CONTINUED DEVELOPMENT OF A FISH ASSEMBLAGE ASSESSMENT METHOD FOR NON-WADEBALE RIVERS IN MAINE & NEW ENGLAND: 2002 - 2006

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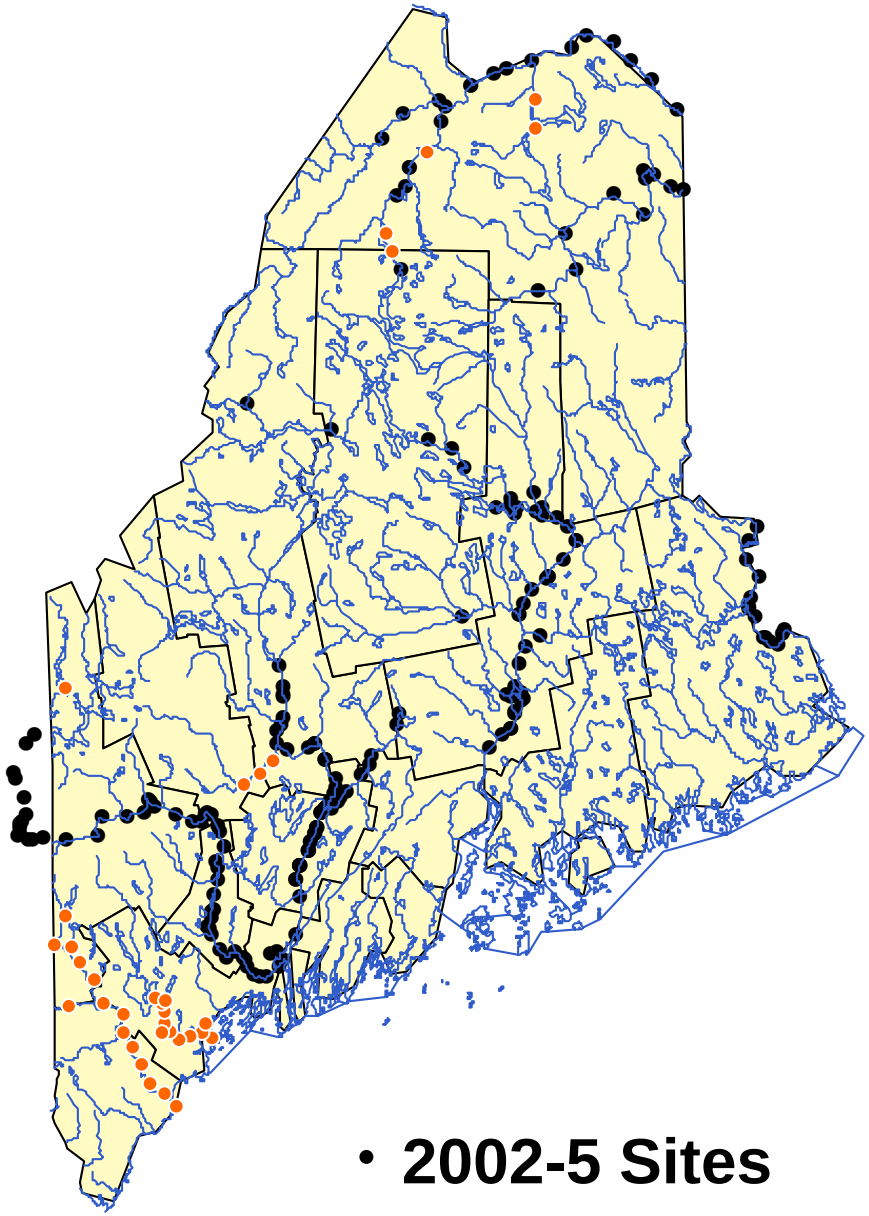


Kennebec River (2002-6)

- 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)

Sebasticook 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)

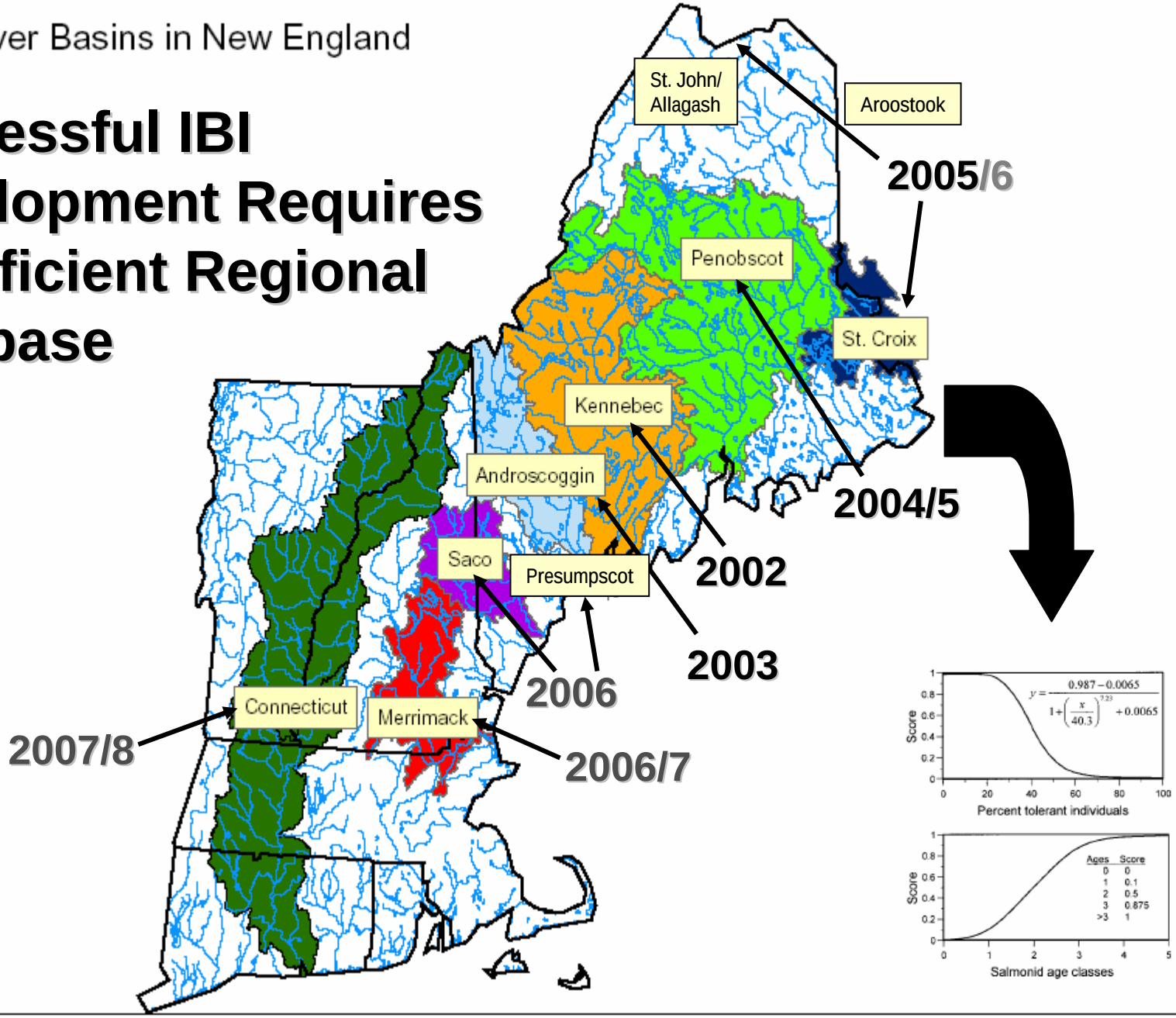
- St. John (14 sites), Allagash (5 sites), Aroostook (10 sites), St. Croix (12 sites)

Southern Maine Rivers (2006)

- Presumpcot R., Saco R.

Major River Basins in New England

Successful IBI Development Requires a Sufficient Regional Database



Why Knowledge of the Fish Assemblage is Important

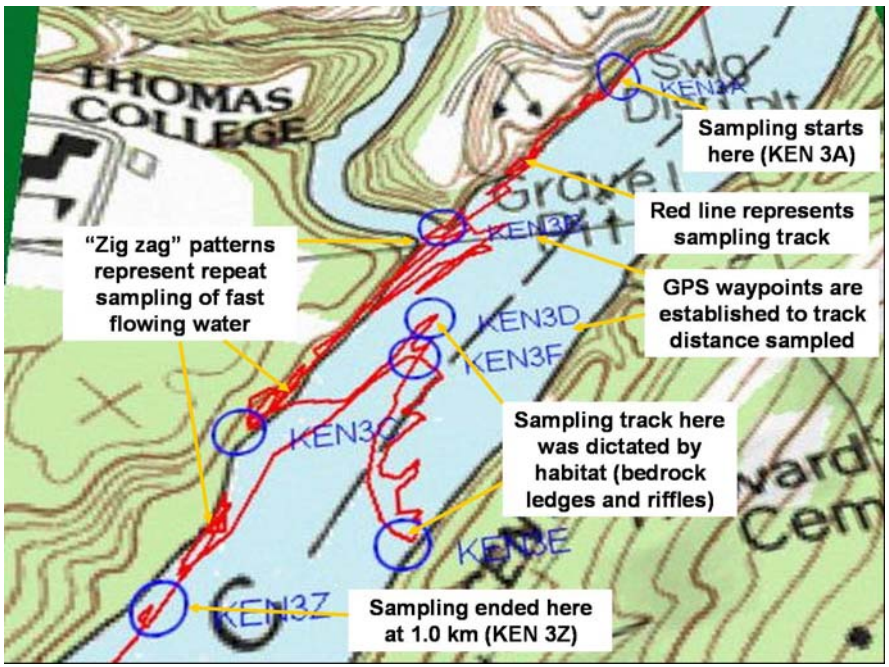
Current Issues:

- **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 Conflicts with High Profile Restoration Goals –** do non-native species pose an unintentional deterrent or barrier?

Sampling Methods

Standardized Approach:

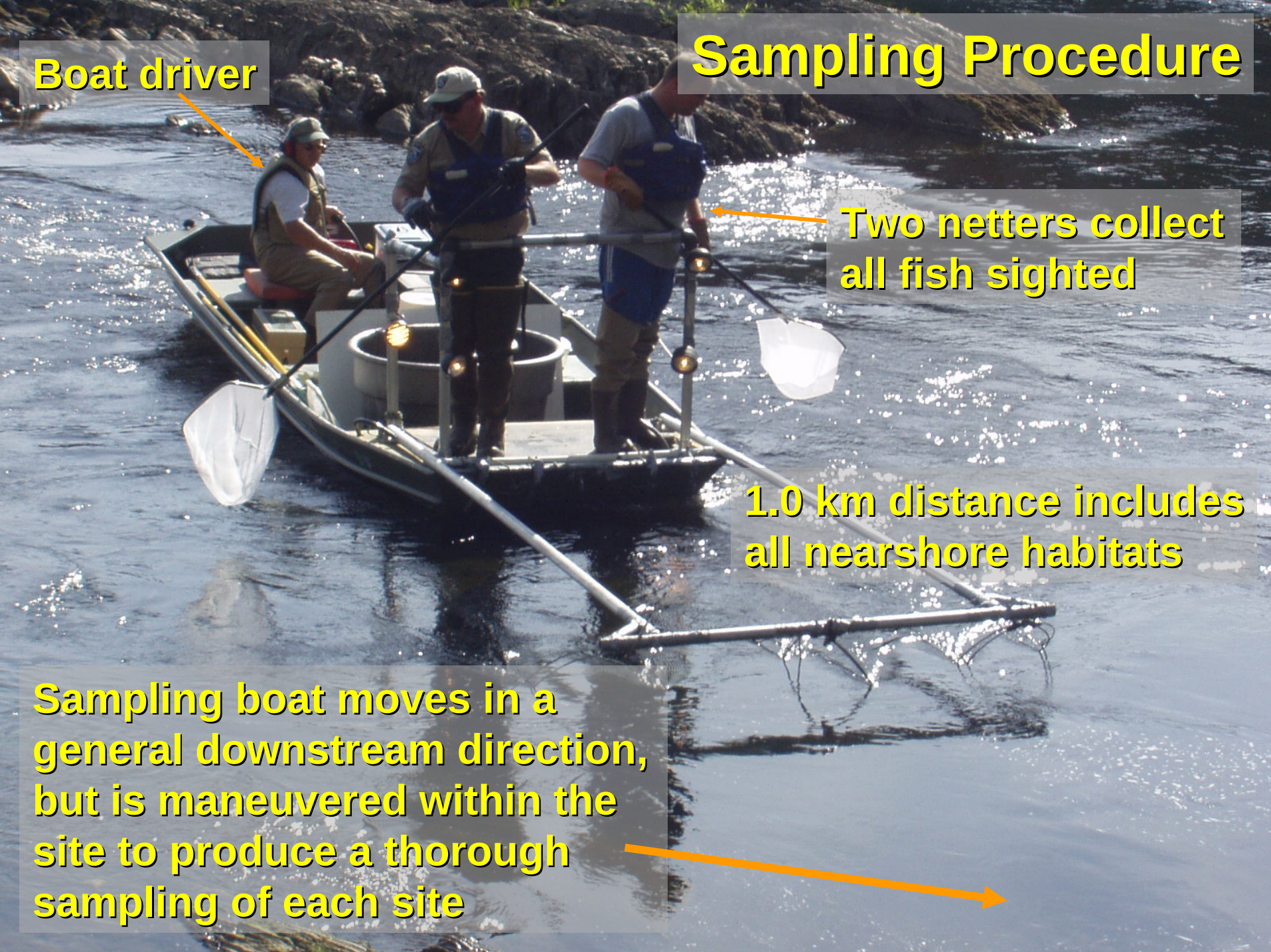
- Pulsed D.C. boat electrofishing – effort indexed to distance
- Electrode array customized for Maine river conditions
- Intensive survey design – mainstem & non-wadeable tribs.
- Field water quality and habitat data
- July – September index period

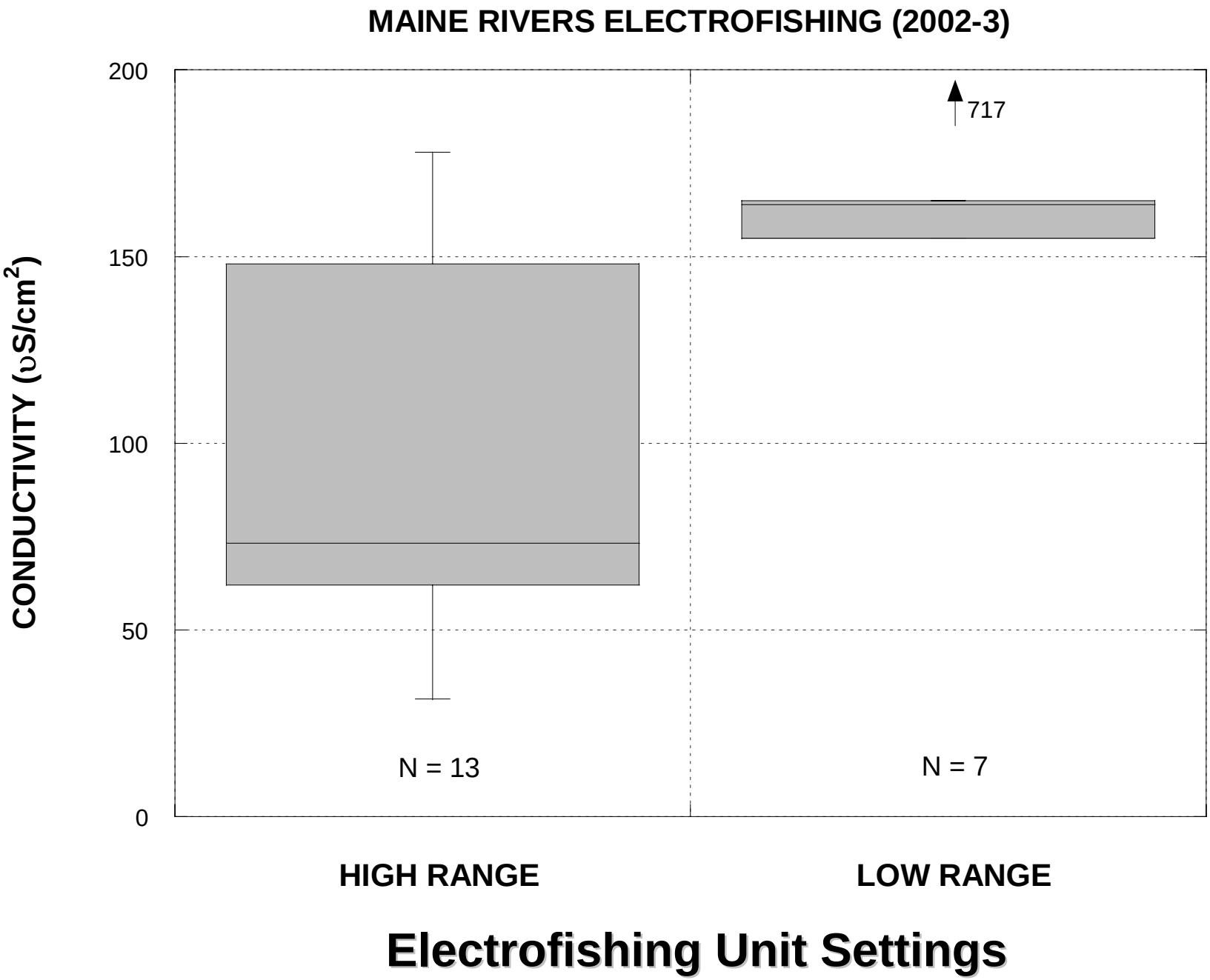


- Geo-referenced sample site location and sample track

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


MAINE RIVERS ELECTROFISHING (2002-3)
CONDUCTIVITY (υS/cm²)
200
150
100
50
0
717
N = 13
N = 7
HIGH RANGE
LOW RANGE
Electrofishing Unit Settings

