Identification and assessment of New Hampshire stream fish assemblages

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Importance of fish assemblage identification and assessment

- Assists in understanding NH's aquatic communities with respect to species distributions and frequency of occurrence
- Provides a basis for identifying unique resource types, their expected locations, and frequency of occurrence
- Establishes expectations based on minimal anthropogenic impacts
- Allows for the development of accurate and precise biological indices that can be used to characterize overall community condition
- Useful in setting achievable resource management objectives for regulatory, restoration, and protection activities
- Helpful in communicating to the public and providing a common understanding of what a "natural" system should look like

Defining Assemblages

What is an Assemblage?

A collection of co-occurring species defined by common environmental characteristics within similar habitats

How does it apply to New Hampshire stream fish?

Discernable differences in species composition in relation to geographic location, thermal regime, habitat characteristics

Why is it important to define the major assemblage types?

Each type has unique ecological qualities that can be quantified and used for determining assemblage condition and most appropriate management actions

Assemblage A.

Burbot

Brook trout

Slimy sculpin

Assemblage B.

Blacknose dace

Smallmouth bass

Fallfish

Observations tell us these systems are different, but how can the differences be quantified and used to set expectations (i.e. ecological structure/function; thermal regime, etc.) - LET THE DATA TELL US!

- Northern location
- Steep gradient
- Canopy cover
- Boulder/cobble substrate
- Cold water

- Southern location
- Low gradient
- Open canopy
- Sand/gravel substrate
- Warm water

DES Biomonitoring Program

- Began collecting fish and macroinvertebrate data from wadeable streams in 1997
- Focus on "reference" (minimally impacted) and highly impacted conditions and achieving broad coverage of sample locations across state
- Goal of developing numeric indices capable of describing biological condition
- Fish sampling includes backpack electroshocking ~150m stream reach, identification and enumeration of fish species
- Also collect water chemistry and habitat data from each location

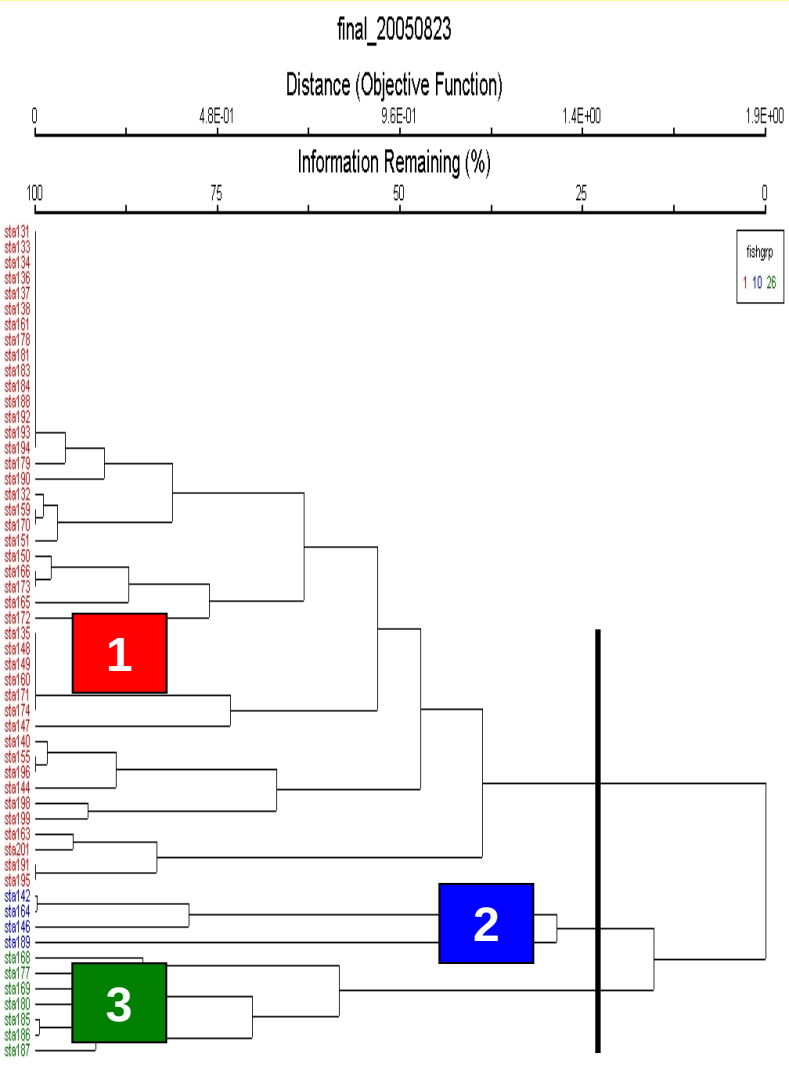
Steps in Defining Fish Assemblage Types

1) Minimally impacted sites summarized by presence / absence of 14 fish species
2) Cluster analysis and NMDS ordination – identification of major groups
3) Predictive model construction
4) Identification of applicable watersheds

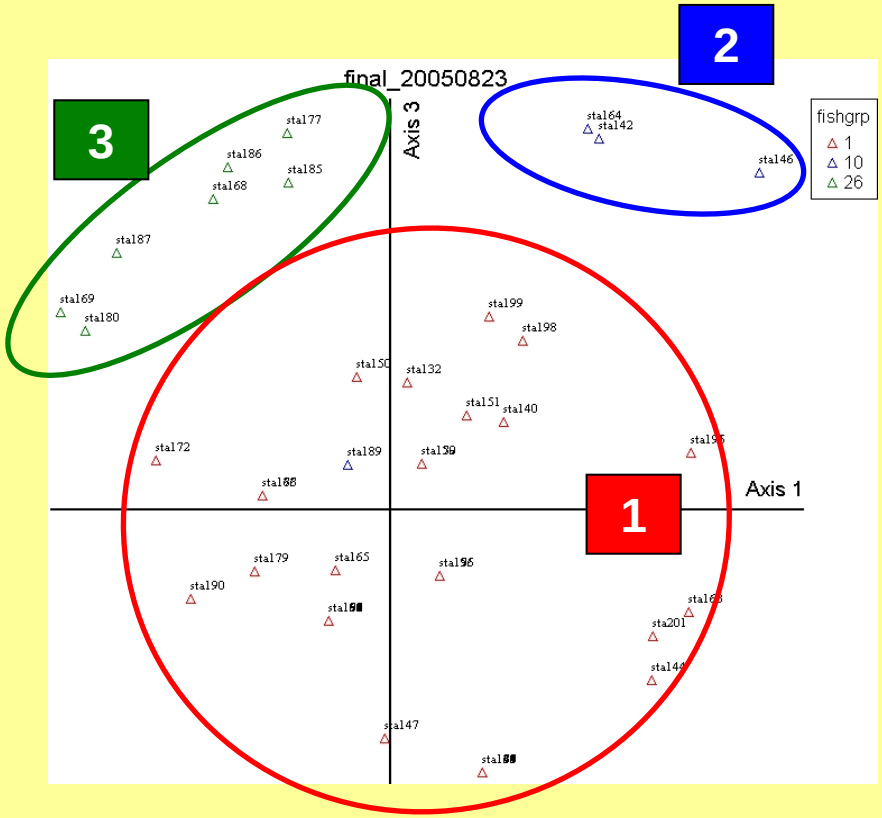
Basic hypothesis: At least 2 major assemblage types exist (cold / warm)

