Ohio EPA
Division of Surface Water

Headwater Stream Initiative

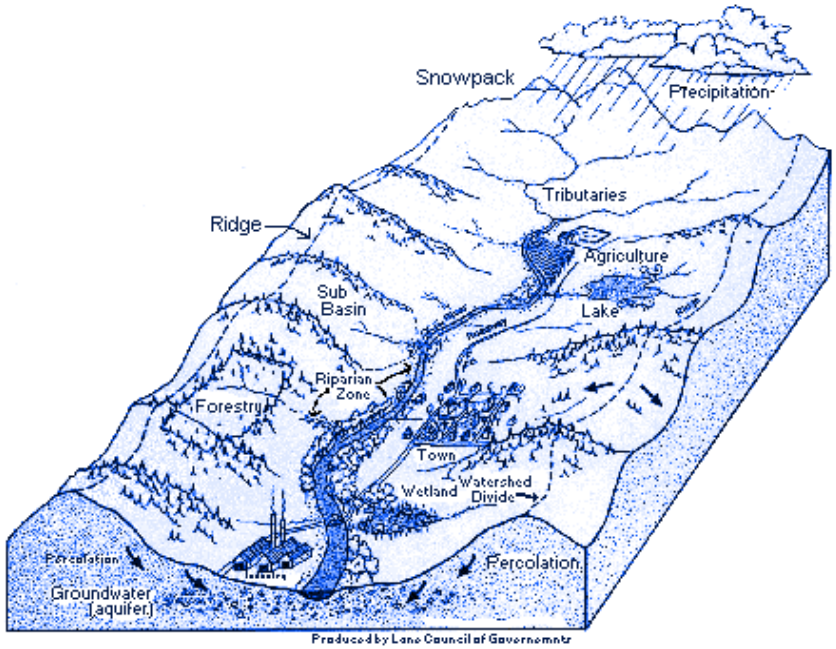
- Robert D. Davic
- Steve Tuckerman
- Paul Anderson
- Mike Bolton

Why are headwater streams important?

- The most prevalent form of stream in the state, with over 115,000 miles estimated to exist (vs. 21,000 miles of named streams).
- Provide habitat for native fauna well adapted to headwater stream conditions.
- Important in the assimilation of pollutants and storage of runoff and flood waters.
- The “capillaries” of the state’s stream network.

Federal Clean Water Act

- **The Clean Water Act provides authority for states to issue water quality standards and "designated uses" to all waters of the United States <u>upstream to the highest reaches of the tributary streams</u>.**
- Source: Memorandum dated January 19, 2001, General Counsels of USEPA and US Army corps of Engineers