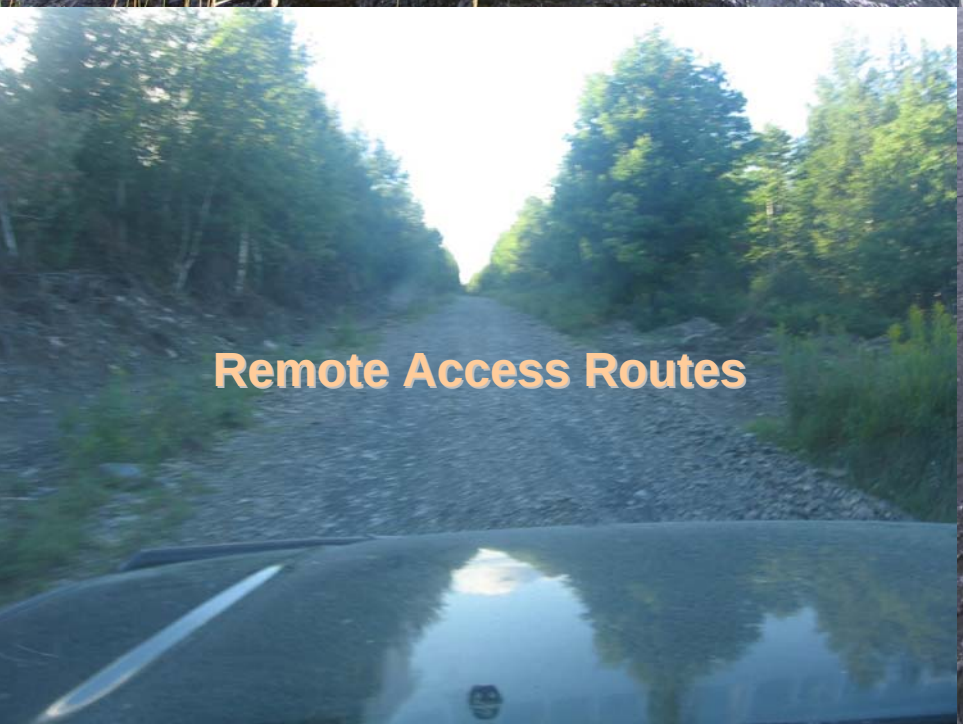
Developed in 2005 to Access Medium Sized and Shallower Rivers

Launching & Retrieving

Smith-Root 2.5 GPP Unit


Navigates small non-wadeable rivers


0.7-1.0 km sampling sites


Remote Access Routes


Standard sampling procedure

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 SubstrateTYPE BOXES; Estimate % present

TYPE	POOL	RIFFLE
☐☐-BLDR /SLBS[10]	____	____
☐☐-BOULDER [9]	____	____
☐☐-COBBLE [8]	____	____
☐☐-HARDPAN [4]	____	____
☐☐-MUCK [2]	____	____
☐☐-SILT [2]	____	____
☐☐-GRAVEL [7]	____	____
☐☐-SAND [6]	____	____
☐☐-BEDROCK[5]	____	____
☐☐-DETRITUS[3]	____	____
☐☐-ARTIFICIAL[0]	____	____

NOTE: Ignore Sludge Originating From Point Sources

SUBSTRATE ORIGIN Check ONE (OR 2 & AVERAGE)

☐-LIMESTONE [1]
☐-TILLS [1]
☐-WETLANDS[0]
☐-HARDPAN [0]
☐-SANDSTONE [0]
☐-RIP/RAP [0]
☐-LACUSTRINE [0]
☐-SHALE [-1]
☐-COAL FINES [-2]

SILT: ____ ____ ____ EMBEDDEDNESS:

SUBSTRATE QUALITY Check ONE (OR 2 & AVERAGE)

☐- SILT HEAVY [-2]
☐-SILT MODERATE [-1]
☐-SILT NORMAL [0]
☐-SILT FREE [1]
☐-EXTENSIVE [-2]
☐-MODERATE [-1]
☐-NORMAL [0]
☐-NONE [1]

Substrate ☐ Max 20

NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >)
☐-4 or More [2]
☐-3 or Less [0]

COMMENTS_____

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

(Structure) TYPE: Score All That Occur

___UNDERCUT BANKS [1]
___OVERHANGING VEGETATION [1]
___SHALLOWS (IN SLOW WATER) [1]
___ROOTMATS [1]
___POOLS> 70 cm [2]
___ROOTWADS [1]
___BOULDERS [1]
___OXBOWS, BACKWATERS [1]
___AQUATIC MACROPHYTES [1]
___LOGS OR WOODY DEBRIS [1]

COMMENTS:_____

AMOUNT: (Check ONLY One or check 2 and AVERAGE)

☐ - EXTENSIVE > 75% [11]
☐ - MODERATE 25-75% [7]
☐ - SPARSE 5-25% [3]
☐ - NEARLY ABSENT < 5%[1]

Cover ☐ Max 20

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

SINUOSITY
☐ - HIGH [4]
☐ - MODERATE [3]
☐ - LOW [2]
☐ - NONE [1]

DEVELOPMENT
☐ - EXCELLENT [7]
☐ - GOOD [5]
☐ - FAIR [3]
☐ - POOR [1]

CHANNELIZATION
☐ - NONE [6]
☐ - RECOVERED [4]
☐ - RECOVERING [3]
☐ - RECENT OR NO RECOVERY [1]

STABILITY
☐ - HIGH [3]
☐ - MODERATE [2]
☐ - LOW [1]

MODIFICATIONS/OTHER
☐ - SNAGGING
☐ - RELOCATION
☐ - CANOPY REMOVAL
☐ - DREDGING
☐ - ONE SIDE CHANNEL MODIFICATIONS
☐ - IMPOUND.
☐ - ISLANDS
☐ - LEVEED
☐ - BANK SHAPING

Channel ☐ Max 20

COMMENTS:_____

Project Status

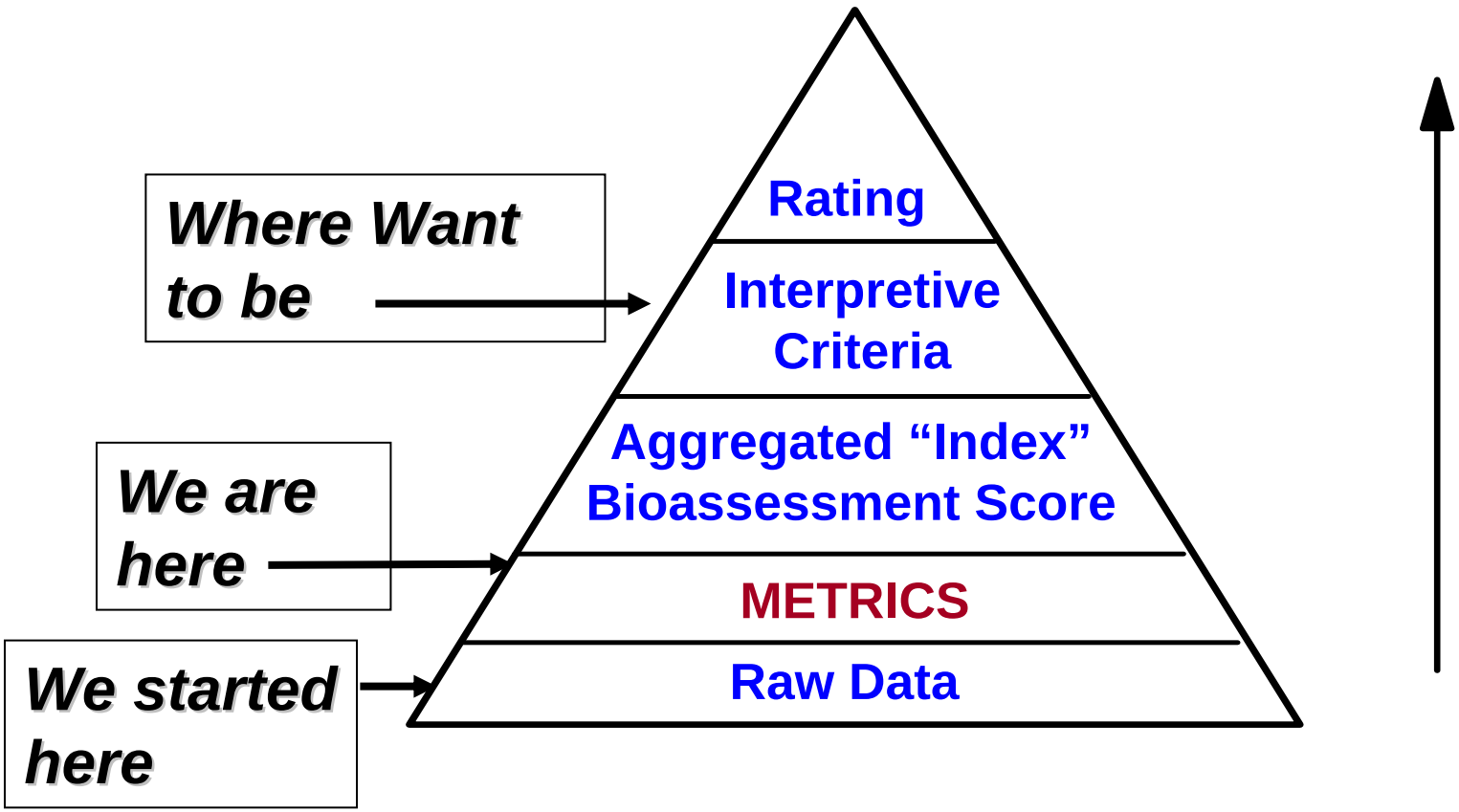
Development of standardized field methods:

- 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:

- Distribution & abundance of key species
- Baseline assemblage parameters
- Analysis of core stressors – habitat, T (°C)
- Autecology of each species – pre-IBI

Data Manipulation Hierarchy of Field Collected Biological Samples



Relative Abundance Data

Species List

River Code: **50-001**	Stream: **Kennebec River (ust. Edwards Dam)**	River Segment Totals
Mile Range: **59.20**		Date Range: 08/08/2002
Thru: **75.00**		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
	Stream Total				4,830	376.30		16.90		
	Number of Species				18					
	Number of Hybrids				1					

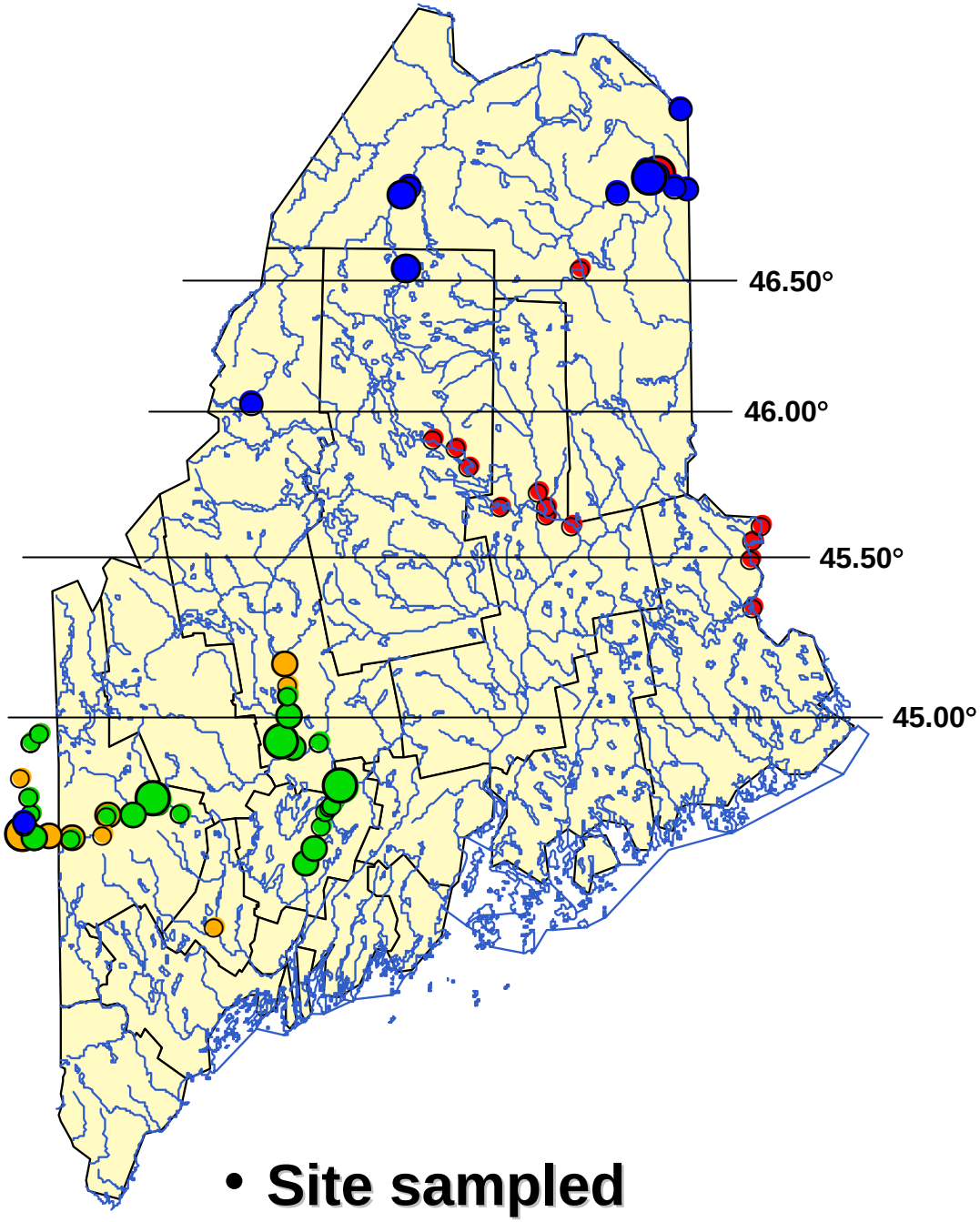
Cold Water Species: Salmon and Trout

Landlocked salmon
(Intracontinental Introduced)

Rainbow trout
(Intercontinental Introduced)

Brook trout
(Indigenous Native)

Brown trout
(Intercontinental Introduced)



- Brown trout
- Rainbow trout
- Brook trout
- Landlocked salmon

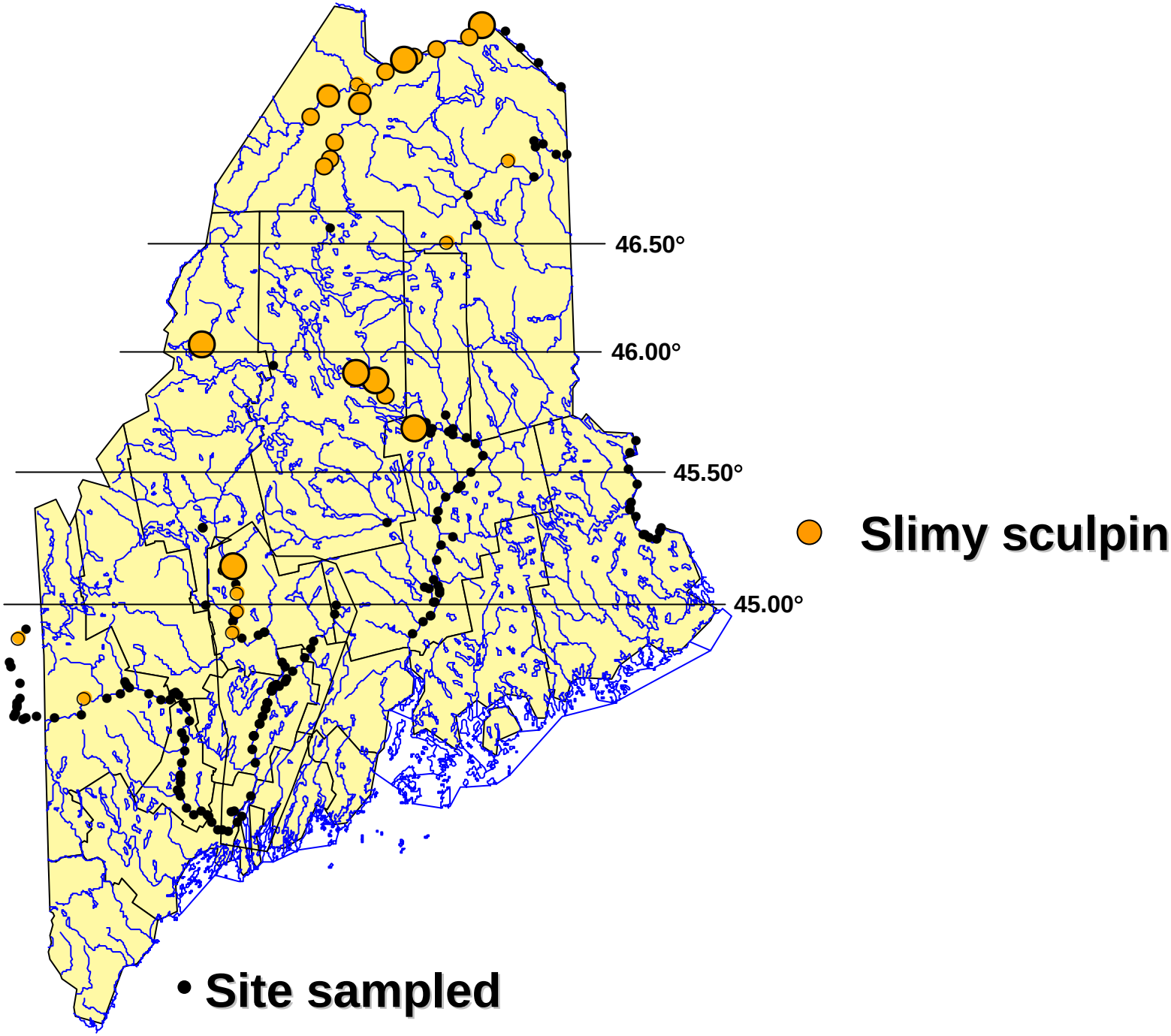
Cold Water Species: Non-Salmonids (Indigenous Natives)