Major groupings

Cluster Analysis



NMDS Ordination



****Results indicate 3 distinct groups exist****

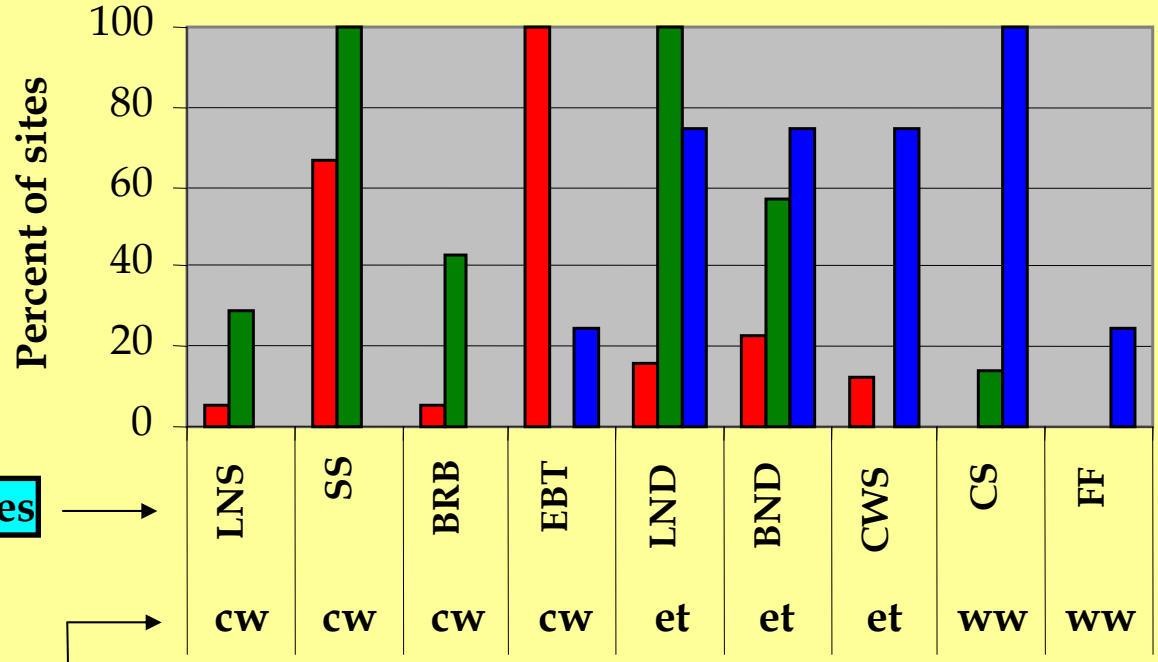
Species Frequency of Occurrence

Major grouping from cluster analysis / NMDS

1 Strict coldwater

2 Warmwater

3 Transitional water



Species

Thermal Preference

cw = coldwater
et = eurythermal
ww = warmwater

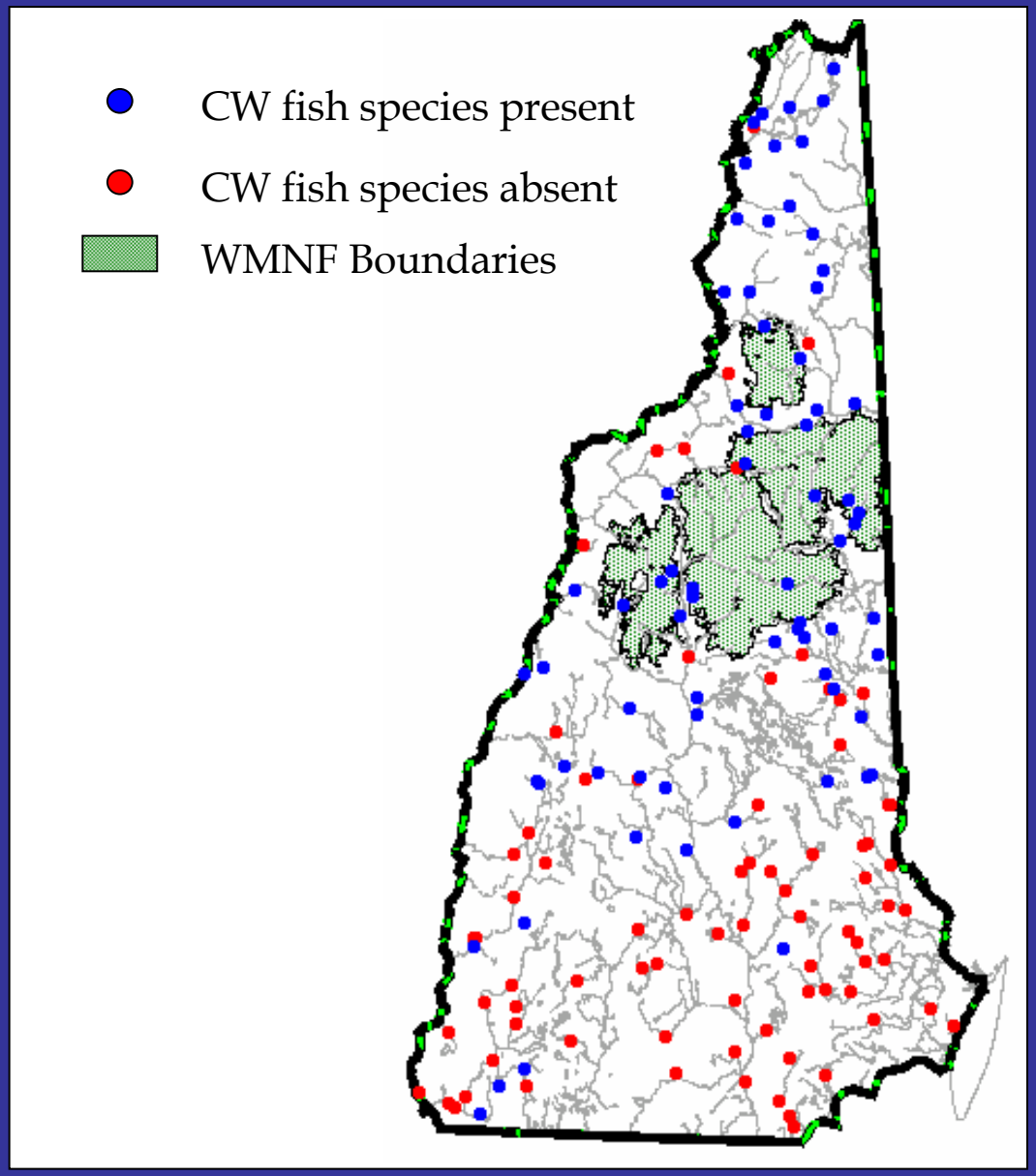
1 CW species dominate

2 WW species dominate

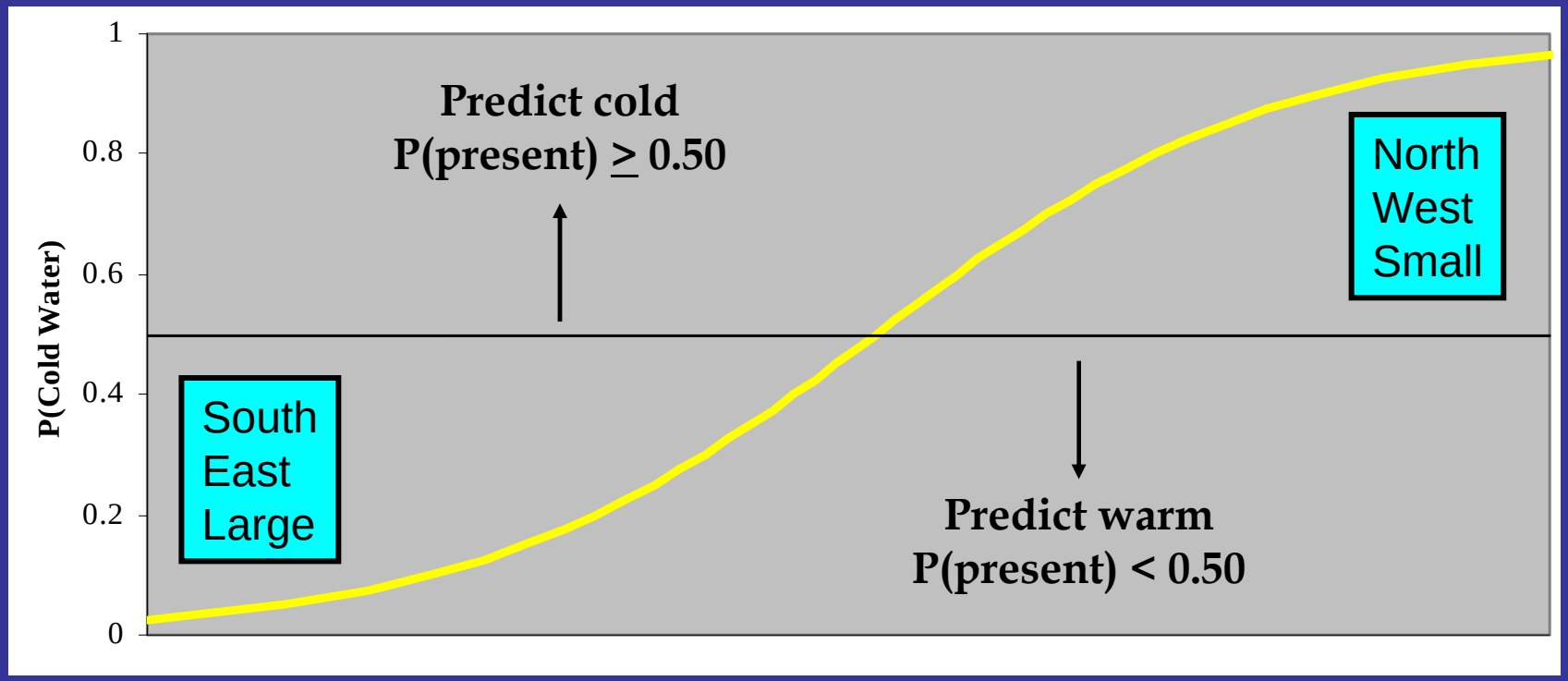
3 Mix of all species

Development of Predictive Model:
Focus on sites with observed cold vs. non-cold water fish species

1) Obvious and most logical difference
2) Northwest sites are coldwater and southeast sites are warmwater
3) Logistic regression equation developed based on presence/absence of brook trout or slimy sculpin; returns probability of occurrence (0 – 1)
4) Most important factors in predicting were latitude, longitude, drainage area
