
- Lake chub (AI, Ar, SJ)
- Blacknose dace (AI, Ar, SJ)
- Longnose dace
- N. Redbelly dace (AI)
- Pearl dace
- Finescale dace (AI)
- Golden shiner (AI, SC)
- Fathead minnow (AI)
- Burbot (ALL)
- Banded killifish (Ar)
- Brown bullhead (ALL)
- Redbreast sunfish (Ar)
- Pumpkinseed (AI,SC,SJ)
- Yellow perch (Ar,SC,SJ)
- Slimy sculpin (AI,Ar,SJ)
- Brook stickleback (Ar)

## Salmonids

*(Managed, Non-indigenous)*

- Landlocked salmon (SJ,SC)
- Brown trout
- Rainbow trout

## Non-native Freshwater

*“Non-indigenous”*

- Central mudminnow (SJ)
- Chain pickerel (SC)
- Spottail shiner
- Smallmouth bass (SC,SJ)
- Largemouth bass
- Rock bass (NH only)
- White catfish
- Black crappie
- Bluegill (Sa,Ps)

*“Alien Invasive”*

- Gizzard shad
- Muskellunge (AI, SJ)
- Northern pike
- Common carp
- Rudd\*

## Anadromous

- Sea lamprey
- Atlantic sturgeon (Ke)
- Shortnose sturgeon (Ps)
- Shortnose sturgeon\*
- Alewife (SC)
- Blueback herring
- American shad
- Atlantic salmon
- White perch (SC)
- Striped bass (SC)
- Rainbow smelt (SC)

## Catadromous

- American eel

## Native Tidal

- Mummichog
- 3-spine stickleback (AI,Ar)
- 4-spine stickleback
- 9-spine stickleback (Ar)
- Northern silverside
- Atlantic tomcod (Ps)

\* - prev. recorded, not collected; \*\* - new species collected in 2006

**Ascertaining the status of native riverine fish assemblages is a major goal of this project**





# A shrinking refuge?

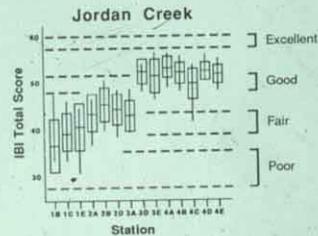


## Assessing Biological Integrity in Running Waters A Method and Its Rationale

James R. Karr  
Kurt D. Fausch  
Paul L. Angermeier  
Philip R. Yant  
Isaac J. Schlosser