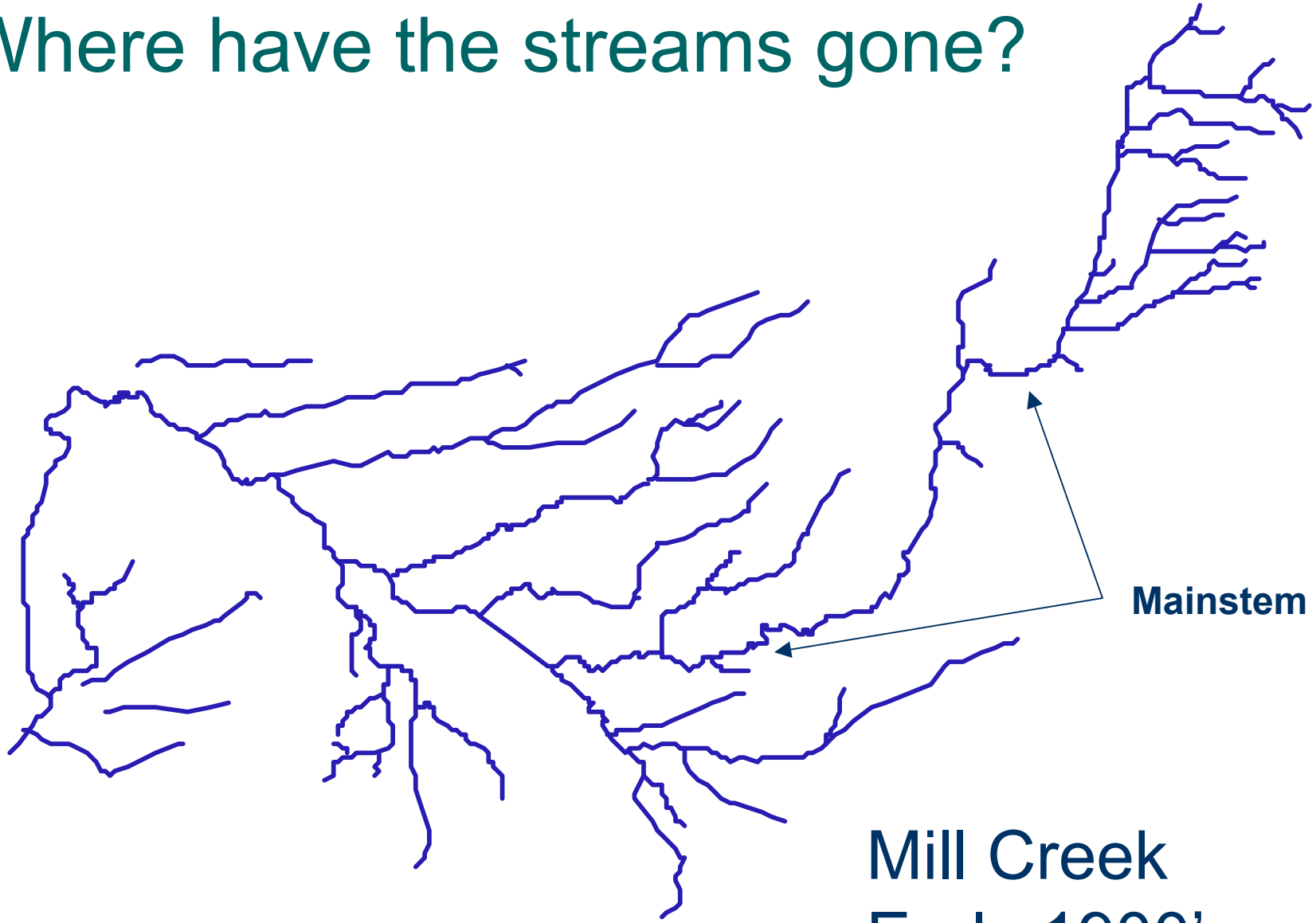
Ohio EPA
Headwater Stream Initiative

- Ohio rules require all water bodies to have designated uses.
  [OAC 3745-1-01, OAC 3745-1-07 (A)(1)]
- Current stream use designations are inadequate to classify small headwater streams.
- Since 1999 research has been conducted to determine appropriate methods for classifying headwater streams.
- Data will be used to propose new aquatic life use designations for “primary headwater habitat” streams in Ohio.

Primary Headwater Habitat Streams

- Primary headwater habitat (PHWH) streams are incapable of meeting established biocriteria for fish because of their small size and lack of deep pools.
- Generally < 1 mi^2 watershed area and pools less than 40 cm in depth.
- "Primary Headwater Habitat" term is used to distinguish from "headwater" fish streams in current use designations (<20 mi^2).

Where have the streams gone?