5) ~80% accuracy in predicting streams w/ cold vs. warmwater species



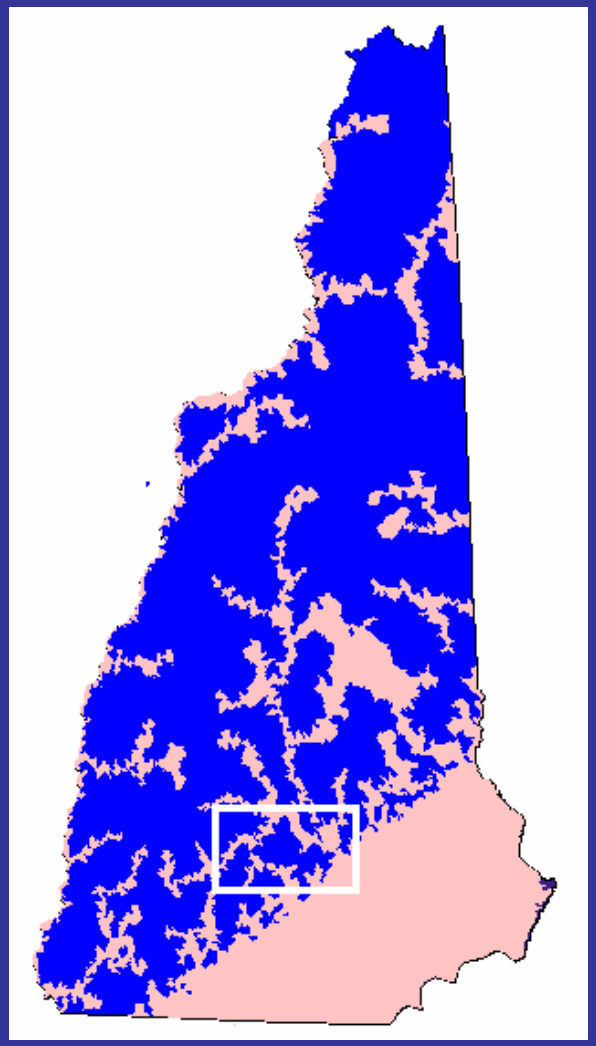
Cold vs. warmwater predictive model expression



South ←	Latitude	→ North
East ←	Longitude	→ West
Large ←	Watershed Size	→ Small

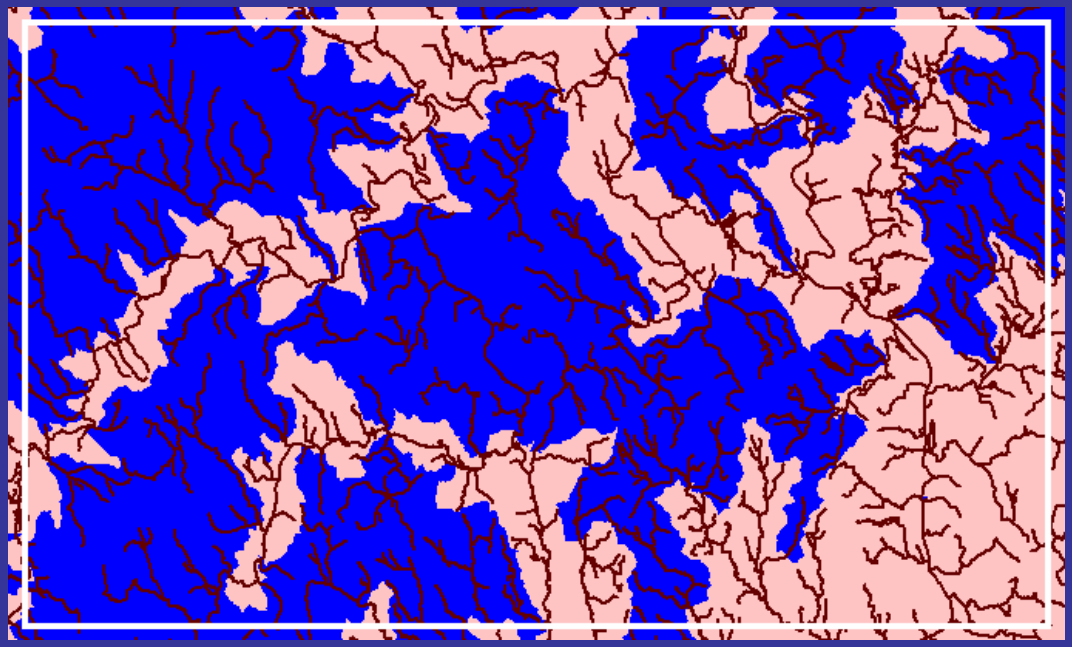
Increasing probability of occurrence as move from SE to NW and decreasing drainage area

Predictive Model Application to Watersheds



Latitude, Longitude based on watershed centroid

Drainage area from individual watersheds



Can predict streams able to support CW species in absence of human impact

Only first approximation

Based on land area ~35% WW; 65% CW (includes TW assemblage)

Defining Fish Assemblage Types

Remember 3 Primary Groups

1	2	3
Strict coldwater	**Warmwater**	**Transitional water**
CW species	WW species	All species; including CW species

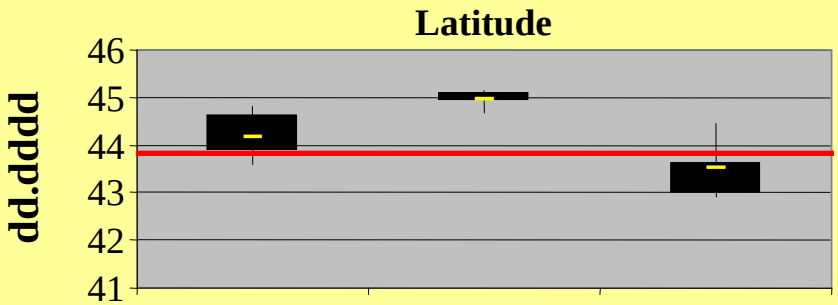
1) Is stream expected to supported coldwater fish species
Use predictive model