Illinois Natural History Survey  
Special Publication 5 September 1986



# Guidelines for Deriving Regionally Relevant “IBI Type” Assessment Tools

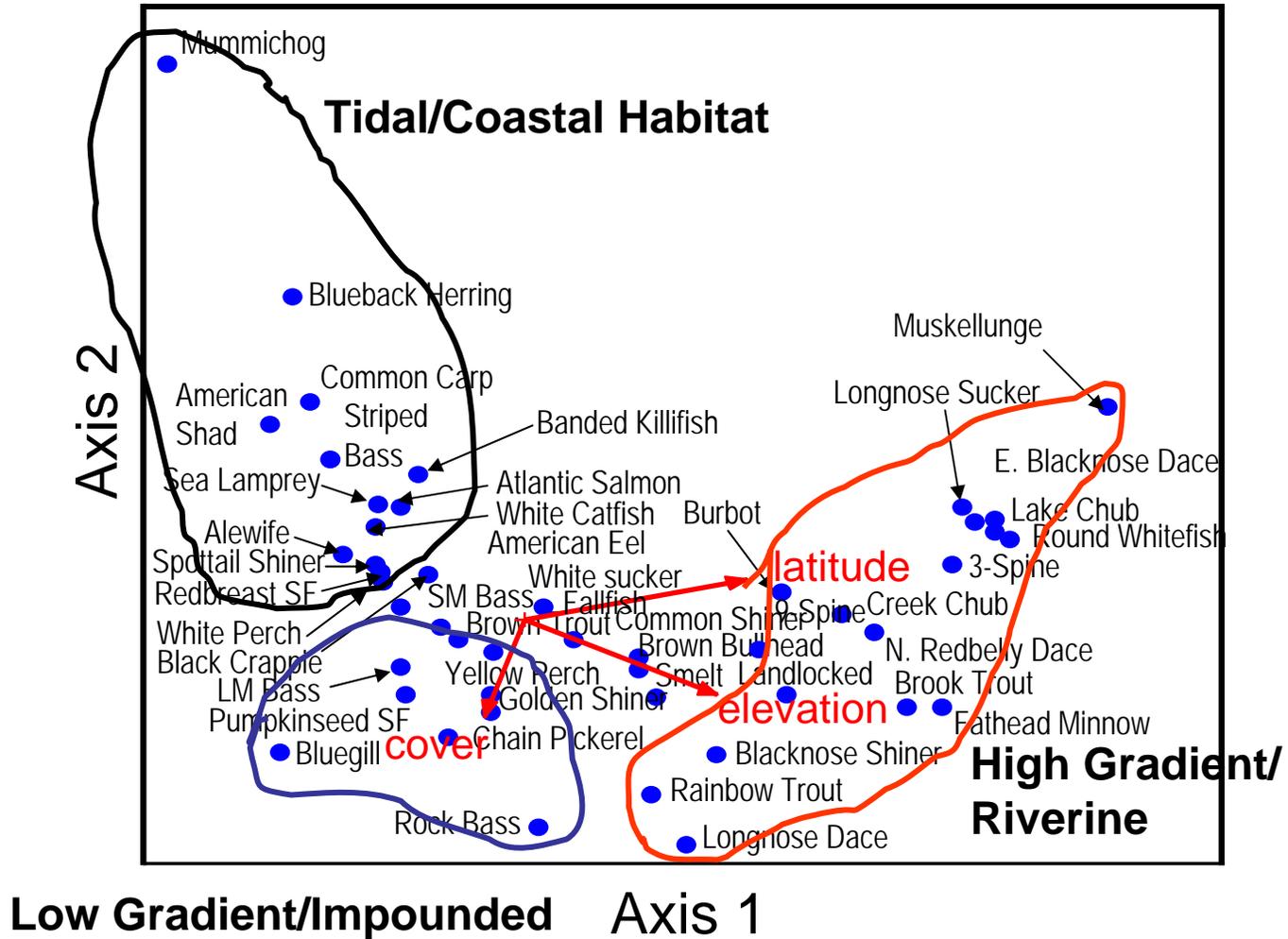
- Karr et al. (1986) provides guidance for metric development, substitution, and modification.
- Requires detailed knowledge of the regional fauna including life history, taxonomy, zoogeography, and natural history.
- Requires an extensive database from consistent sampling of both reference condition and a gradient of human disturbance.
- Requires extensive testing of candidate metrics and aggregate indices.