Mill Creek
Early 1900's

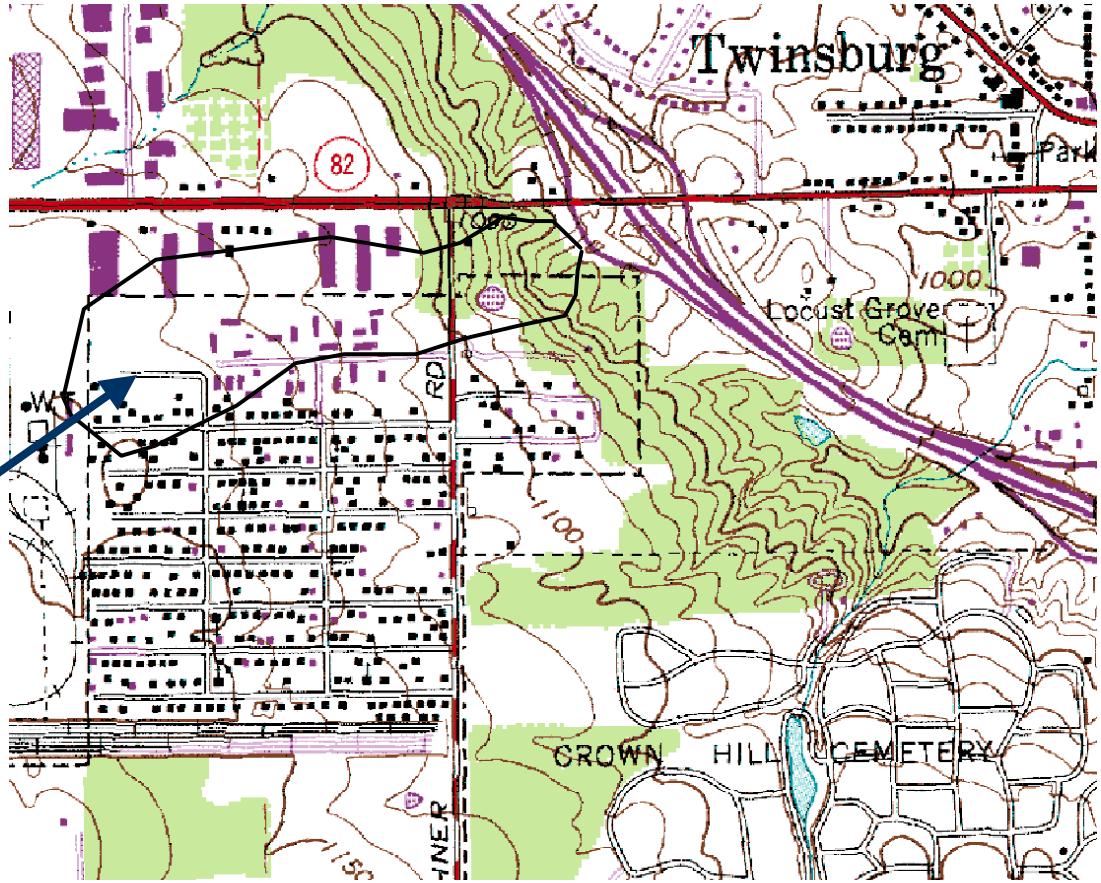
Where have the streams gone?