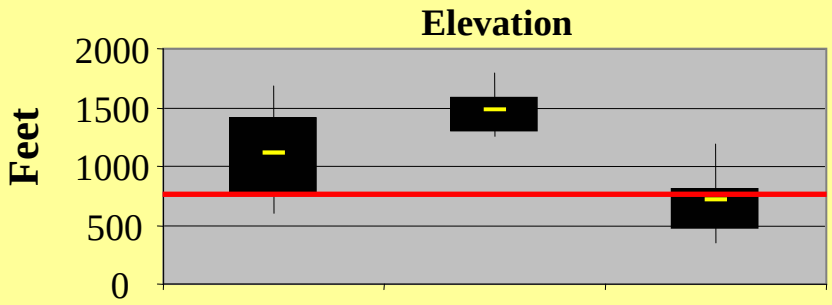
Yes (≥0.50) → **Cold- and Transitional water**

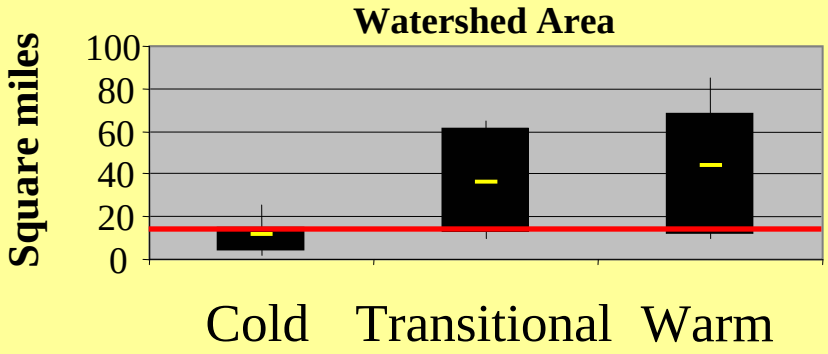
No (<0.50) → **Warmwater**

Need to separate cold- and transitional water assemblages

Define Strict Coldwater - Revisit environmental variables from original dataset







RULES TO DEFINE

All warmwater sites are below 43.75°

All warmwater sites <775′ elevation

Strict coldwater <15 square miles drainage

Add based on professional experience

Streams in CT basin <15 sq. mi.

Defining Fish Assemblage Types

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Use predictive model

Yes (≥0.50) → **Cold- and Transitional water**

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Cold- and Transitional water →

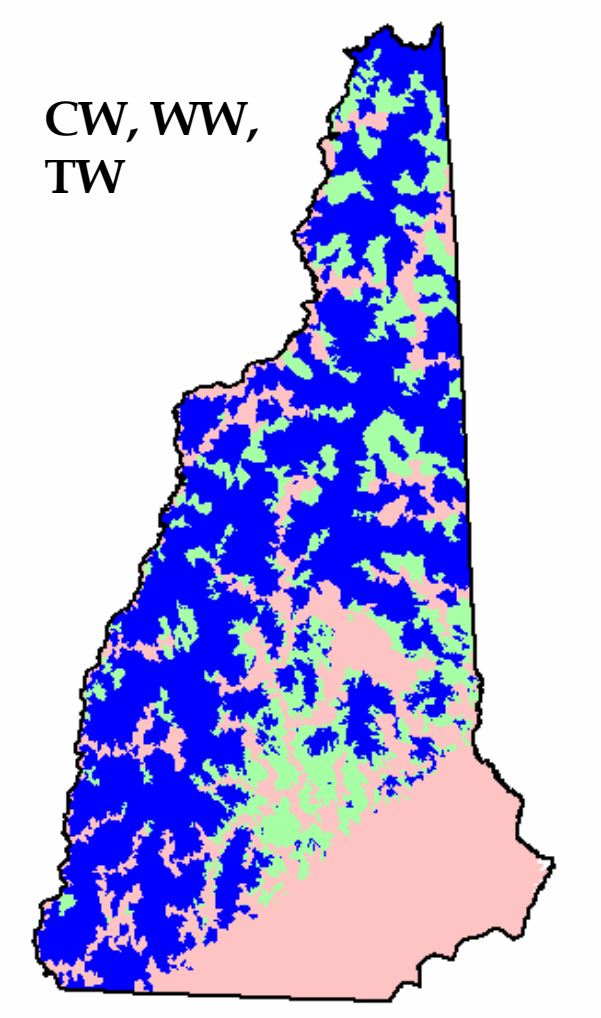
Strict coldwater

1) >43.75° latitude & <15mi²
2) CT river basin & <15mi²
3) Rest of state >775' elevation & <15mi²

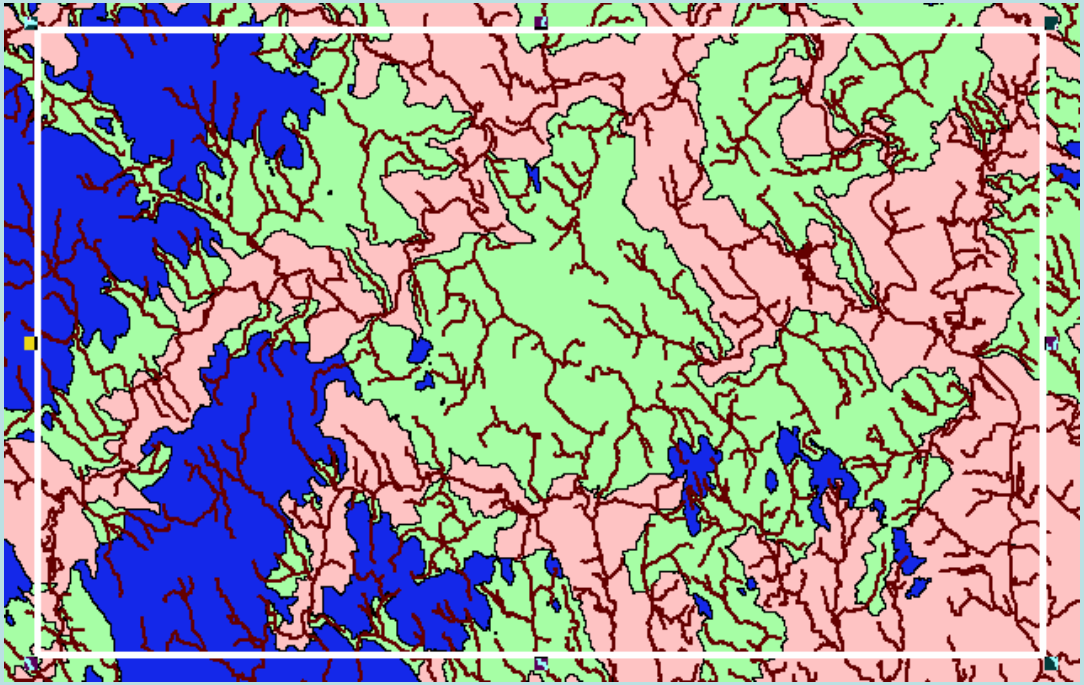
→ Remaining Area → **Transitional water**