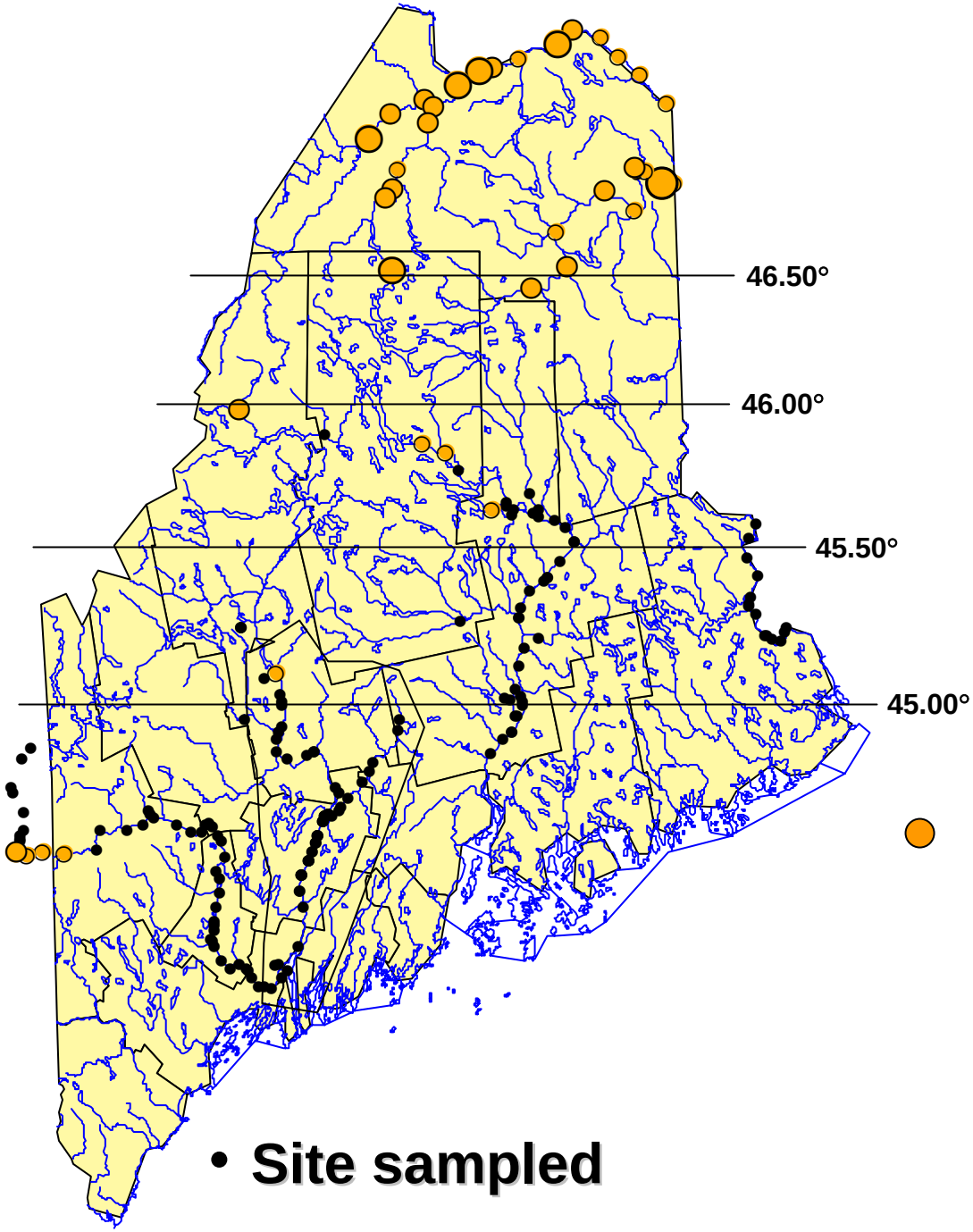
Common white sucker (adult life stage)

Slimy sculpin

Lake chub

Burbot


46.50°
46.00°
45.50°
45.00°
Slimy sculpin
• Site sampled


46.50°
46.00°
45.50°
45.00°
Lake chub
Site sampled

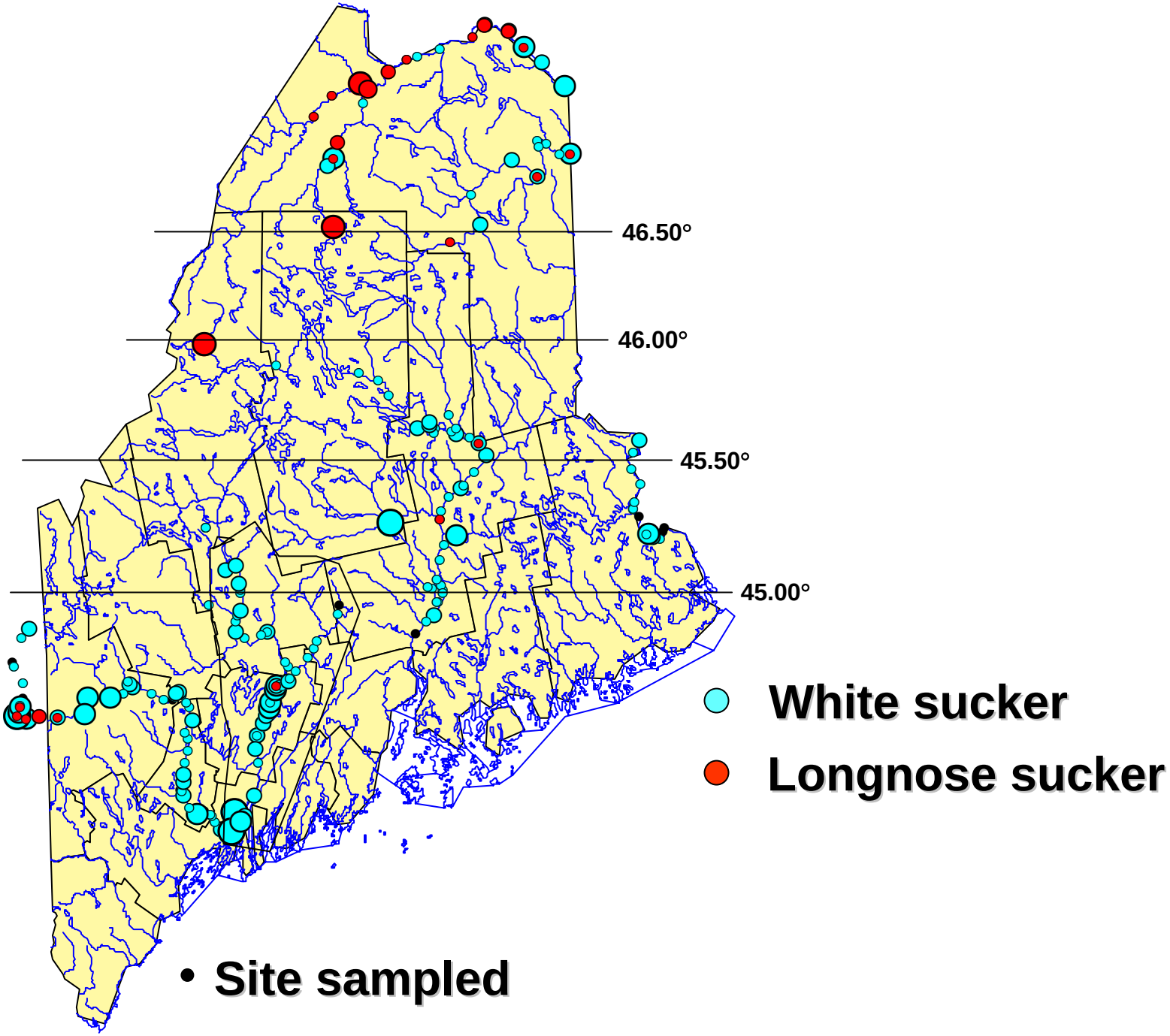
Cold Water Species: Non-Salmonids (Indigenous Natives)

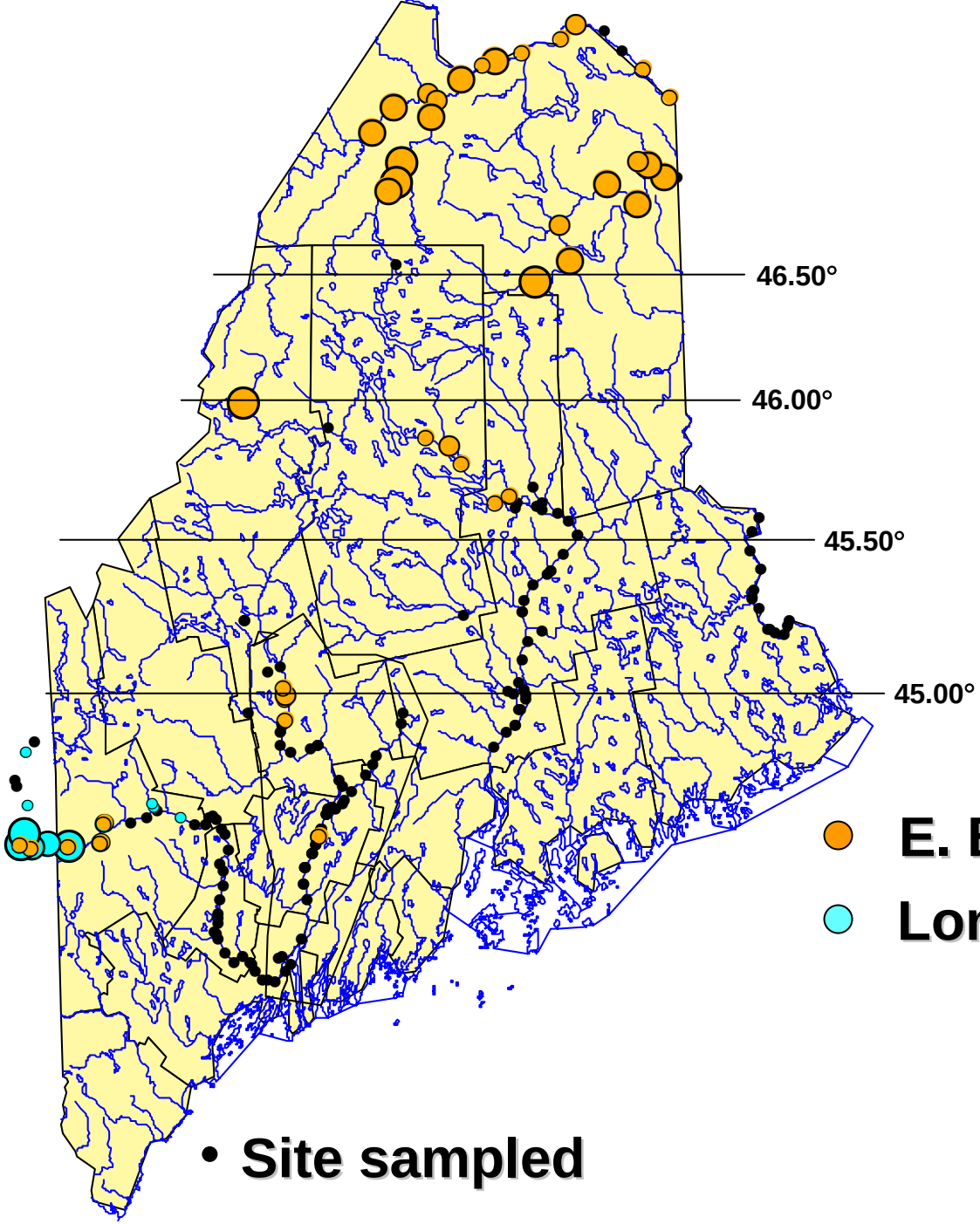
Round Whitefish

Longnose Sucker

Blacknose Dace

Longnose Dace


46.50°
46.00°
45.50°
45.00°
White sucker
Longnose sucker
• Site sampled


46.50°
46.00°
45.50°
45.00°
E. Blacknose dace
Longnose dace
• Site sampled

Widely Distributed Species: Cyprinidae

Fallfish
(Indigenous Native)

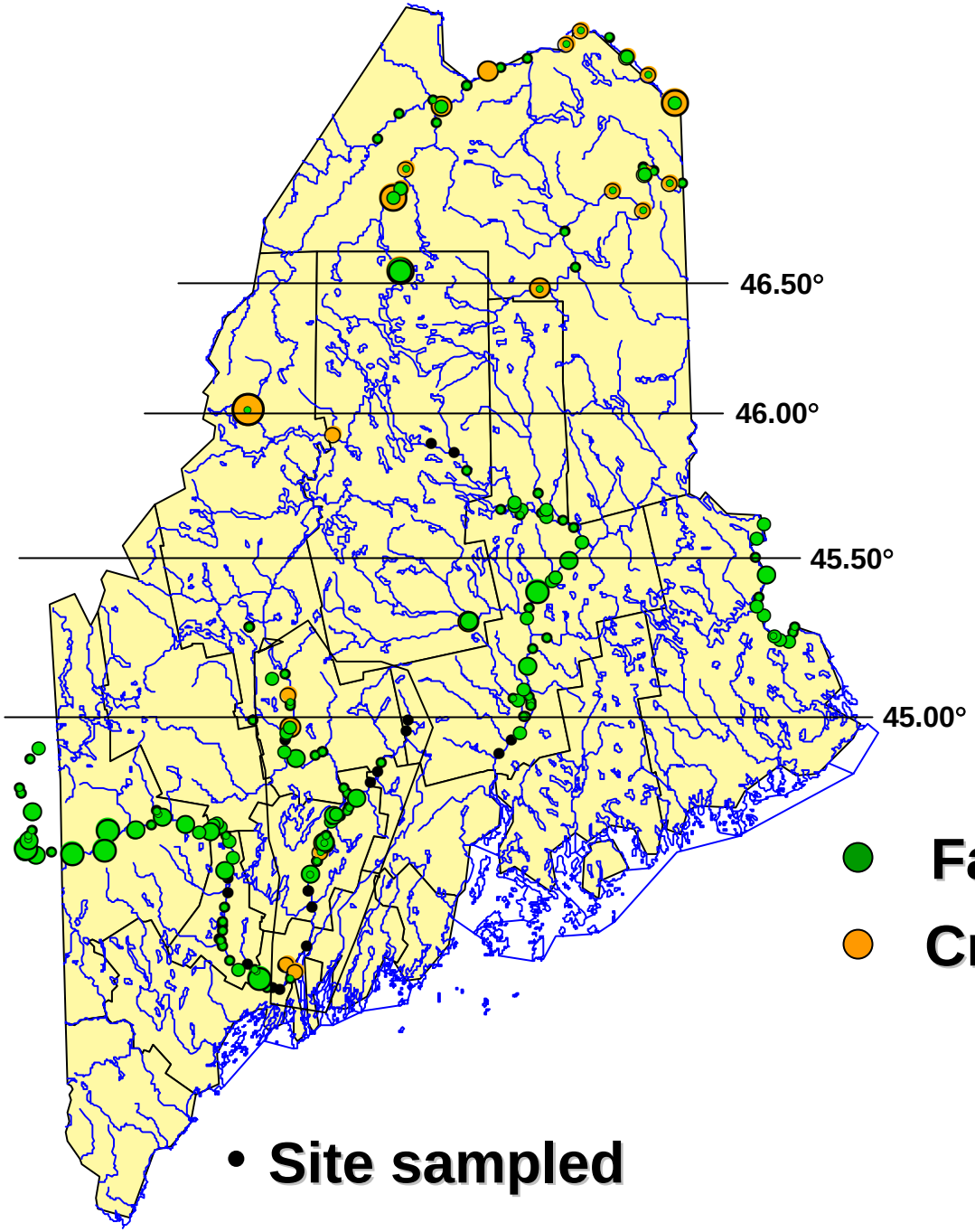
Common shiner
(Indigenous Native)