Mill Creek
Present Day

Source: Cuyahoga SWCD

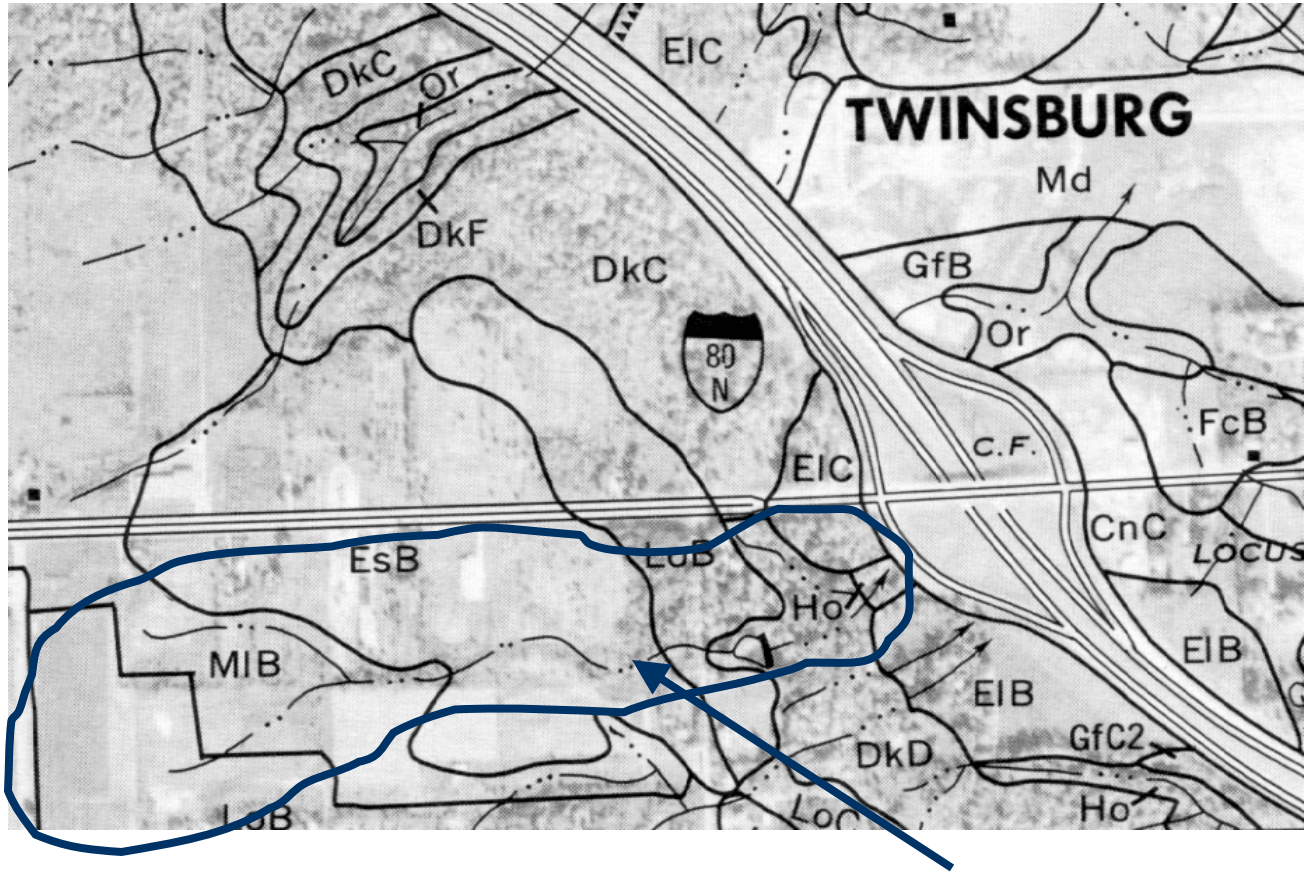
Desktop Headwater Stream Identification

- **USGS 1: 24,000 Topographic Mapping Scale**



0.68 sq. mi.

Desktop Headwater Stream Identification



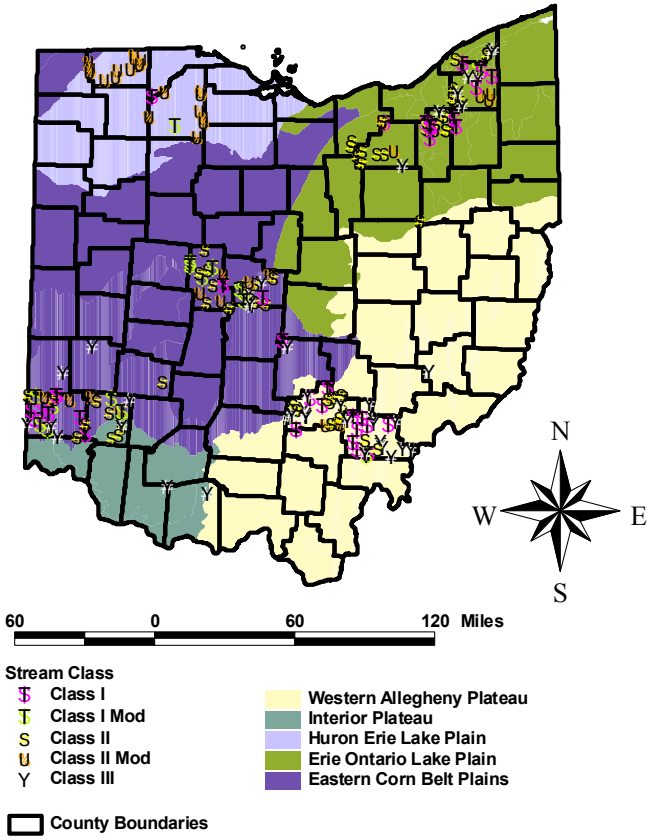
- **NRCS Soil Map including hydro-layer**

Scale Range = 1:15,000 to 1:20,000

Watershed from previous USGS slide

Primary Headwater Stream (PHWH) Evaluation Methodologies

- An evaluation protocol for PHWH streams was developed in 1999.
- A total of 305 sites were sampled by the Ohio EPA in 1999-2000. Quarterly biological monitoring of reference sites was also conducted.
- Randomized sampling of five geographic areas was conducted in 2000 to estimate the distribution of different types of headwater streams in the state.