Areas expected to support cold-, transitional-, and warmwater assemblages

Statewide Results



Detailed Results



CW TW WW

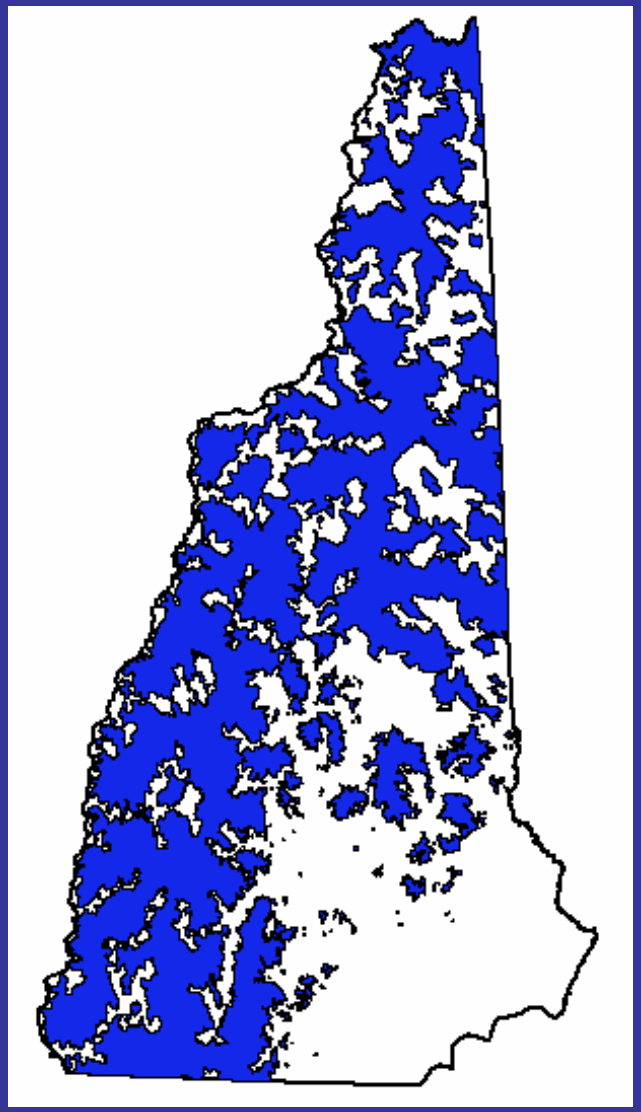
CW = 48.7%; TW = 17.1%; WW = 34.2%

Assessment of strict coldwater fish assemblages

- Index developed in 2006
- Restricted to streams expected to support coldwater fish species year round; all have between 2 – 4 fish species

NH Strict Coldwater fish assemblage (NH CW-IBI)

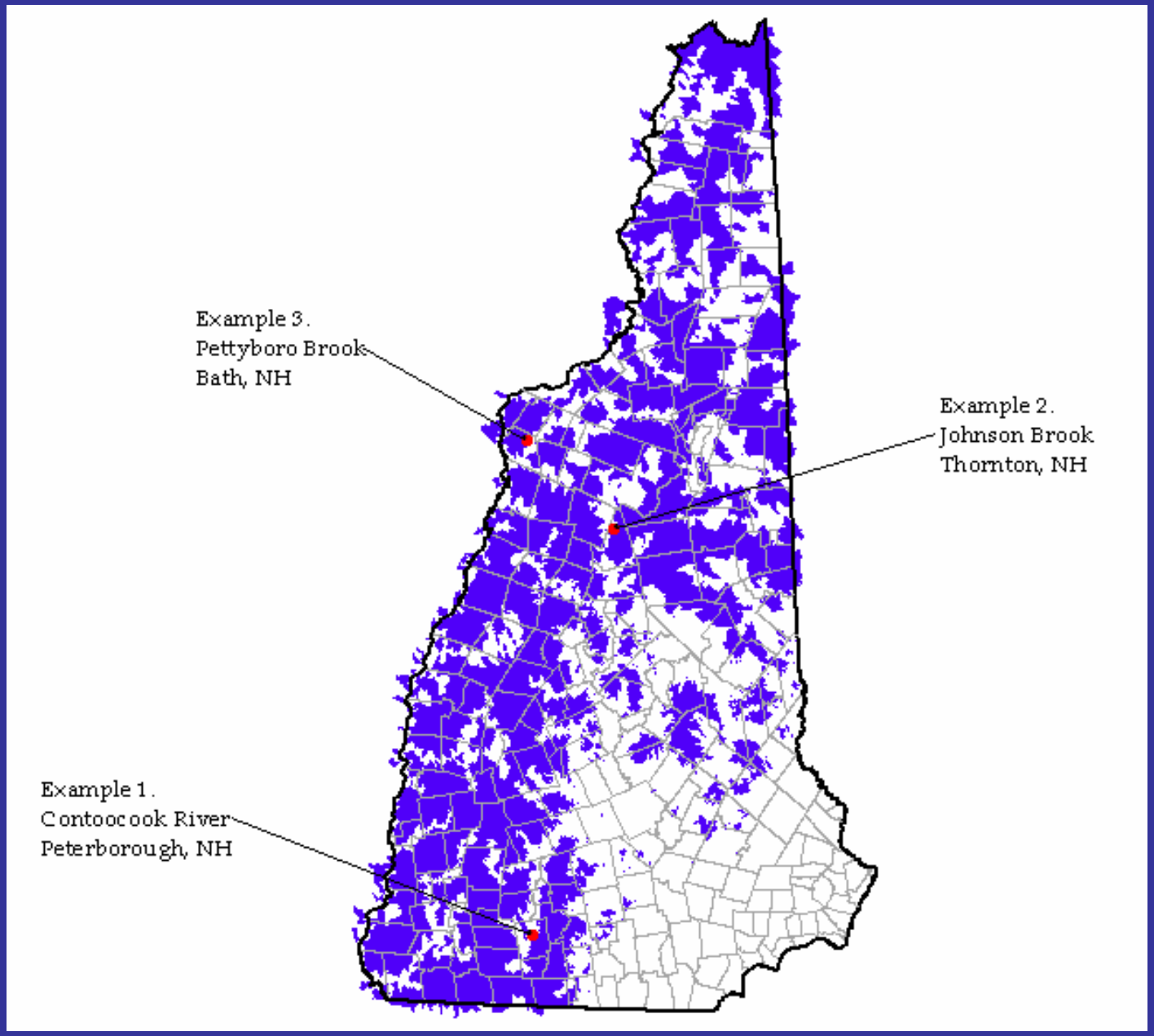
Just the highlights and examples



Individual metrics receive score of 1.5 (bad), 4.5 (fair) , 7.5 (good)

METRIC	RESPONSE
% CW Individuals	+
% Top Carnivore Individuals	+
% Brook Trout Individuals	+
% Generalist Feeder Individuals	-
# of Tolerant Species	-
Brook Trout Age Class	+
CW-IBI Score (Threshold)	**9 – 45 (30)**

CW – IBI examples



Contoocook River, Peterborough NH

<u>Is the CW – IBI applicable?</u>

1) Latitude: 42.900N

(latitude must be >43.75N to not consider major basin)

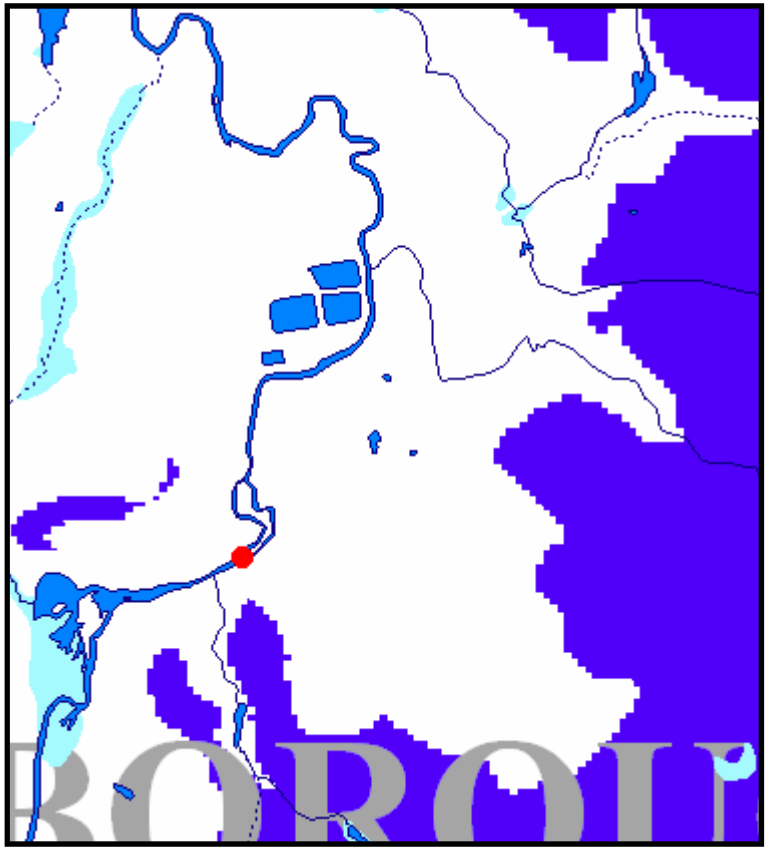
2) Major Basin: Merrimack

(elevation must be >775 ft. and drainage area <15 sq. mi.)