Creek chub

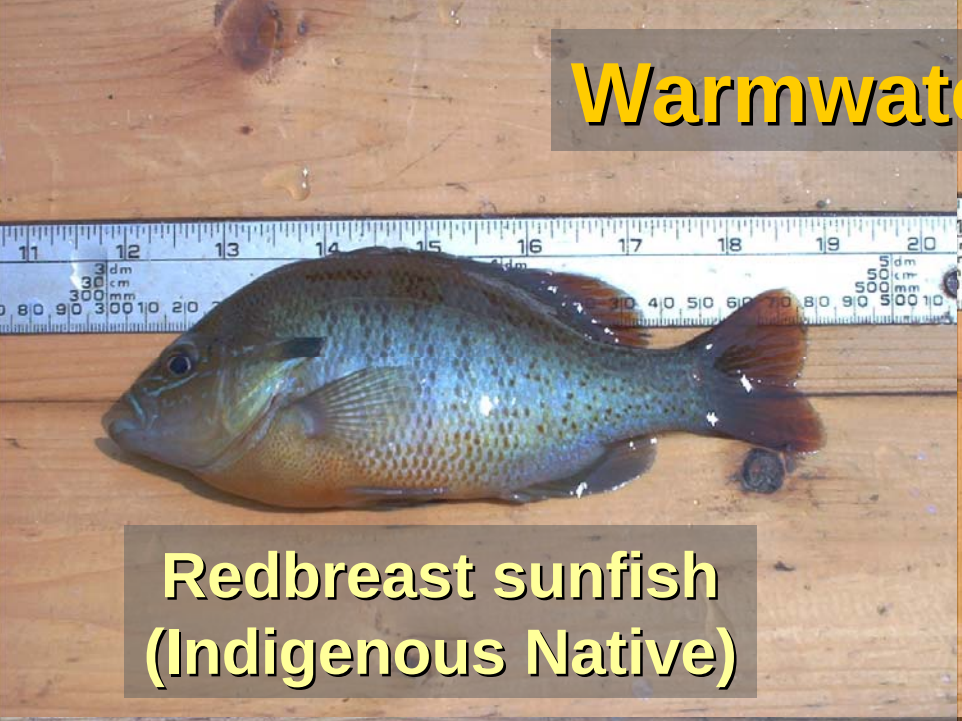
Fallfish

Common shiner
(All Indigenous Native)

Golden shiner
(Indigenous Native)


46.50°
46.00°
45.50°
45.00°
Fallfish
Creek chub
• Site sampled

Warmwater Species

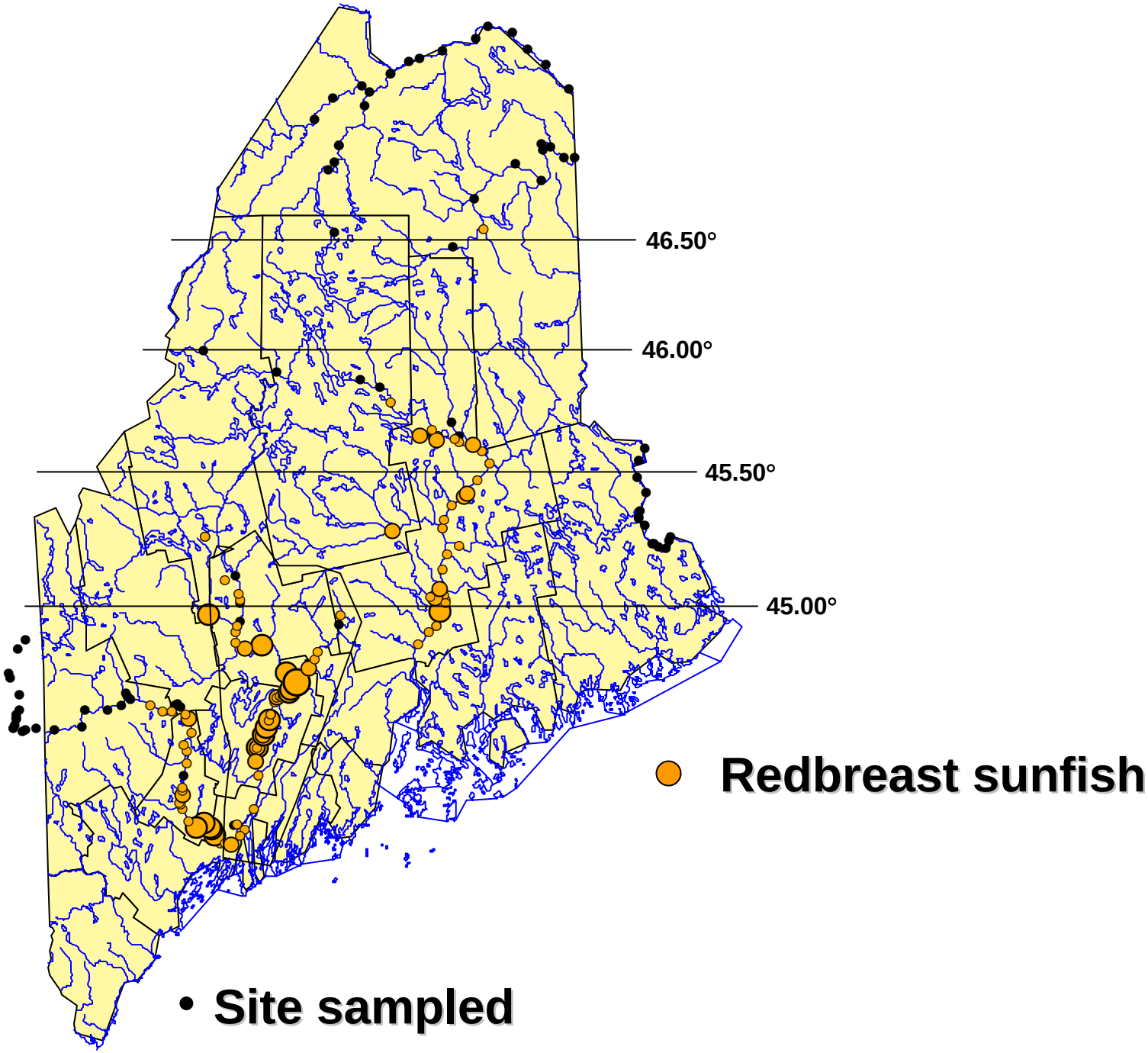


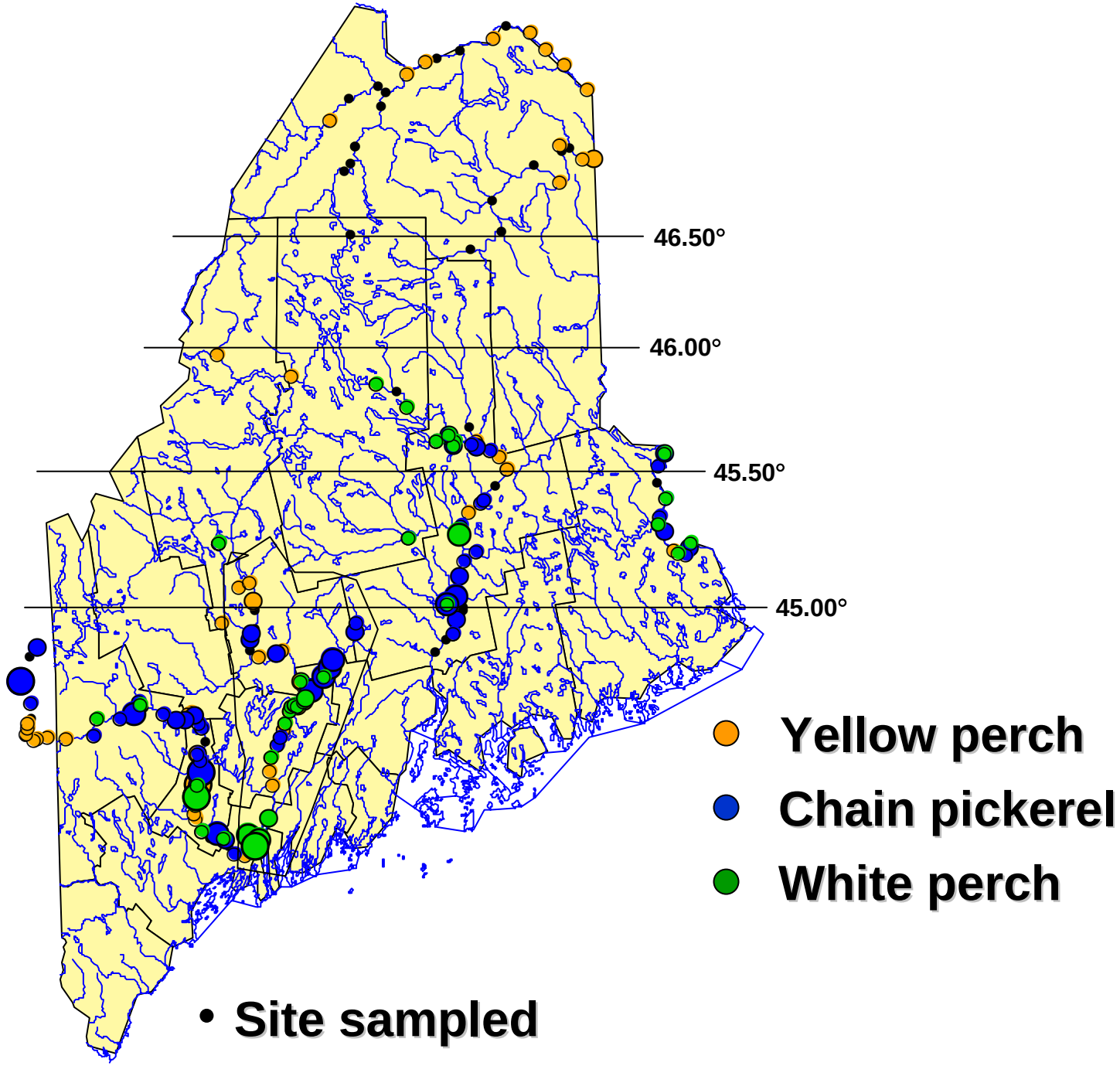
Redbreast sunfish
(Indigenous Native)

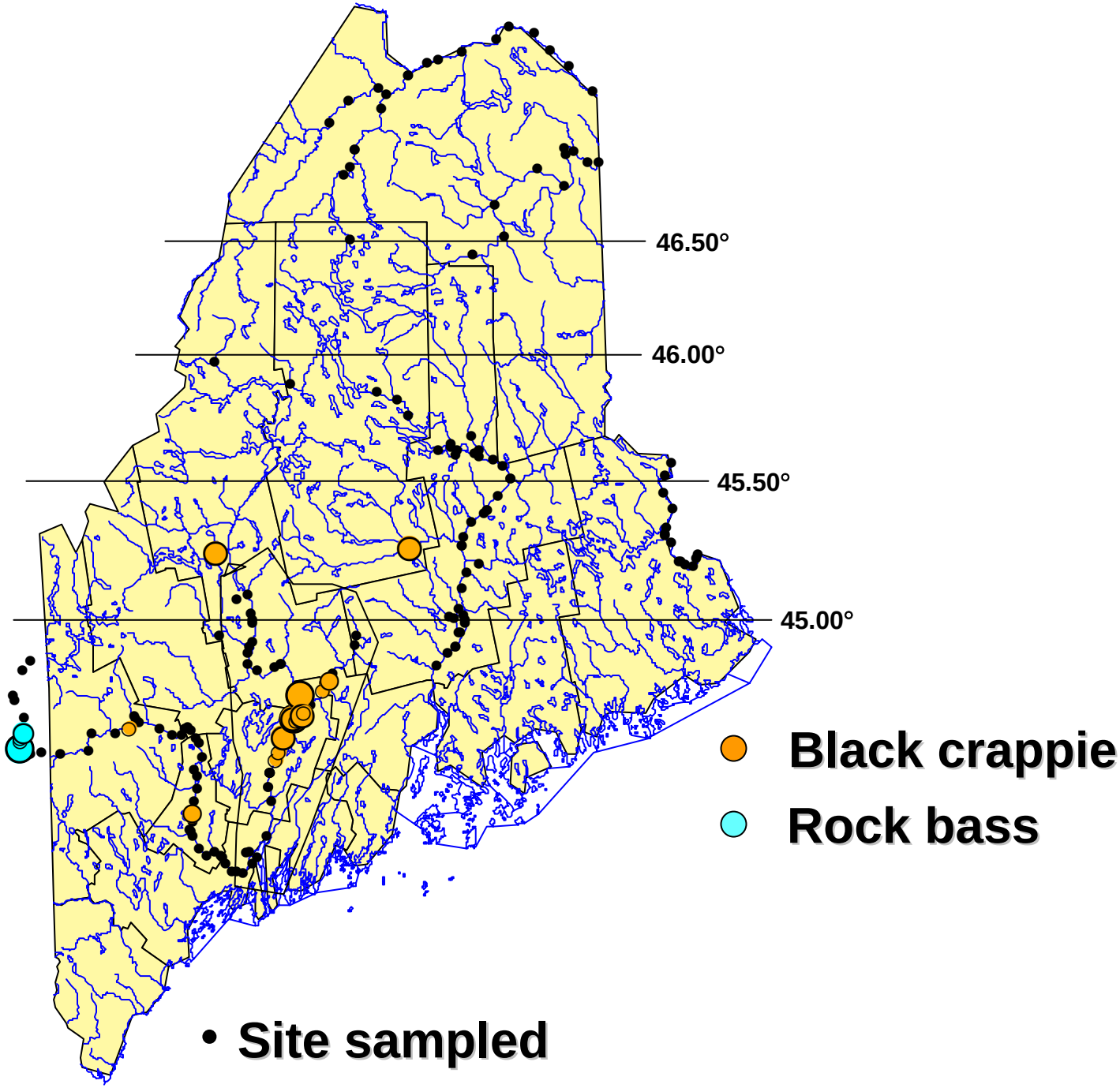
Pumpkinseed sunfish
(Indigenous Native)

Yellow perch
(Indigenous Native)

Black crappie
(Introduced)

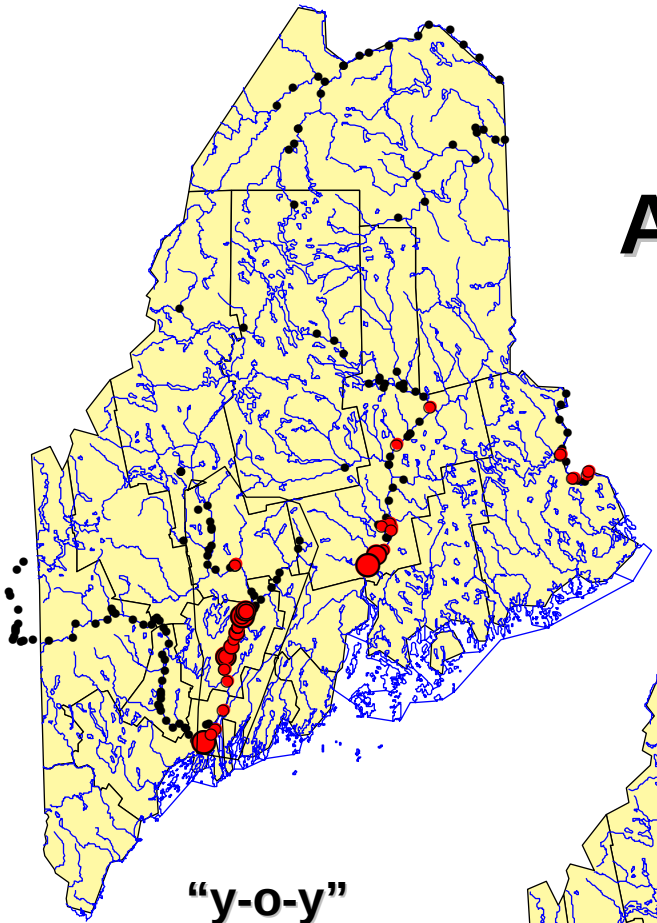

46.50°
46.00°
45.50°
45.00°
Redbreast sunfish
Site sampled


46.50°
46.00°
45.50°
45.00°
Yellow perch
Chain pickerel
White perch
• Site sampled