Study Design: Field Evaluation

- **Biology:**
  - Fish
    Macroinvertebrates
    Amphibians
- **Water Quality:**
  - Field measures
    (DO,pH,Temp.,Conductivity)
- **Physical and Habitat Features:**
  - 61 meter (200 ft) zone

Class I PHWH Streams

- **Ephemeral Flow. Dry channel present annually.**
- **Aquatic life absent or present seasonally - low diversity.**

Modified channel, Delaware Co.

Natural channel, Wood Co.

Class II PHWH Streams

- Warmwater adapted community.
- Flow may be intermittent.
- Permanent pools present annually.

Modified channel, Delaware Co.

Natural channel, Geauga Co.

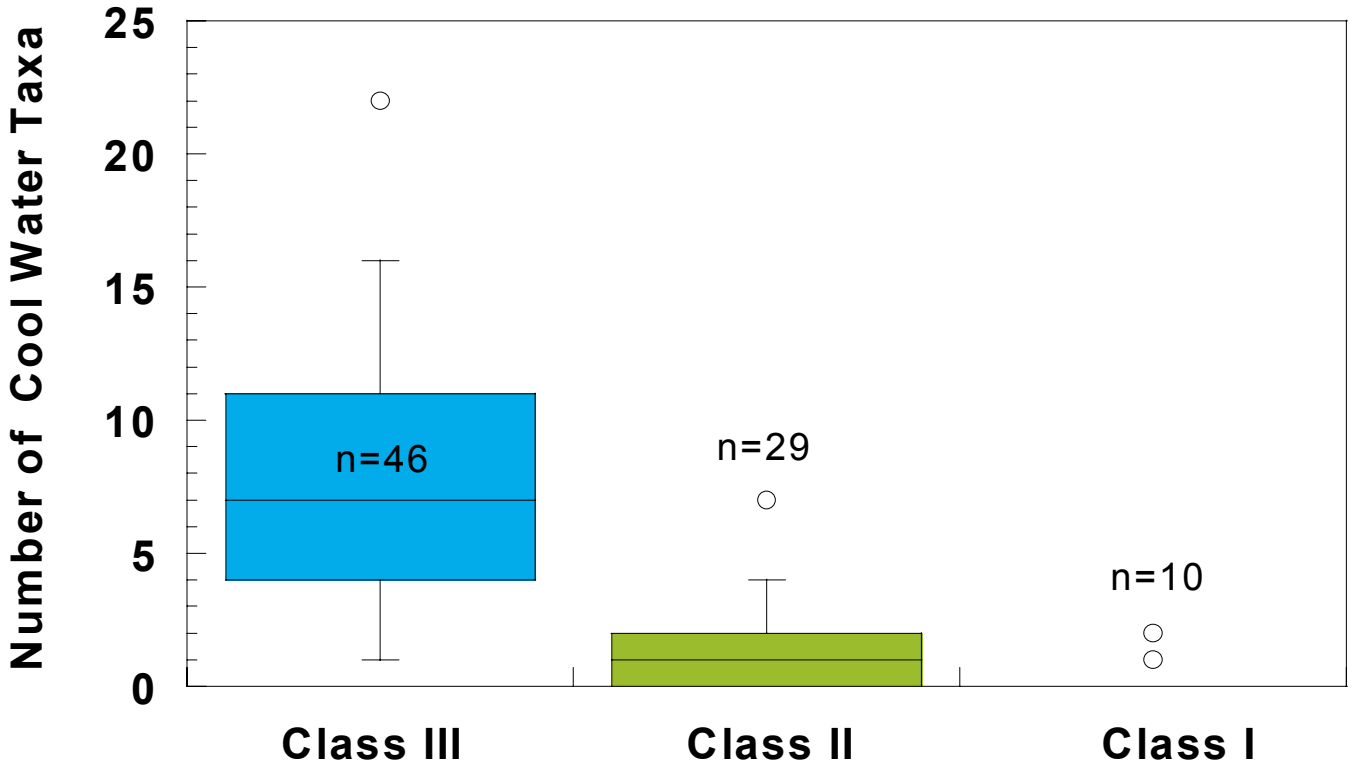
Class III PHWH Streams

- Perennial flow.
- Presence of one or more of the following at all times:
  - Obligate aquatic salamanders
  - Cold water or pioneering fish species
  - Cool water adapted benthic macro-invertebrates.