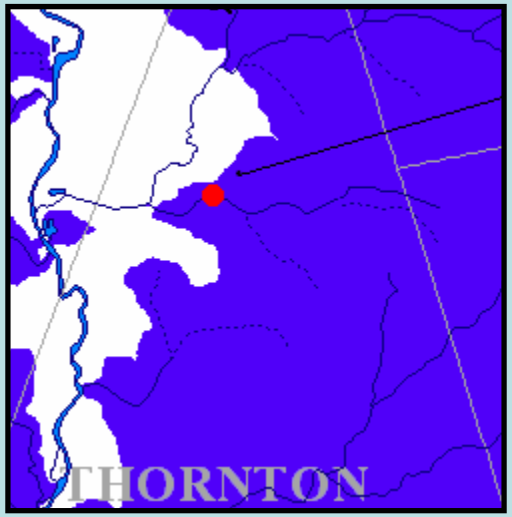
3) Elevation: 702 ft. (not high enough)

4) Watershed Area: 127 sq. mi. (too large)

Answer: CW – IBI is NOT Applicable



Johnson Brook, Thornton, NH



Is the CW – IBI applicable?

1) Latitude: 43.969N

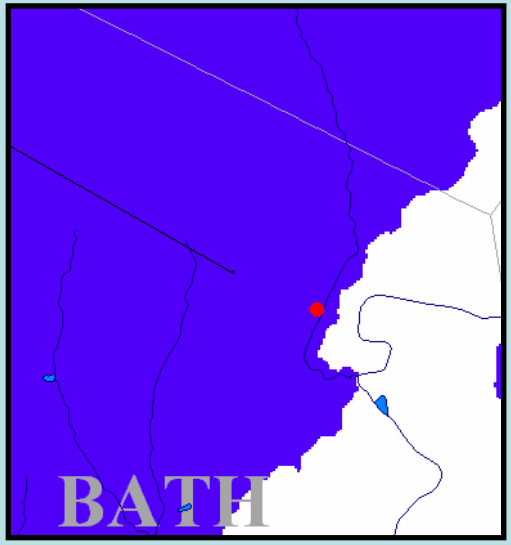
(>43.75N do not need to consider major basin or elevation)

2) Watershed Area: 5.2 sq. mi.

(<15 sq. mi.)

Answer: CW – IBI is Applicable

Petttyboro Brook, Bath, NH



Is the CW – IBI applicable?

1) Latitude: 44.201N

(>43.75N do not need to consider major basin or elevation)

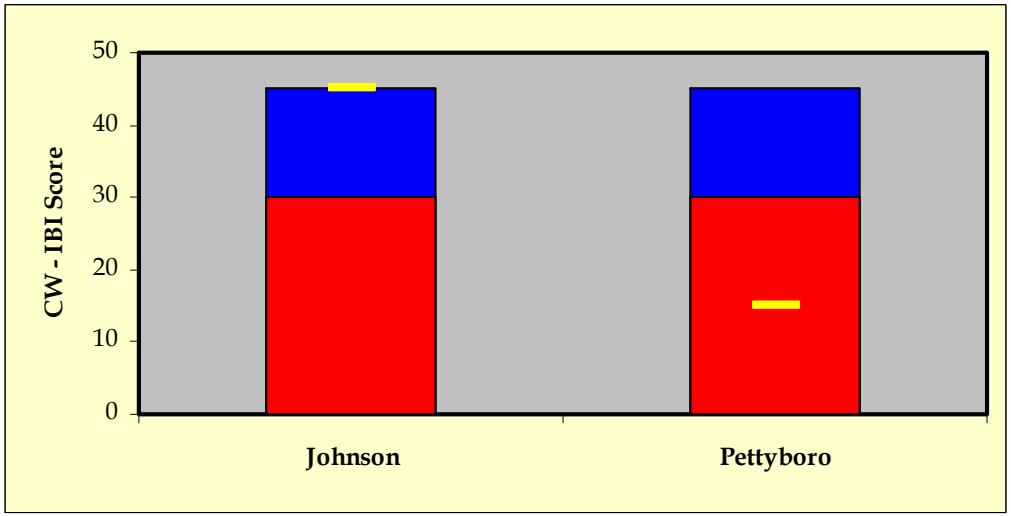
2) Watershed Area: 13.2 sq. mi.

(<15 sq. mi.)