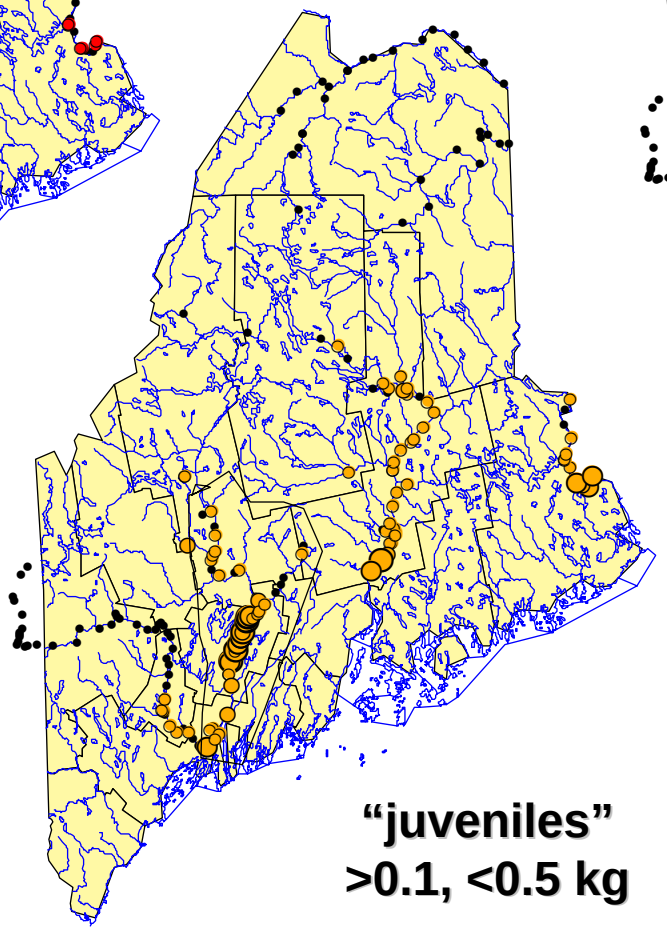

46.50°
46.00°
45.50°
45.00°
Black crappie
Rock bass
Site sampled


Native Species
American eel (Native Diadromous)

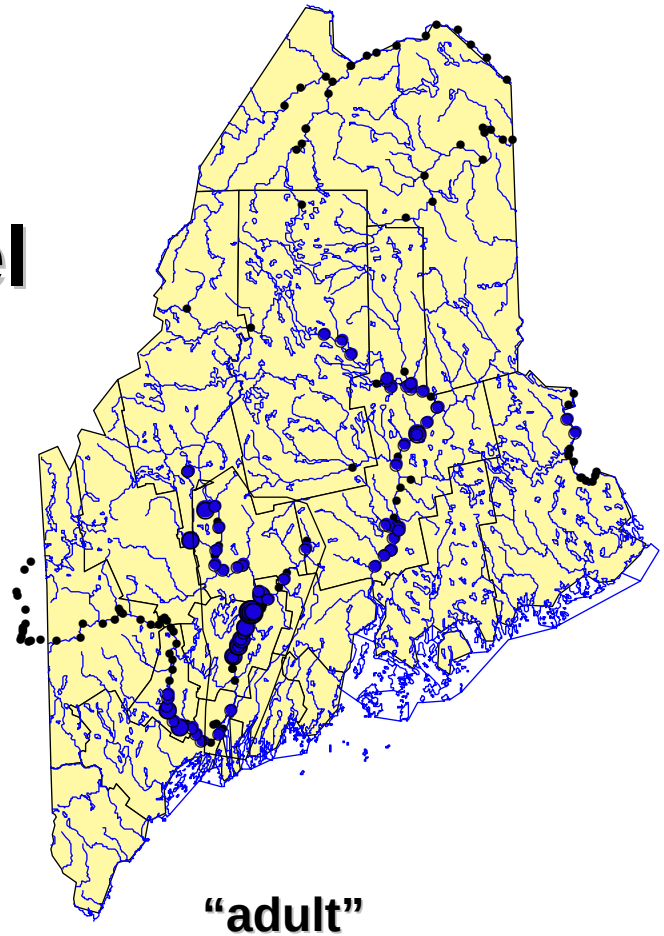
American eel



“y-o-y”
<0.01 kg



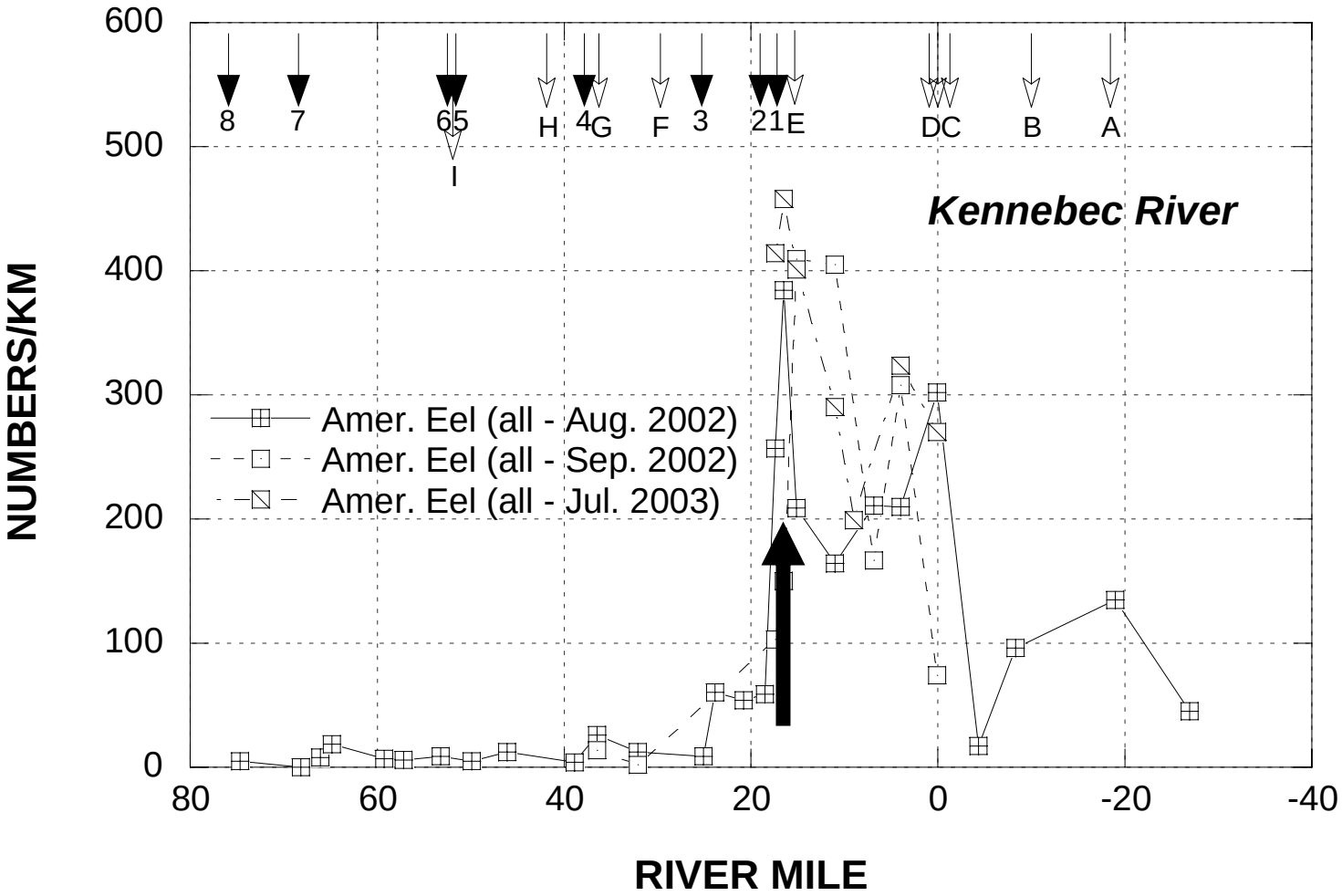
“juveniles”
>0.1, <0.5 kg



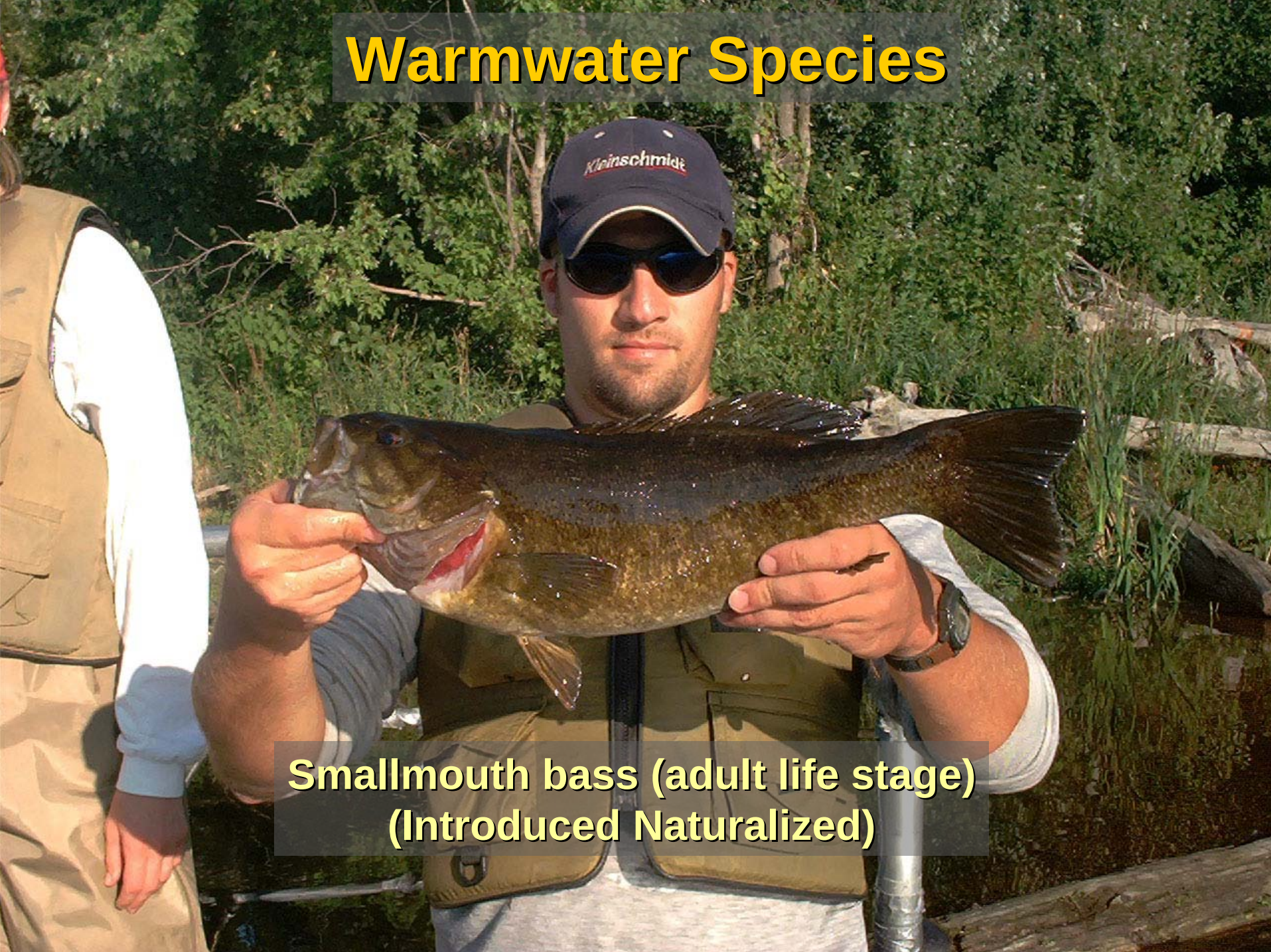
“adult”
>0.5 kg

- Site sampled

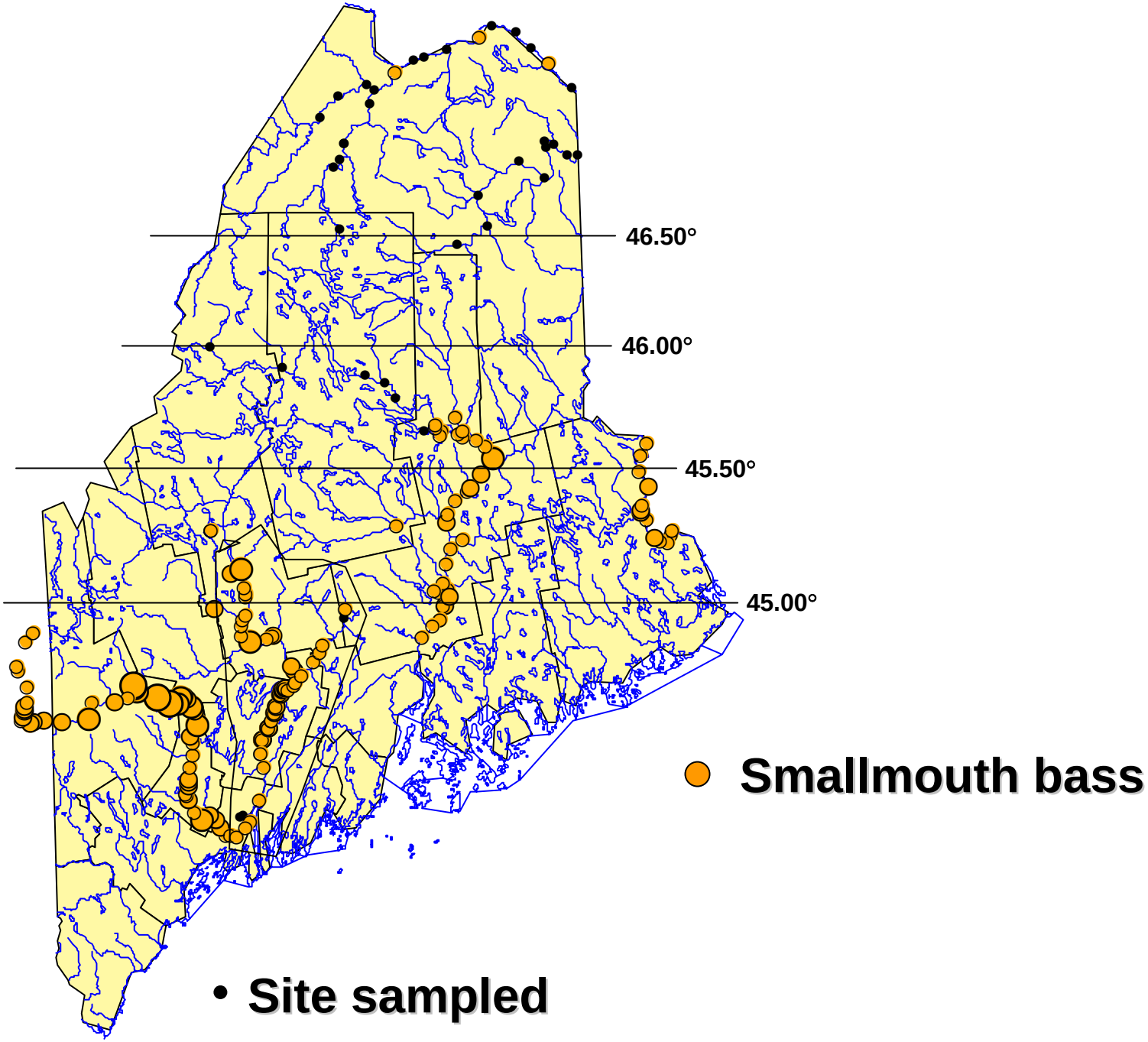
American Eel Abundance



Warmwater Species



Smallmouth bass (adult life stage)
(Introduced Naturalized)


46.50°
46.00°
45.50°
45.00°
Smallmouth bass
Site sampled

Warmwater Species

Smallmouth bass (yoy):
Evidence of successful reproduction

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

- 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

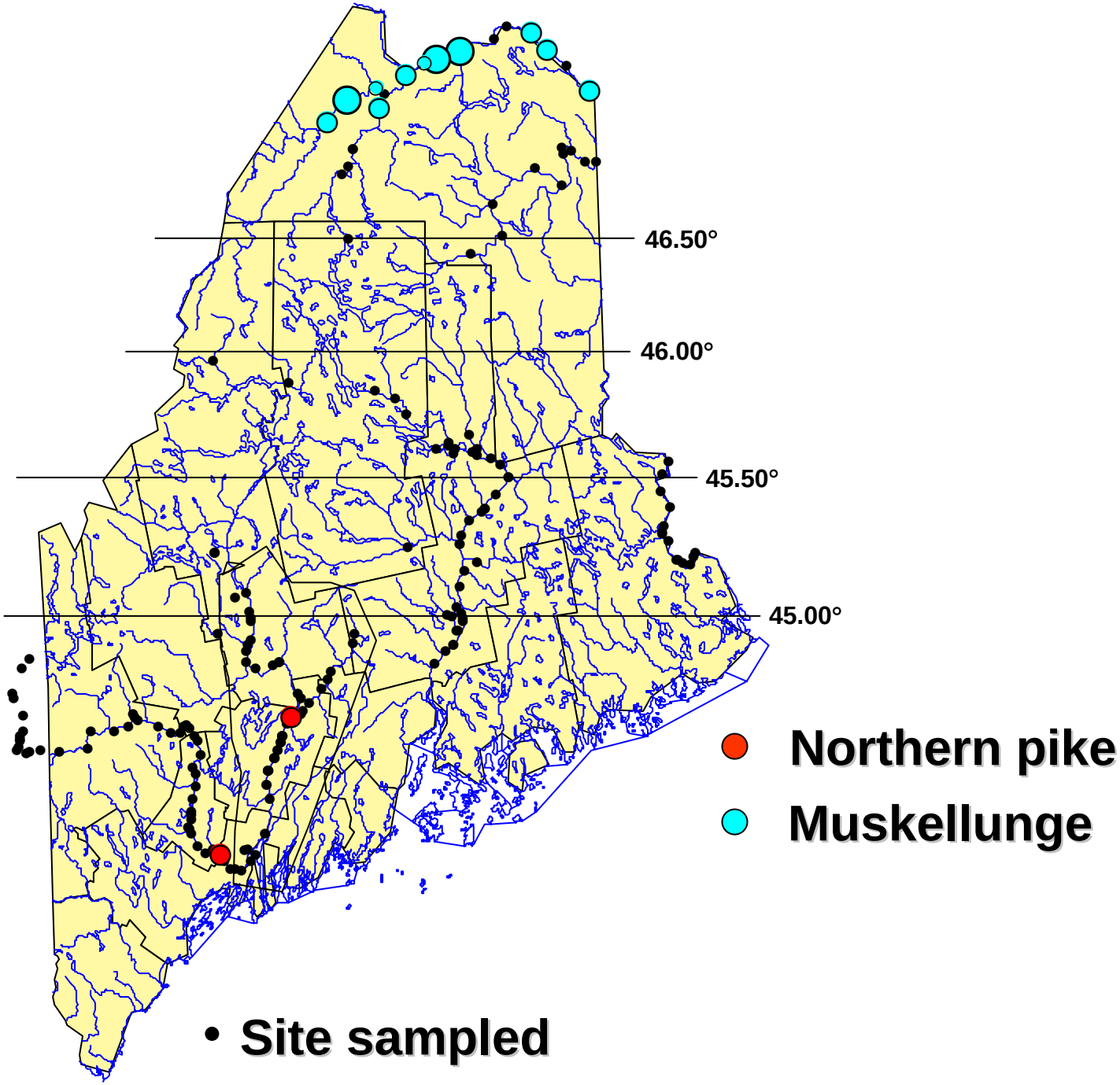
Invasive Alien Species

Northern pike (intracontinental invasive)
Sabattus R. (2003)