# Checklist of Fish Assemblage Development Tasks

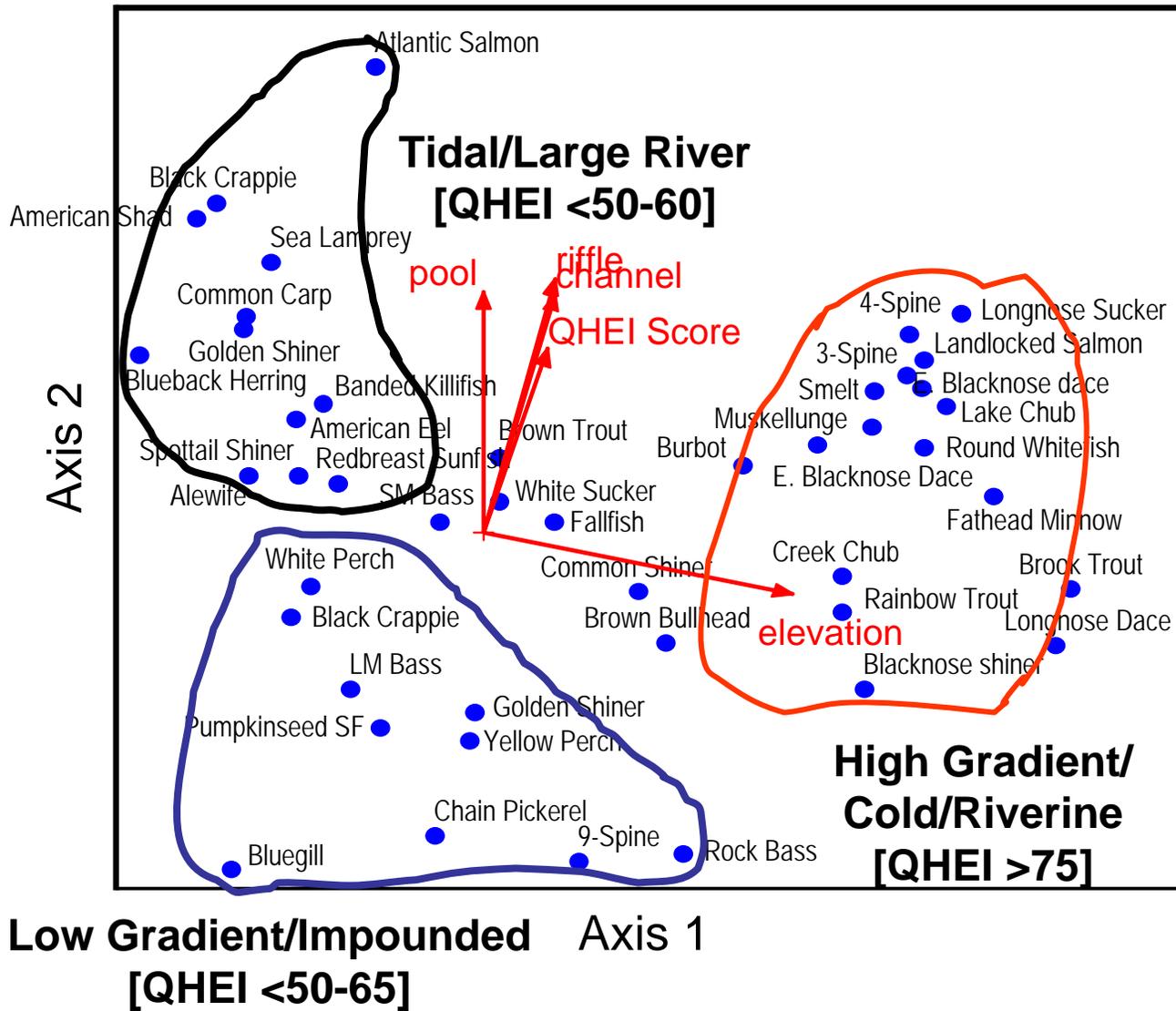
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- Develop an effective & systematic sampling method (2001-3)
- Develop a sufficient spatial & temporal database (2002-6)
- Autecology of extant fauna & metric development (2005-6)
- Classify riverine ecotypes (2006-7)
- Establish “reference condition” – BCG (2007-8)
- Derive and test IBIs with reference and independent test sites (2008)

# Canonical Correspondence Analysis



# Canonical Correspondence Analysis



# Interpretation of Gradients: Using Inference to Define Drivers

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- **Latitudinal – suggests regional thermal influences**
- **Elevational – suggests regional thermal and gradient influences**
- **Gradient (m/km) – reach scale influence on macrohabitat**
- **Smallmouth bass – abundance influences key sentinel and indigenous small species**
- **How to handle co-occurrences?**