Delaware Co.

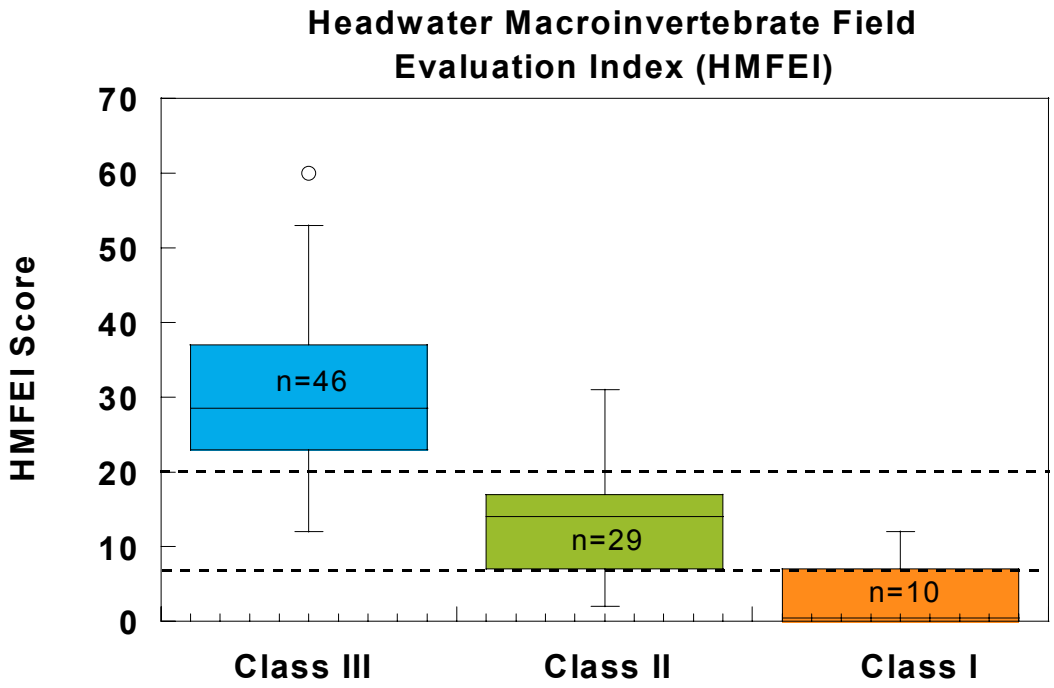
Results: Benthic Macroinvertebrates

Two distinct macroinvertebrate communities:



Results: Headwater Macroinvertebrate Field Evaluation Index (HMFEI)

- Rapid field assessment methodology based upon Family or Order level of taxonomy.
- Scoring based upon correlation to cool water habitats and number of EPT taxa present.
- HMFEI is a surrogate. Final determination based upon lowest taxonomic level identification.



Index developed by Mike Bolton, Ohio EPA Biologist

Vertebrates in PHWH Streams

Reside Dace

Two-lined Salamander

- **Class III PHWH streams characterized by the presence of cold water adapted species of fish and/or salamander species with 1-2 year gilled larval period.**

- **Class II PHWH streams may have pioneering fish species present. Cold water fish species absent. Salamander adults or larvae of species with short duration gilled larval period may be present.**

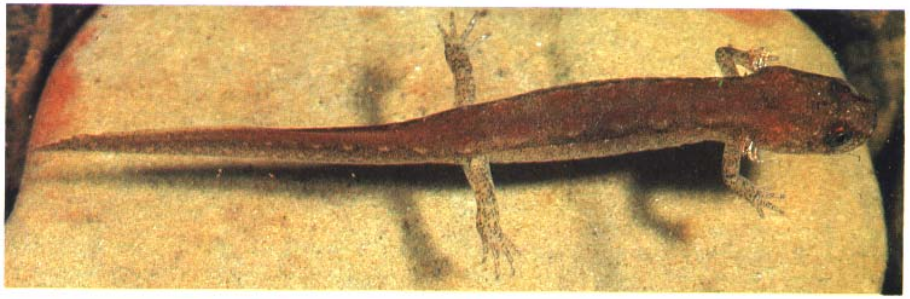
Salamanders Found in Headwater Streams in Ohio