Also collected in Kennebec at Waterville in 2004

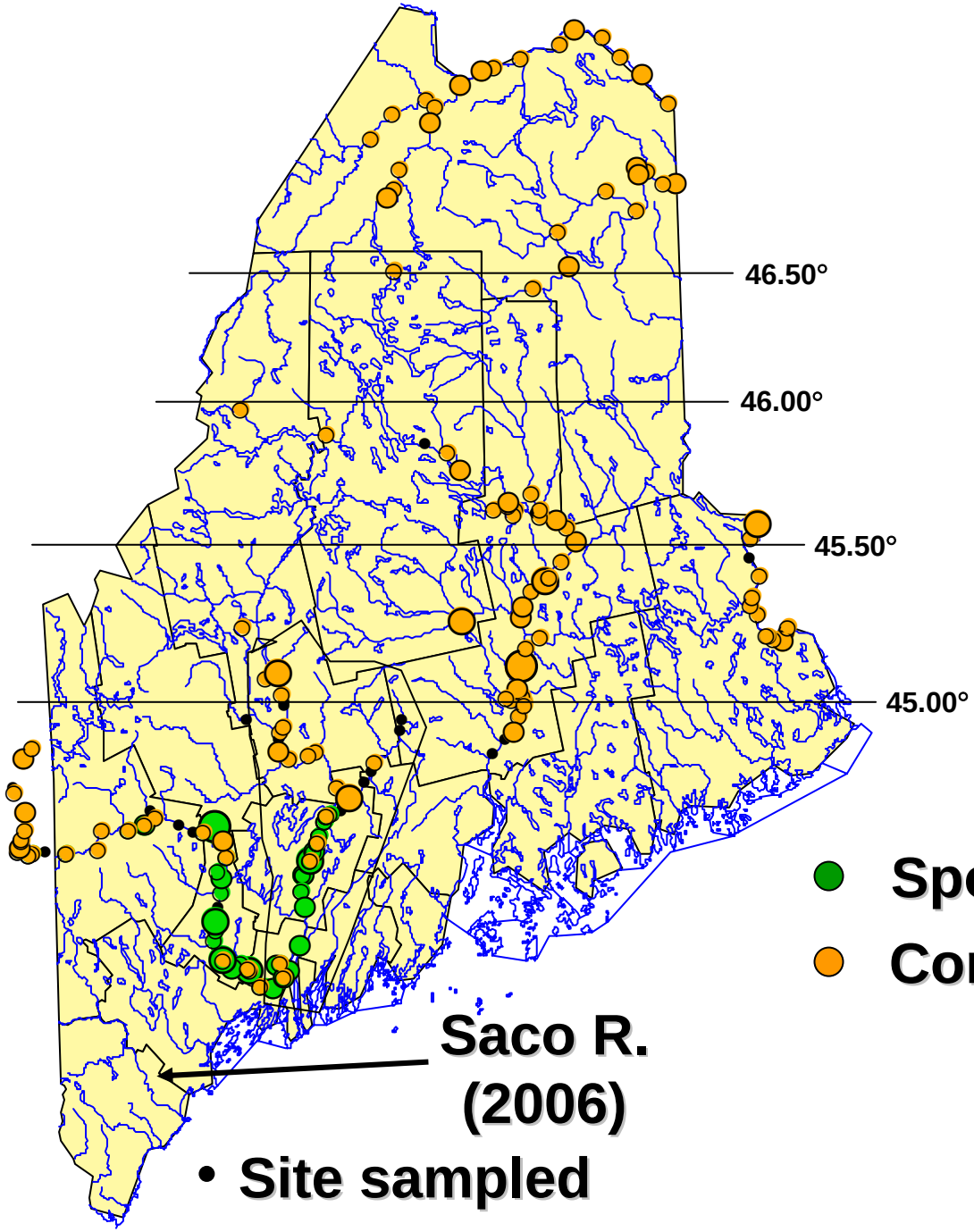
Invasive Alien Species

Muskellunge (intracontinental invasive)
St. John & Allagash R. (2005)


46.50°
46.00°
45.50°
45.00°
Northern pike
Muskellunge
Site sampled

Warmwater Species

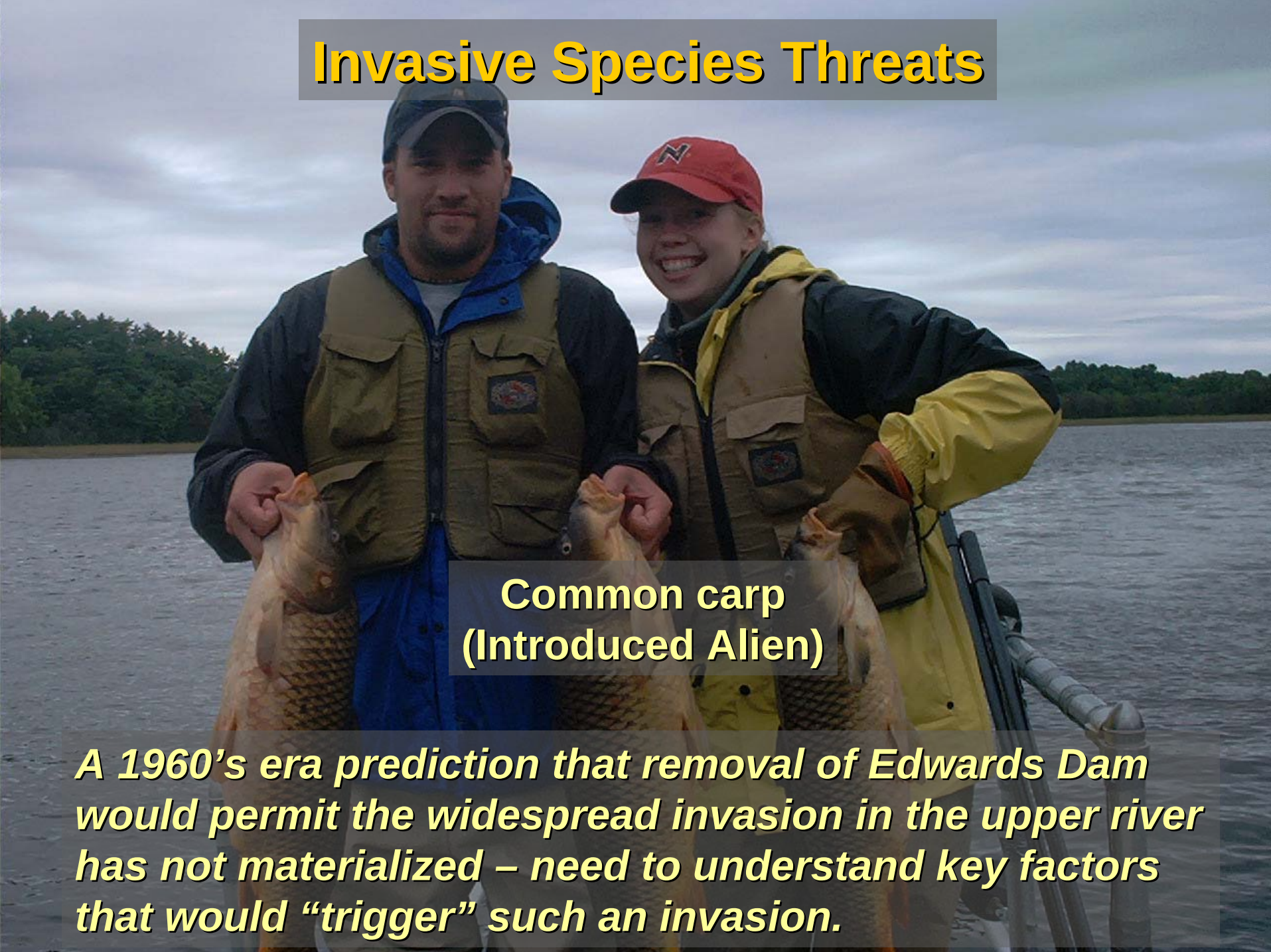
Spottail shiner
(Introduced?)



Spottail shiner

Common shiner

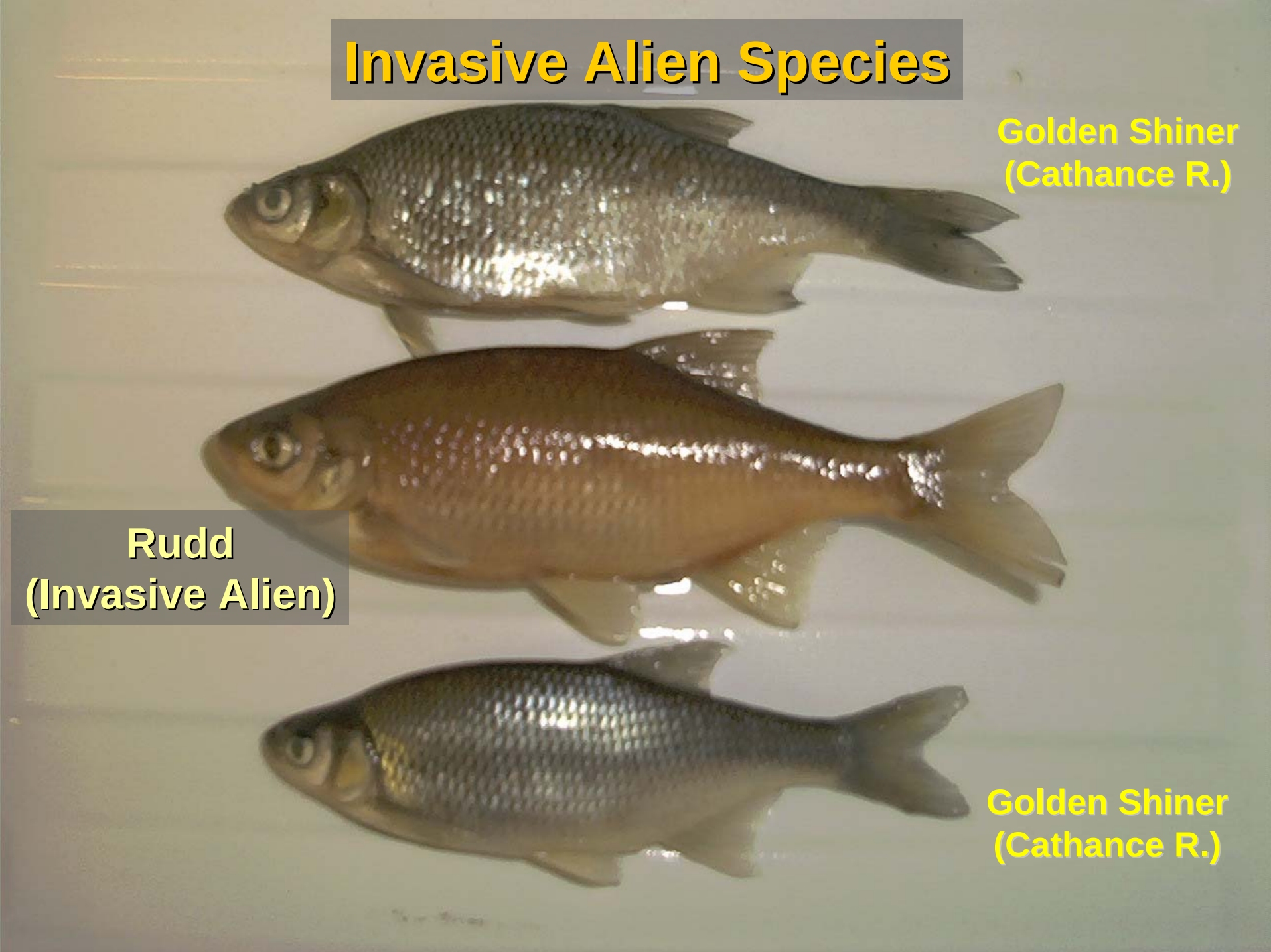
Invasive Species Threats

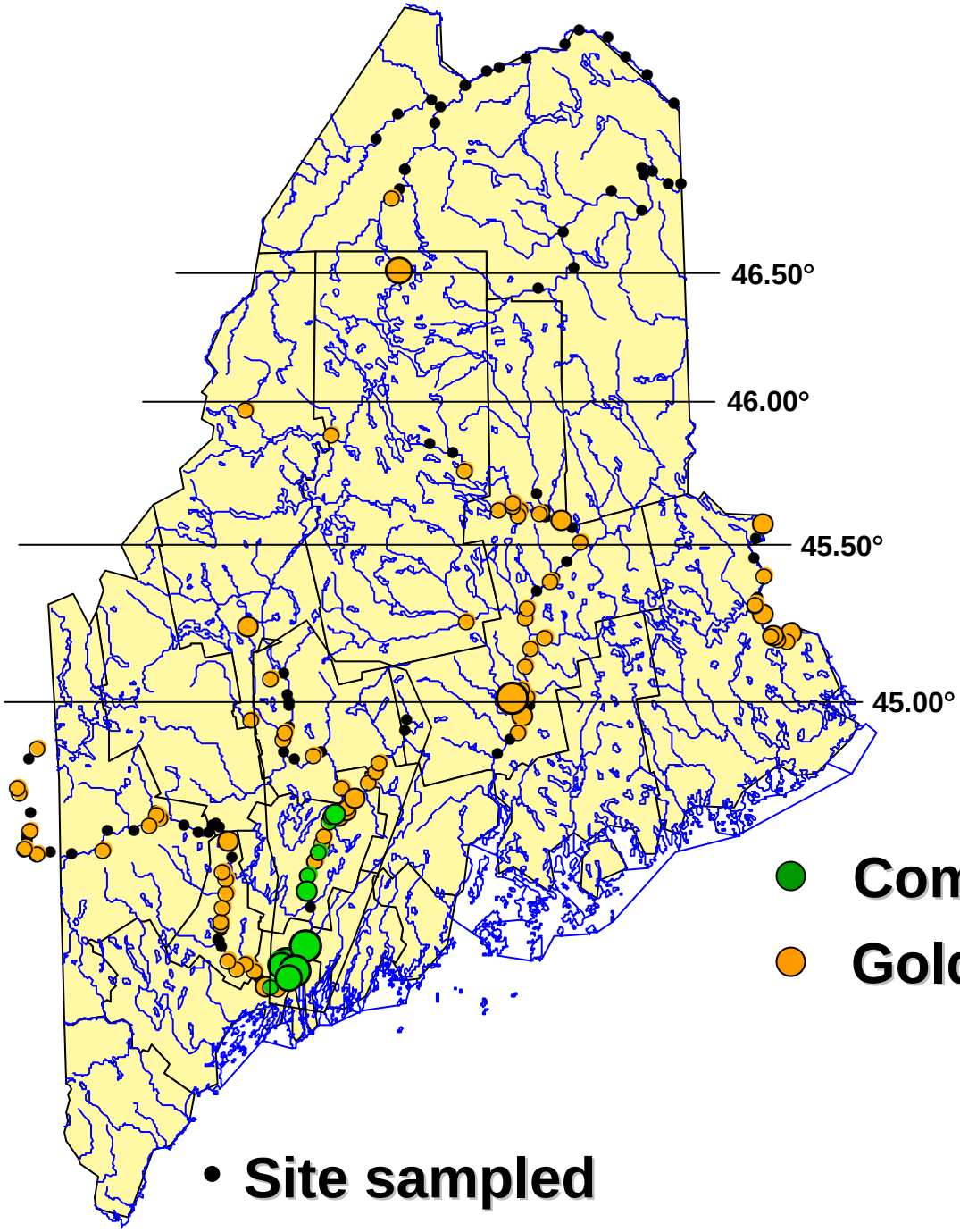


Common carp
(Introduced Alien)

A 1960's era prediction that removal of Edwards Dam would permit the widespread invasion in the upper river has not materialized – need to understand key factors that would "trigger" such an invasion.