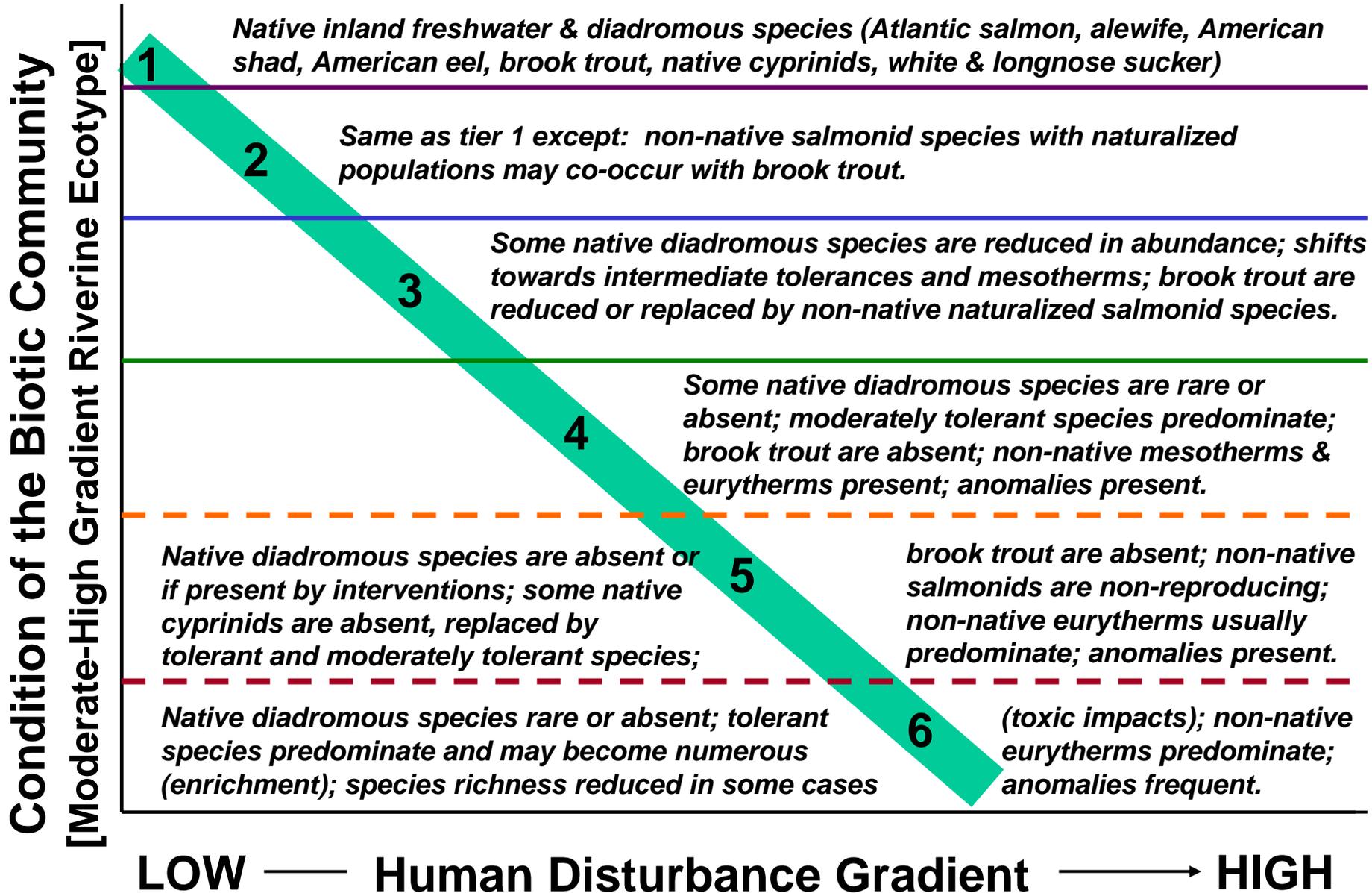
# Candidate IBI Metrics

Table 6. Candidate metrics for further evaluation and possible inclusion in fish assemblage IBIs applicable to non-wadeable rivers of Maine.

Candidate Metric	Expressed As <sup>1</sup>	Intent	Origin <sup>2</sup>
<i>Taxonomic</i>			
Sucker species	N	Long lived species	Original IBI metric
Cyprinid species	B	Important faunal component	Whittier et al. (2000)
Sunfish species	N	Water column inhabitant	Original IBI metric
Clupeid species	%	Diadromous component	None
Adult suckers	%	Riverine run habitat	None
<i>Ecological Role</i>			
Stenothermic species	B	Cold water habitat specialists	Coldwater IBI metric
Steno + Mesothermic sp.	B	Cold & cool water habitat	None
Eurythermic species	B	Signal shift from cold water	None
Fluvial specialists	%	Riverine habitat dependency	Bain and Meixler (2000)
Fluvial dependents	%	Riverine habitat dependency	Bain and Meixler (2000)
Macrohabitat generalists	%	Reflect loss of riverine habitat	Bain and Meixler (2000)
Diadromous species	B	Original component of fauna	None
Native tidal species	B	Reflect tidal habitats	None
<i>Reproduction and Recruitment</i>			
Age classes across all species	N	Reproduction/recruitment	None
Salmonid age classes	B	Reproduction/recruitment	Mebane et al. (2002)
Non-guarding Lithophils	B	Sensitive to substrate quality	Hughes et al. (1998)

Metric values can be expressed as # species, individuals, biomass, or proportion of sample.

# Tiered Aquatic Life Use Conceptual Model: Maine Rivers



# Next Steps

## Baseline data collection:

- Gaps in spatial coverage filled in 2006-7
- Continue lower Kennebec – Waterville to tidal
- Penobscot River – follow dam removals (2008)
- Regional scope – Other New England rivers

## Exploratory Data Analysis (2008):

- Multivariate analyses – explore gradients
- IBI metric development and testing - BCG
- Test IBI for responsiveness along BCG
- Final report due November 30, 2008

# Our Thanks to the Many Project Cooperators

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- U.S. EPA, Region I – project sponsor
- Maine IF&W
- Maine DEP
- Maine DMR & ASC
- Maine DOC
- Allagash Wilderness Waterway
- US F&WS
- Penobscot Indian Nation
- Harvard MCZ
- Numerous volunteers
- Land Owners
- And many, many others!