Answer: CW – IBI is Applicable

Johnson Brook, Thornton, NH

CW – IBI score 45/45; above threshold; supports aquatic life use



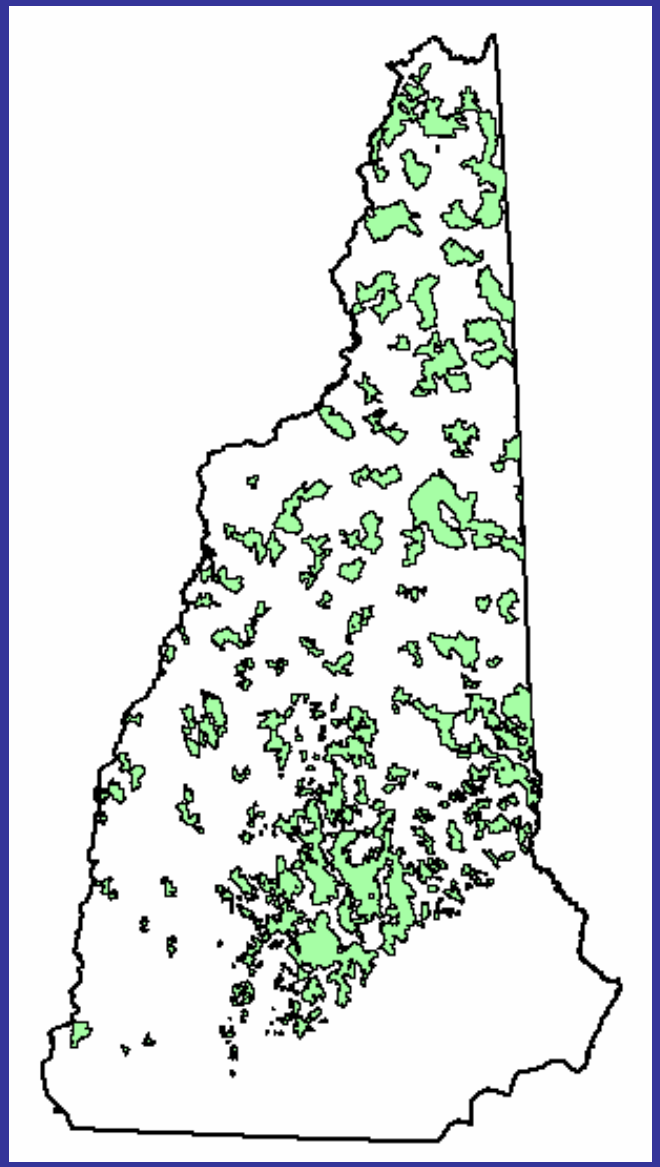
Petttyboro Brook, Bath, NH

CW – IBI score 15/45; below threshold; does not support aquatic life use

Assessment of transitional water fish assemblages

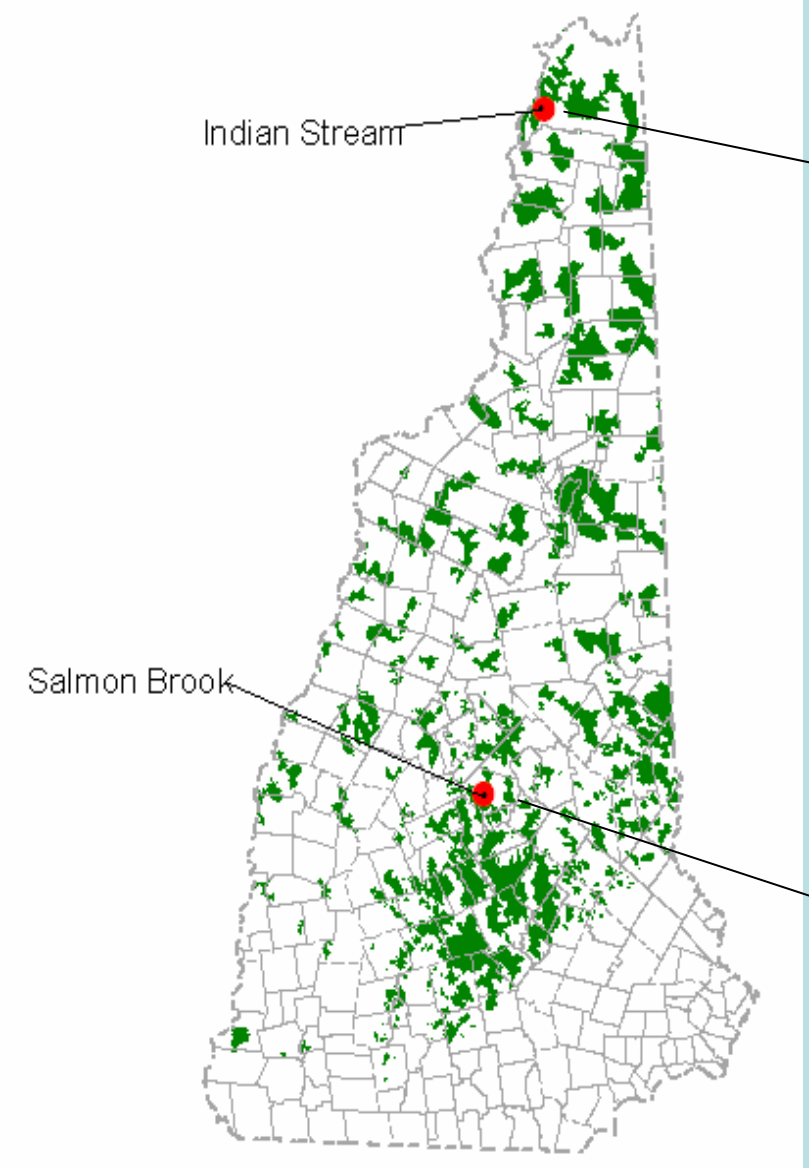
- Index developed in 2008
- Restricted to streams expected to support coldwater fish species year round; >4 fish species
- Generally larger drainage areas than strict coldwater assemblage

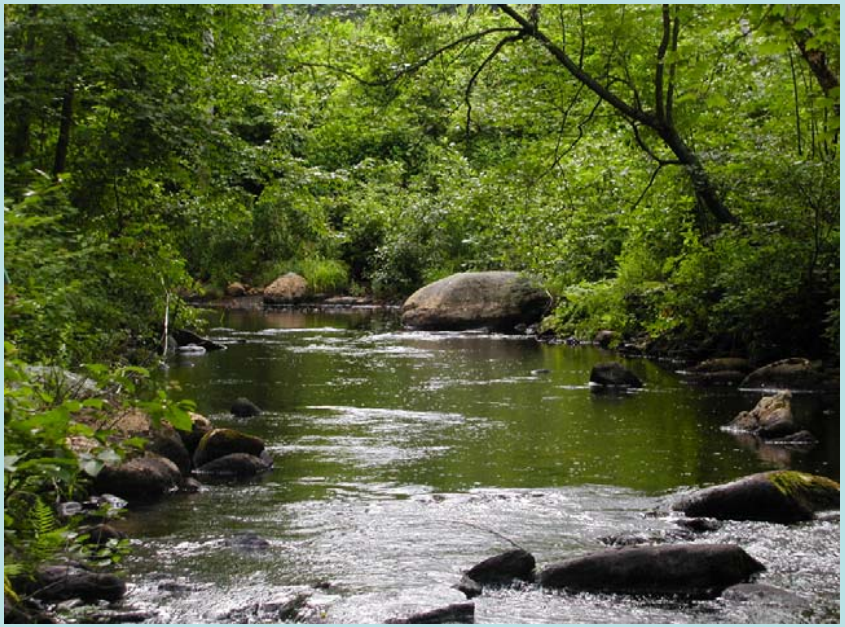
NH Transitional water fish assemblage (NH TW-IBI)



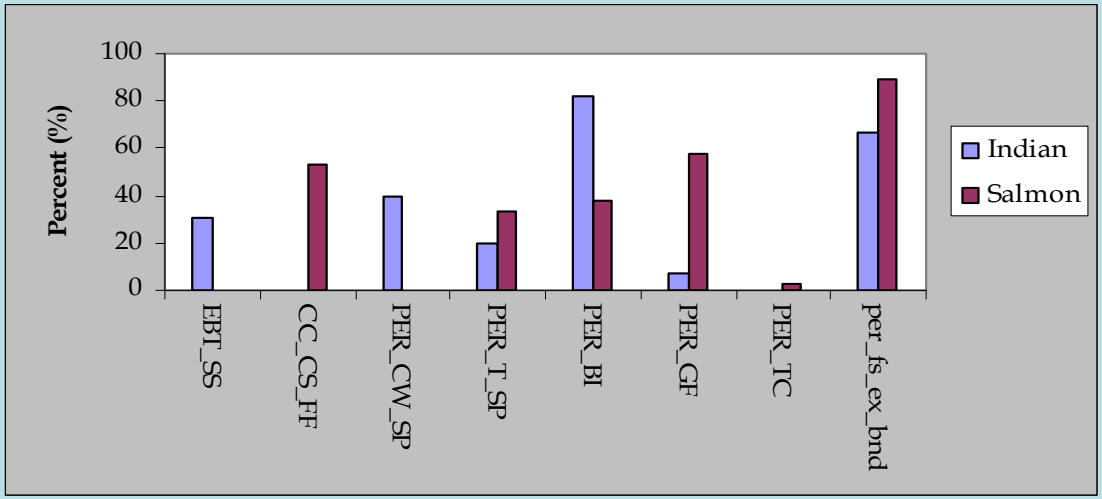
Individual metrics receive score of 1 (bad), 3 (fair) , 5 (good)

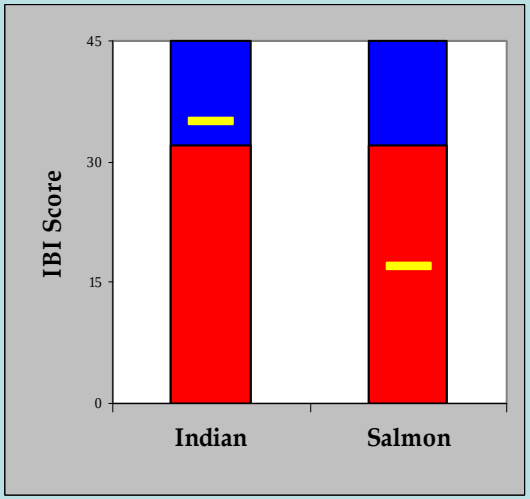
METRIC	RESPONSE
% CW species	+
% Top carnivore individuals	+
% Brook Trout + Slimy Sculpin individuals	+
% Creek chub, Common shiner, Fallfish Individuals	-
% Fluvial specialists, exclude blacknose dace individuals	+
% Generalist feeder individuals	-
% Benthic Insectivore individuals	+
% of Tolerant Species	-
Brook Trout Age Class	+
CW-IBI Score (Threshold)	**9 – 45 (32)**