Invasive Alien Species




46.50°
46.00°
45.50°
45.00°
Common carp
Golden shiner
• Site sampled

Tidal River Habitats

Natural conditions are favorable for unintentional introductions of invasive aliens

Maine Rivers 2006 Faunal Status

Native Freshwater

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

"Alien Invasive"

- Gizzard shad
- Muskellunge (Al, 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 (Al,Ar)
- 4-spine stickleback
- 9-spine stickleback (Ar)
- Northern silverside
- Atlantic tomcod (Ps)

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

Assessing the Impact of Alien Species

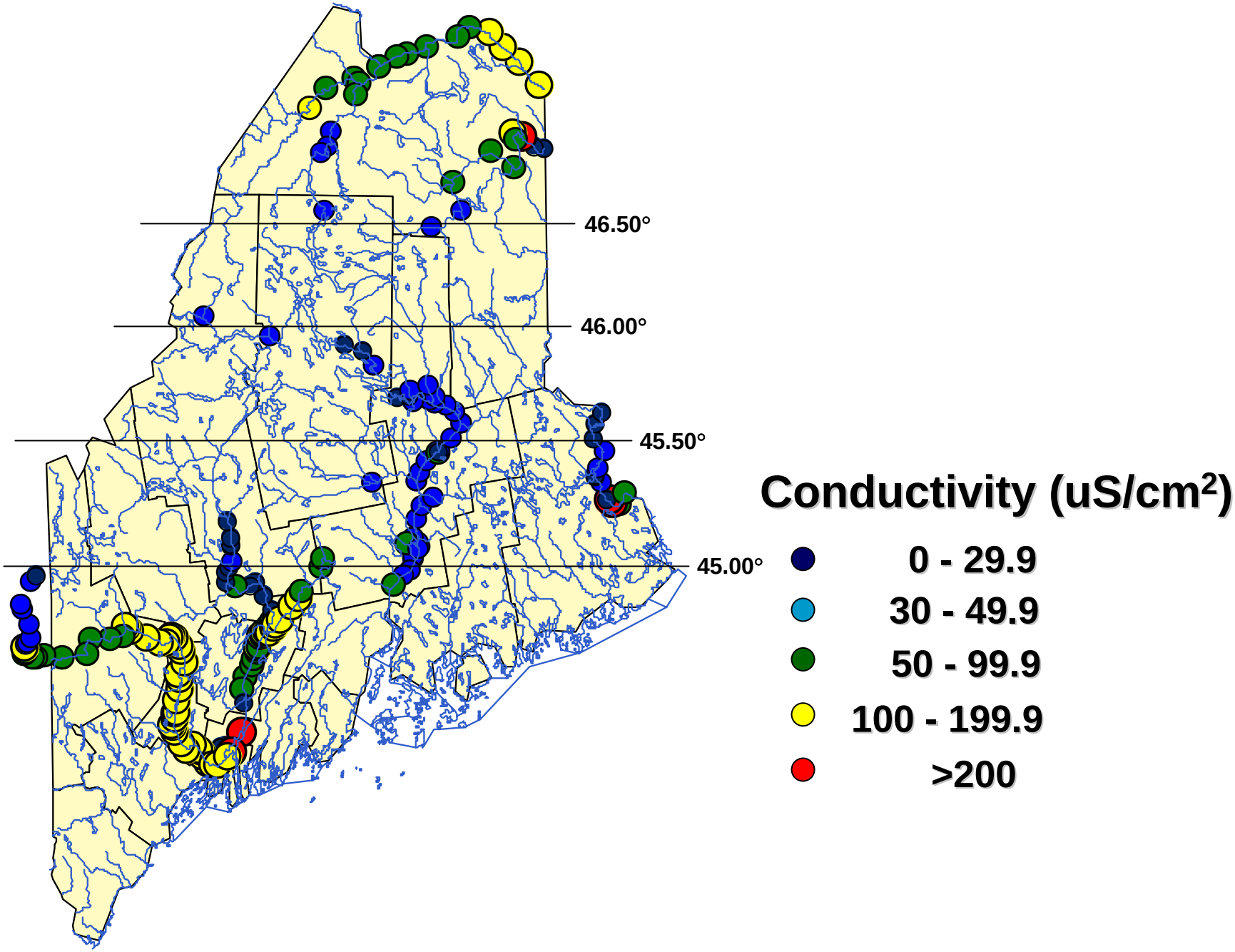
Current Issues:

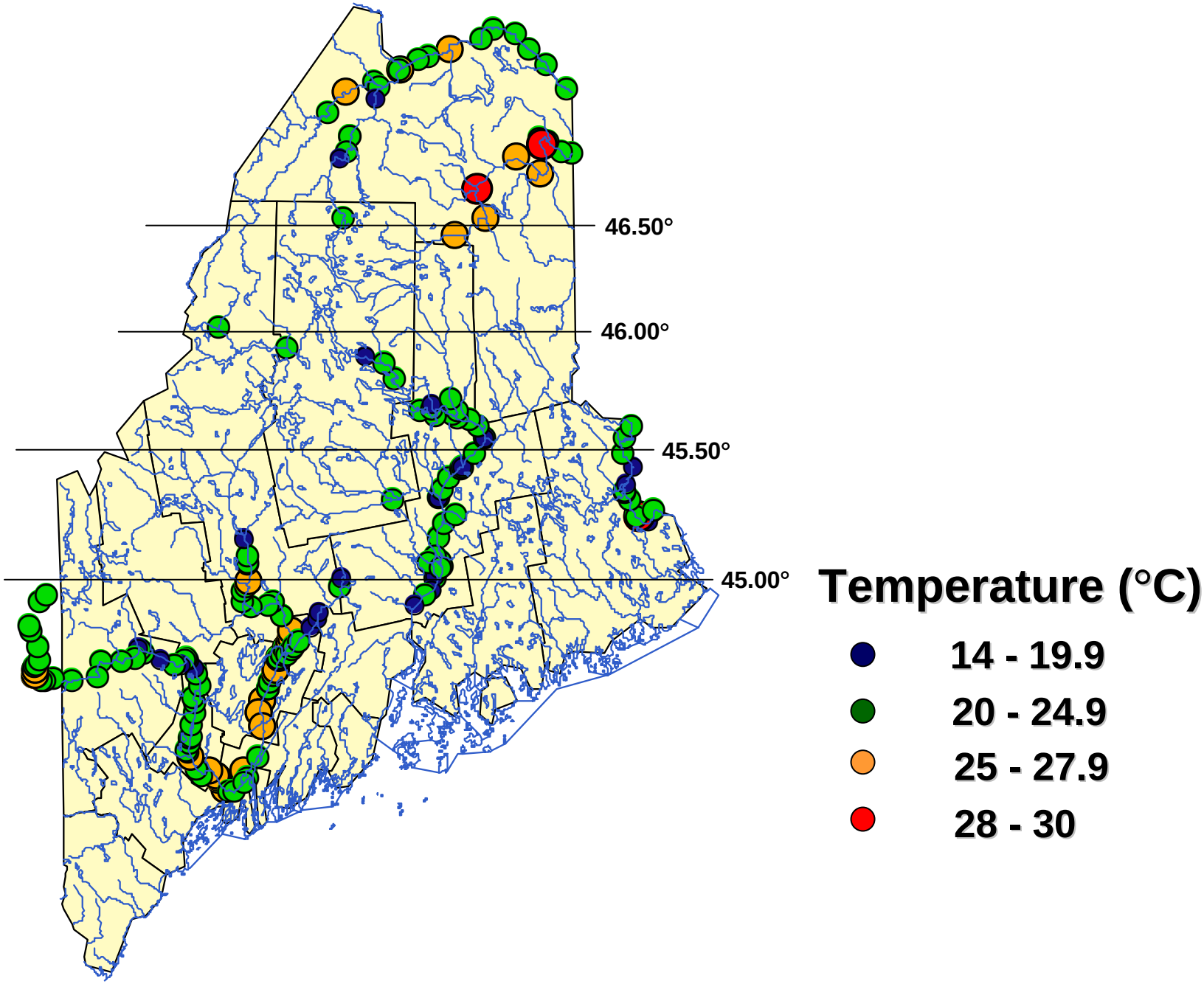
- **Refined Designations of Non-native Species –** effects of each are not equal and some have become a permanent part of the resource.
- **Improved Understanding of Impacts –** impacts are different to cold and warmwater faunas; influence can be misinterpreted, especially with increases in overall species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

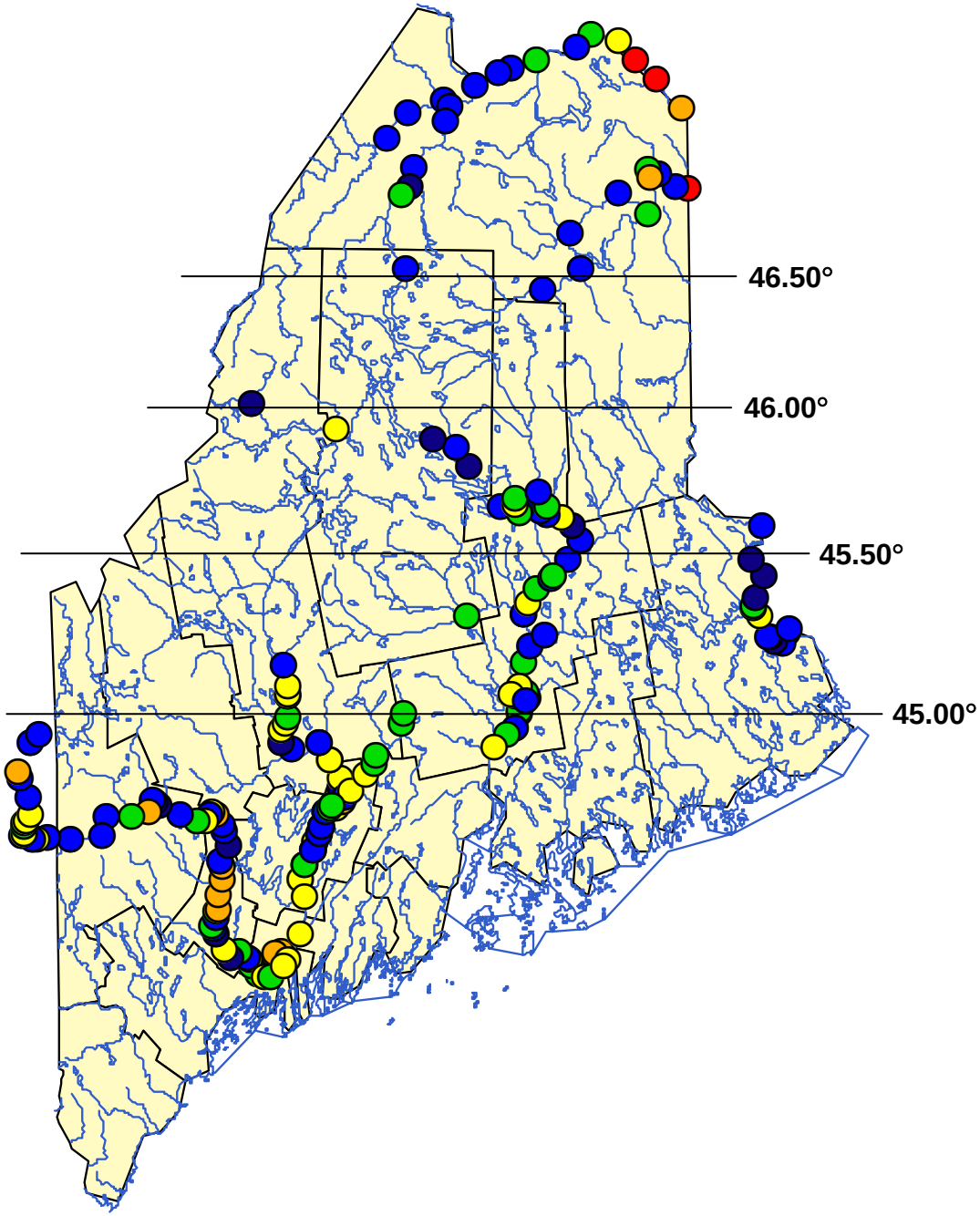
Maine Rivers Assemblage Results Comparison: 2002-5

River	Species	Intro.	No/Km	Kg/km	Effort (km)
Kennebec	37	9	437	56.8	132.1
Androscoggin	32	12	598	31.4	97.0
Sebasticook	15	5	473	28.9	18.5
Penobscot	31	6	335	19.8	42.8
St. John	18	2	211	12.5	14.5
Aroostook	22	1?	311	15.2	9.3
Allagash	19	1	413	10.6	6.3
St. Croix	18	4	274	25.7	13.6
Scioto R. (OH)	82	6*	603	157	107.8

* - 5 as hybrids


46.50°
46.00°
45.50°
45.00°
Conductivity (uS/cm²)
0 - 29.9
30 - 49.9
50 - 99.9
100 - 199.9
>200

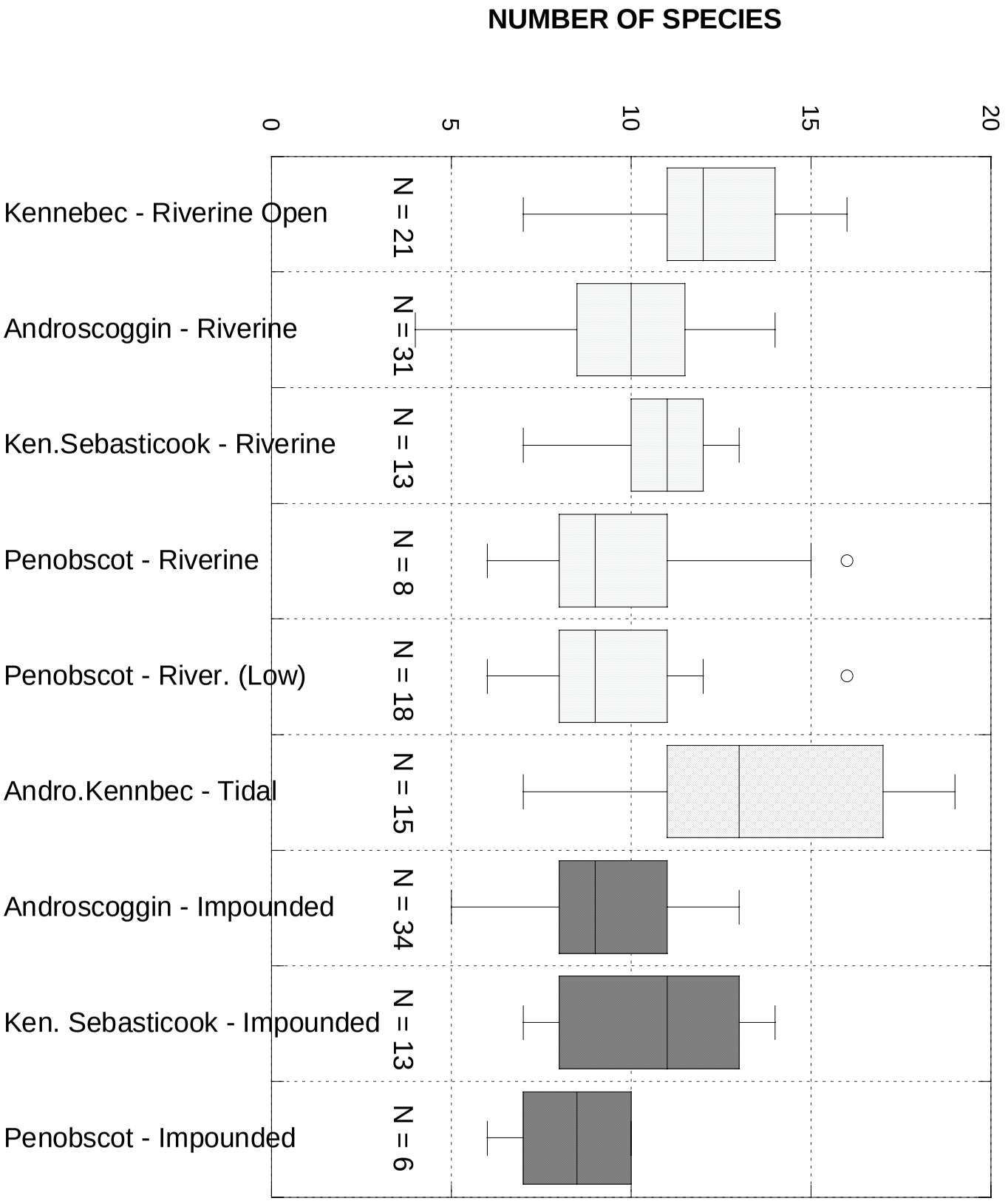

46.50°
46.00°
45.50°
45.00°
Temperature (°C)
14 - 19.9
20 - 24.9
25 - 27.9
28 - 30