Indian Stream
Salmon Brook



Anatomy of the TW IBI





Metrics of interest

- Salmon lacks brook trout and slimy sculpin
- Salmon ~60% CC, CS, FF
- Salmon no CW species
- Salmon ~40% tolerant species
- Salmon ~60% generalist feeders

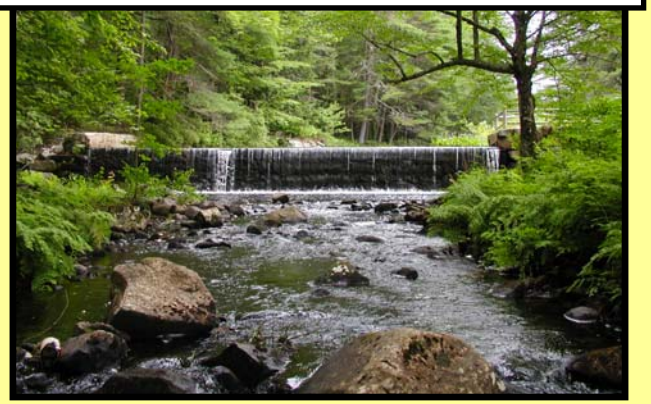
Result

- Indian - 35 / 45; achieves threshold
- Salmon – 17 / 45; fails to achieve threshold

Potential reasons for TW IBI failure at Salmon Brook

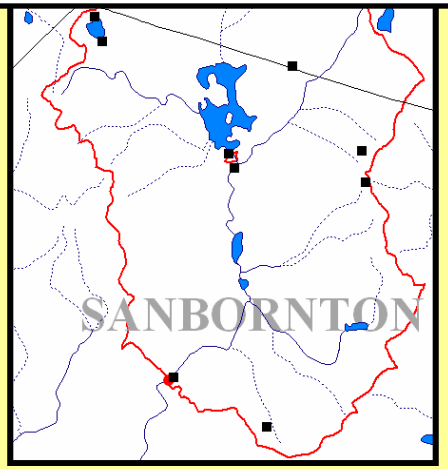
"everything looks fine from the original picture, but…."

Dam immediately upstream

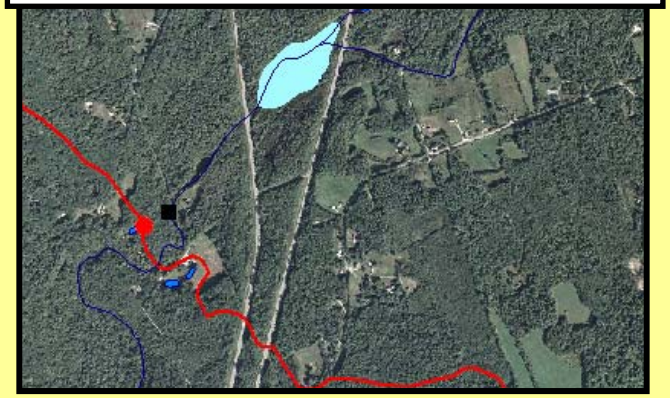


Sedimentation, algal growth

Additional dams in w'shed

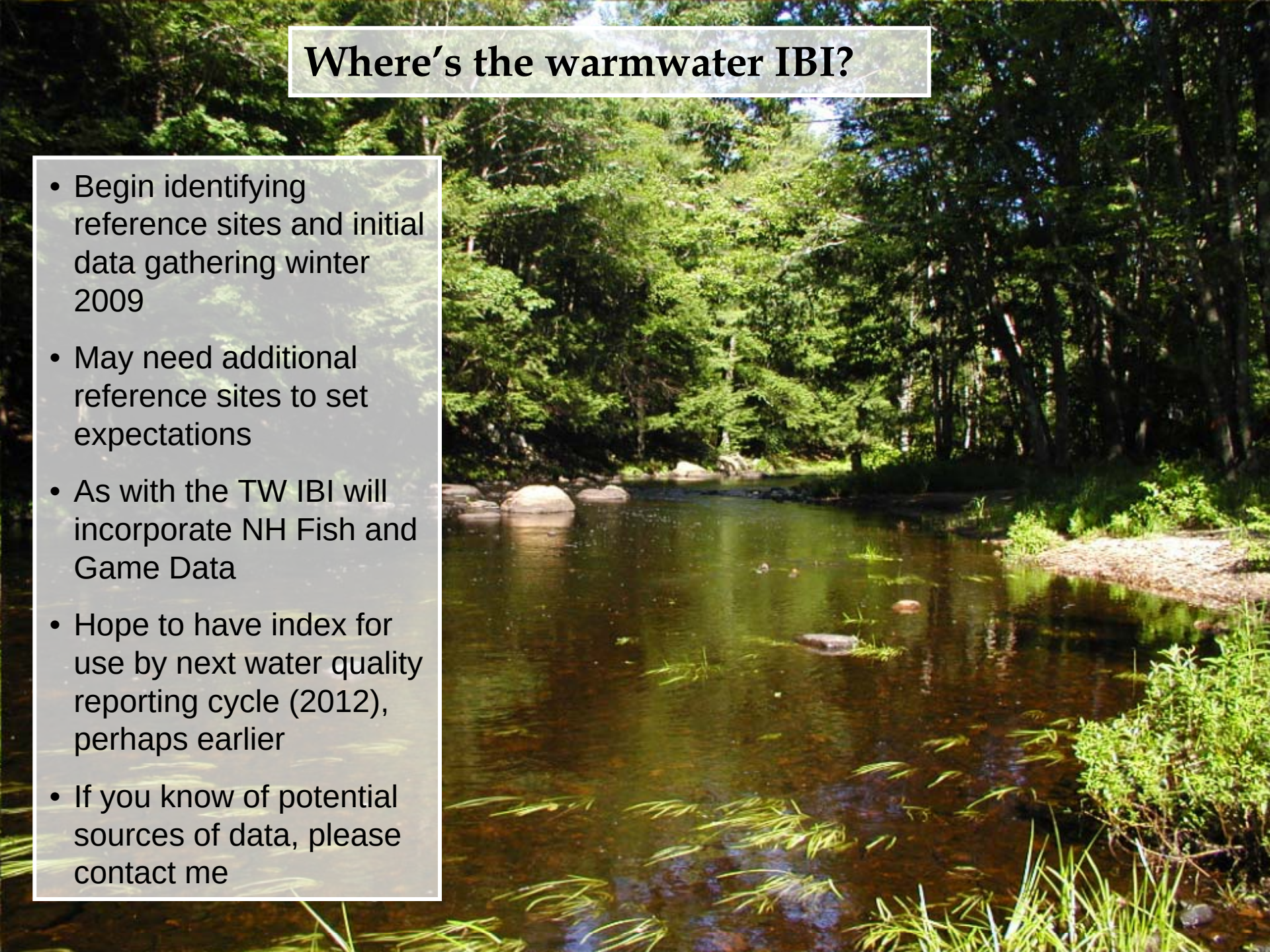


Highway runoff?



Where's the warmwater IBI?

- Begin identifying reference sites and initial data gathering winter 2009
- May need additional reference sites to set expectations
- As with the TW IBI will incorporate NH Fish and Game Data
- Hope to have index for use by next water quality reporting cycle (2012), perhaps earlier
- If you know of potential sources of data, please contact me



Summary

- New Hampshire flowing waters contain three primary fish assemblage types
- CW = ~roughly half land area (48.7%), TW = smallest land area (17.1%); WW = larger rivers, south, east (34.2%)
- Predicted assemblage areas are only a first approximation and should be modified based on field sampling, future research
- CW IBI applies to low diversity, small drainage area streams either in the northern section of the state, CT river drainage, or at higher elevations
- TW IBI designed for coldwater streams with larger drainage areas moving towards a warmwater thermal regime; more species diverse
- WW IBI will be developed in near future
- Use of these tools will be helpful in completing water quality assessments, making permit decisions, restoration activities, and watershed planning efforts

Questions?

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