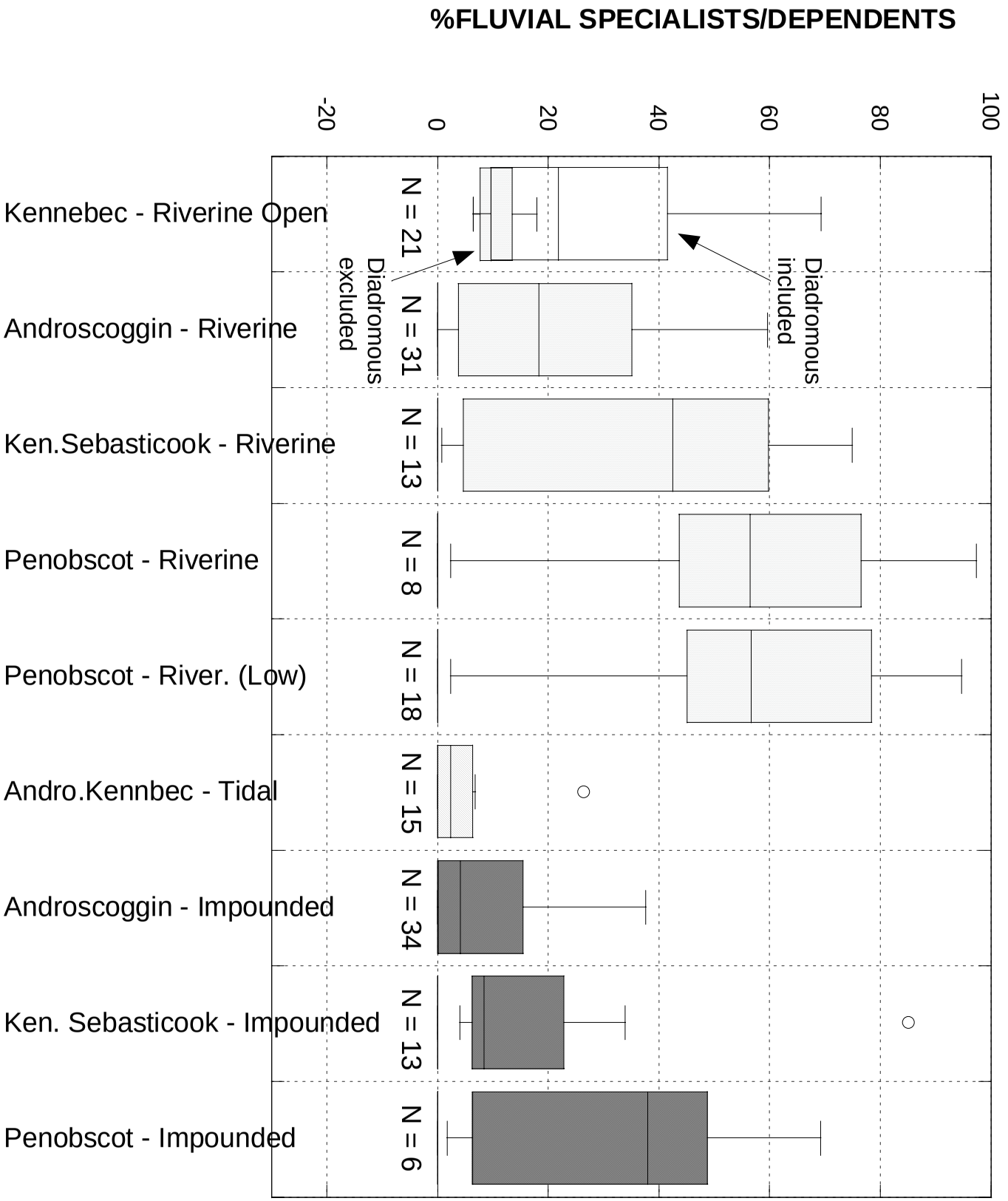
Habitat Quality (QHEI)

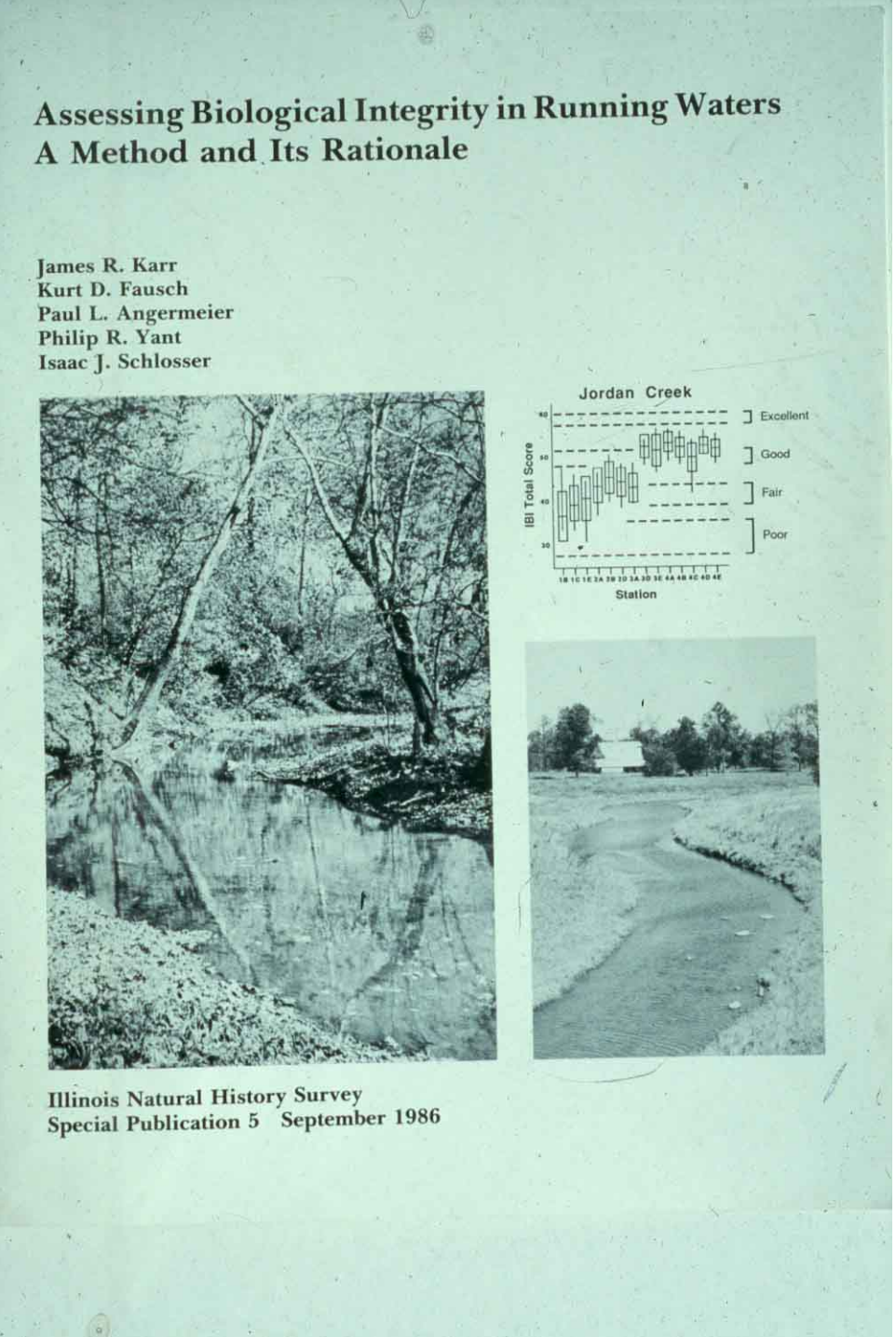
- 20 - 39
- 40 - 49
- 50 - 64
- 65 - 79
- 80 - 89
- 90 - 100

MAINE RIVERS HABITAT (2002-3)


NUMBER OF SPECIES
0
5
10
15
20
Kennebec - Riverine Open
N = 21
Androscoggin - Riverine
N = 31
Ken.Sebasticook - Riverine
N = 13
Penobscot - Riverine
N = 8
Penobscot - River. (Low)
N = 18
Andro.Kennbec - Tidal
N = 15
Androscoggin - Impounded
N = 34
Ken. Sebasticook - Impounded
N = 13
Penobscot - Impounded
N = 6

%MACROHABITAT GENERALISTS
100
80
60
40
20
0
-20
Sebasticook included
Sebasticook excluded
N = 21
N = 31
N = 13
N = 8
N = 18
N = 15
N = 34
N = 13
N = 6
Kennebec - Riverine Open
Androscoggin - Riverine
Ken.Sebasticook - Riverine
Penobscot - Riverine
Penobscot - River. (Low)
Andro.Kennbec - Tidal
Androscoggin - Impounded
Ken. Sebasticook - Impounded
Penobscot - Impounded


%FLUVIAL SPECIALISTS/DEPENDENTS
-20
0
20
40
60
80
100
Kennebec - Riverine Open
Androscoggin - Riverine
Ken.Sebasticook - Riverine
Penobscot - Riverine
Penobscot - River. (Low)
Andro.Kennbec - Tidal
Androscoggin - Impounded
Ken. Sebasticook - Impounded
Penobscot - Impounded
N = 21
N = 31
N = 13
N = 8
N = 18
N = 15
N = 34
N = 13
N = 6
Diadromous excluded
Diadromous included



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

- 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 (2006-7)
- Derive and test IBIs with reference and independent test sites (2007)

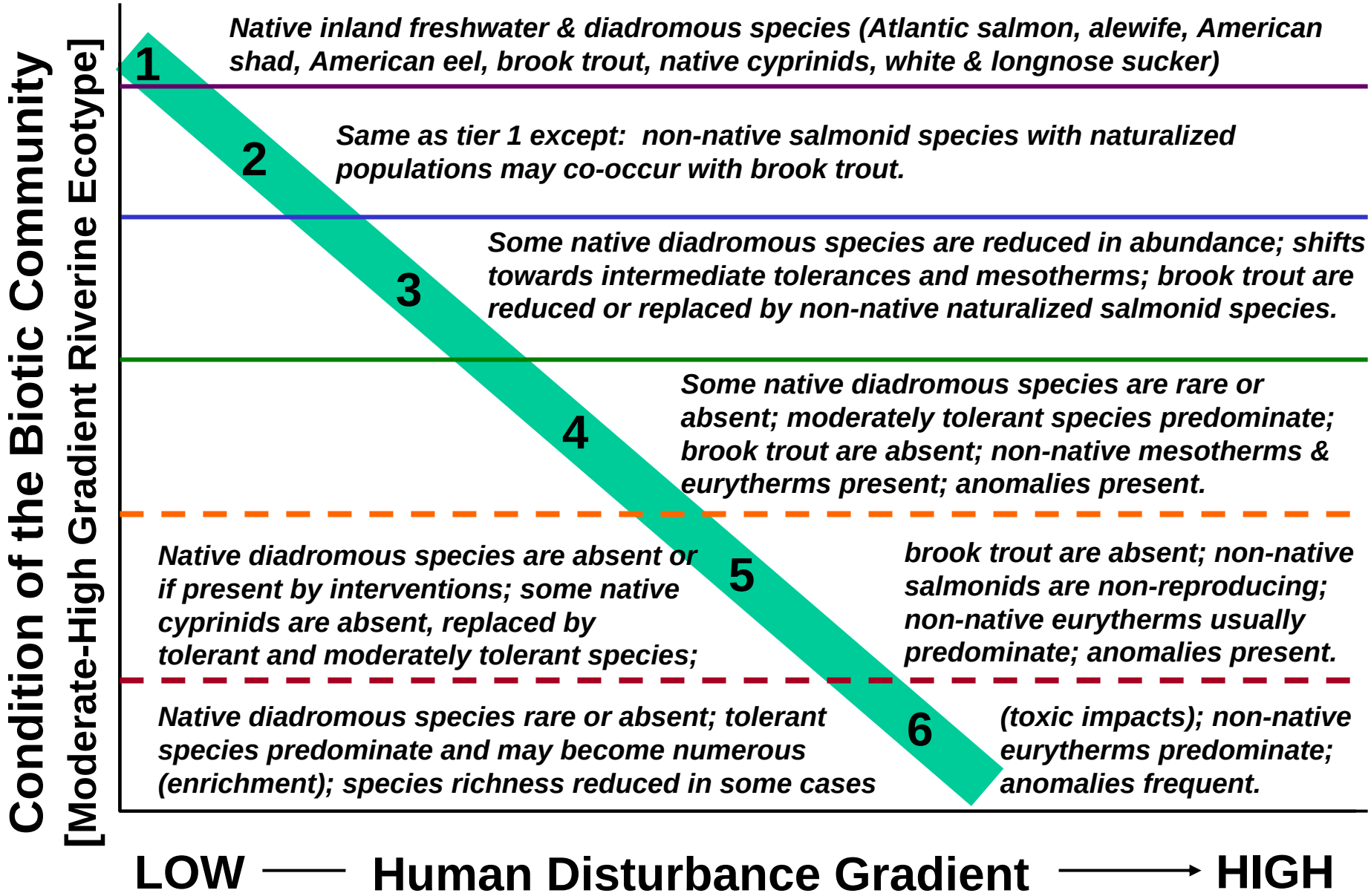
Candidate IBI Metrics

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[1]	Intent	Origin[2]
Taxonomic			
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
Ecological Role			
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
Reproduction and Recruitment			
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

Continue baseline data collection:

- Gaps in spatial coverage – isolated rivers, tribs.
- Continue lower Kennebec – Waterville to tidal
- Penobscot River – follow dam removals (2008)
- Regional scope – other New England rivers

Exploratory Data Analysis (2007):

- Stress/response patterns – QHEI, T(°C)
- IBI metric development and testing - BCG
- Test IBI for responsiveness along BCG

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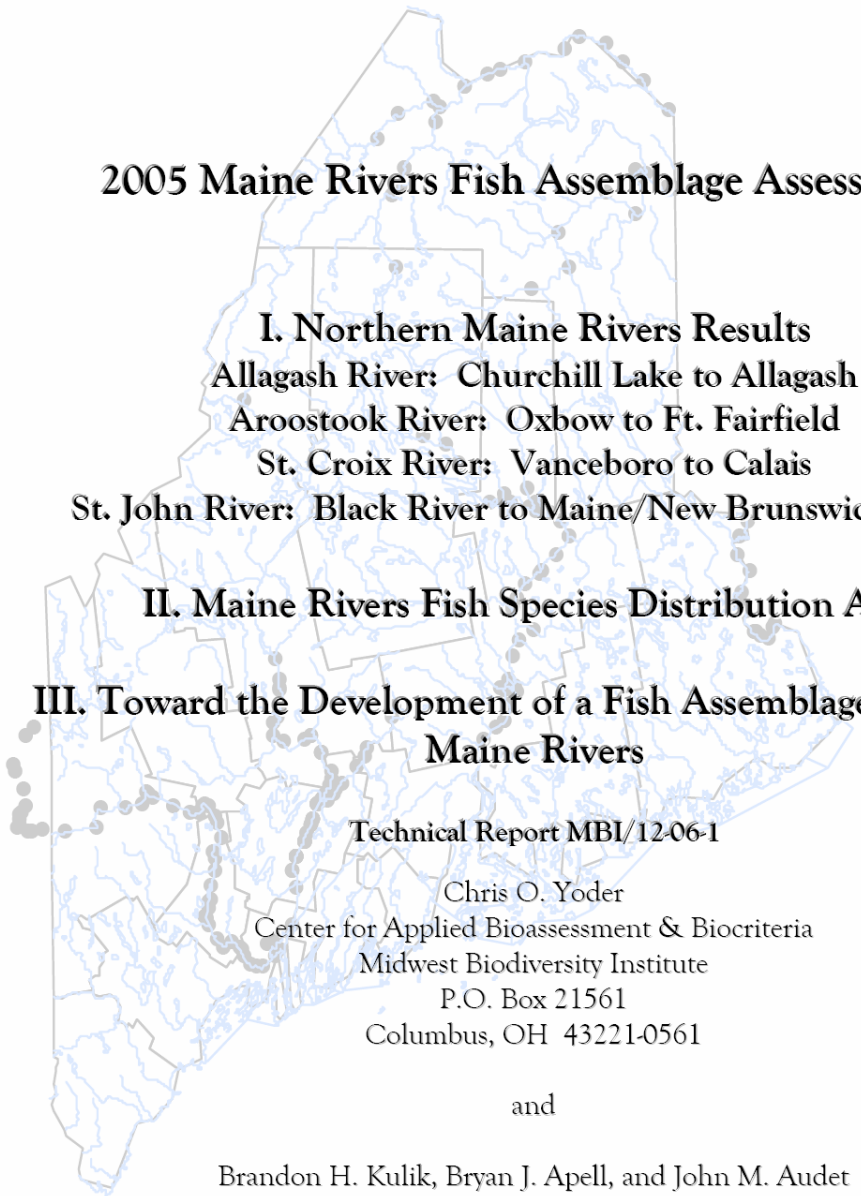

2005 Maine Rivers Fish Assemblage Assessment:

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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