Class III Streams (Gilled larvae present on annual basis)

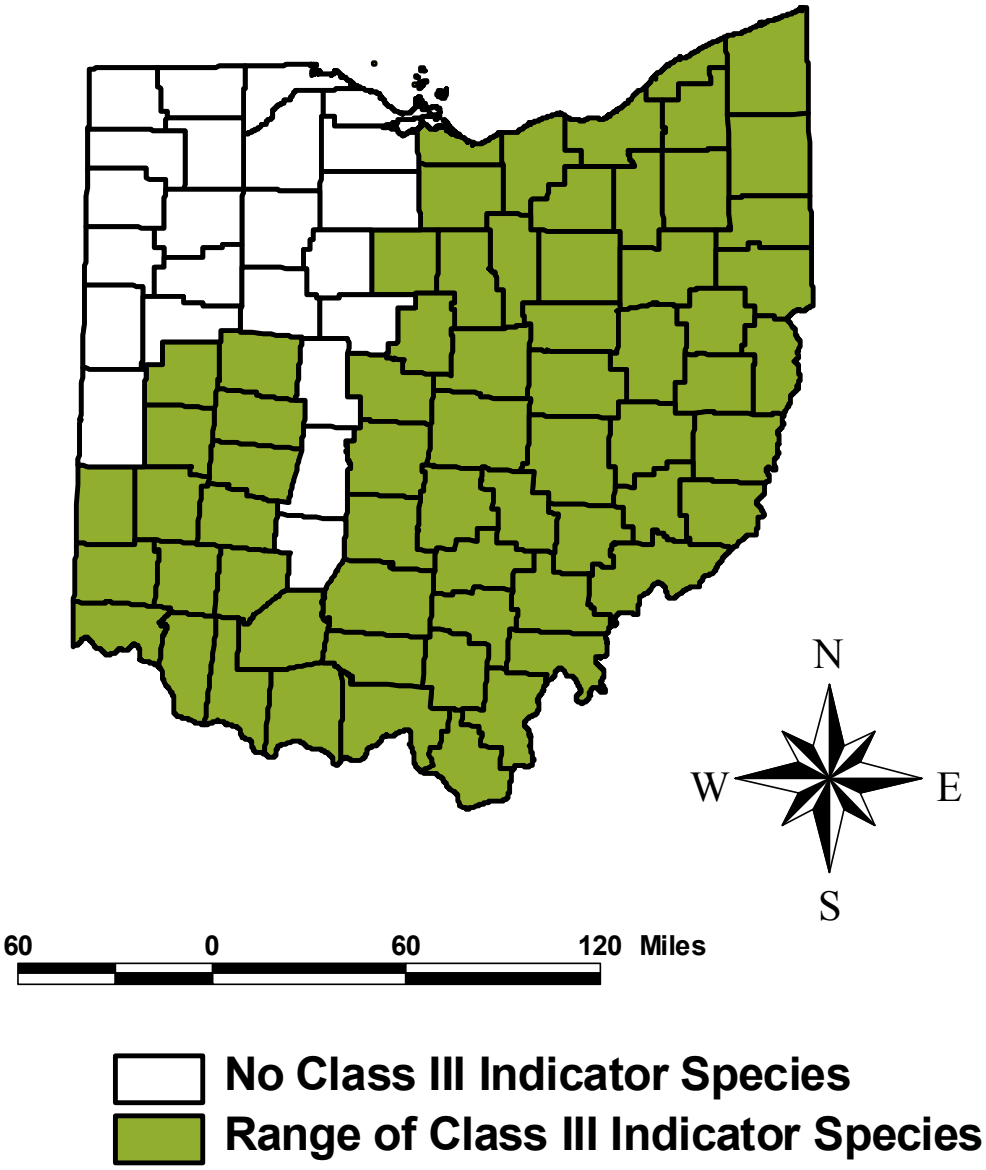
- Plethodontidae (Lungless)
- Subfamily Plethodontinae:
  - *Gyrinophilus* (2 species)
  - *Pseudotriton* (2 species)
  - *Eurycea* (4 species)

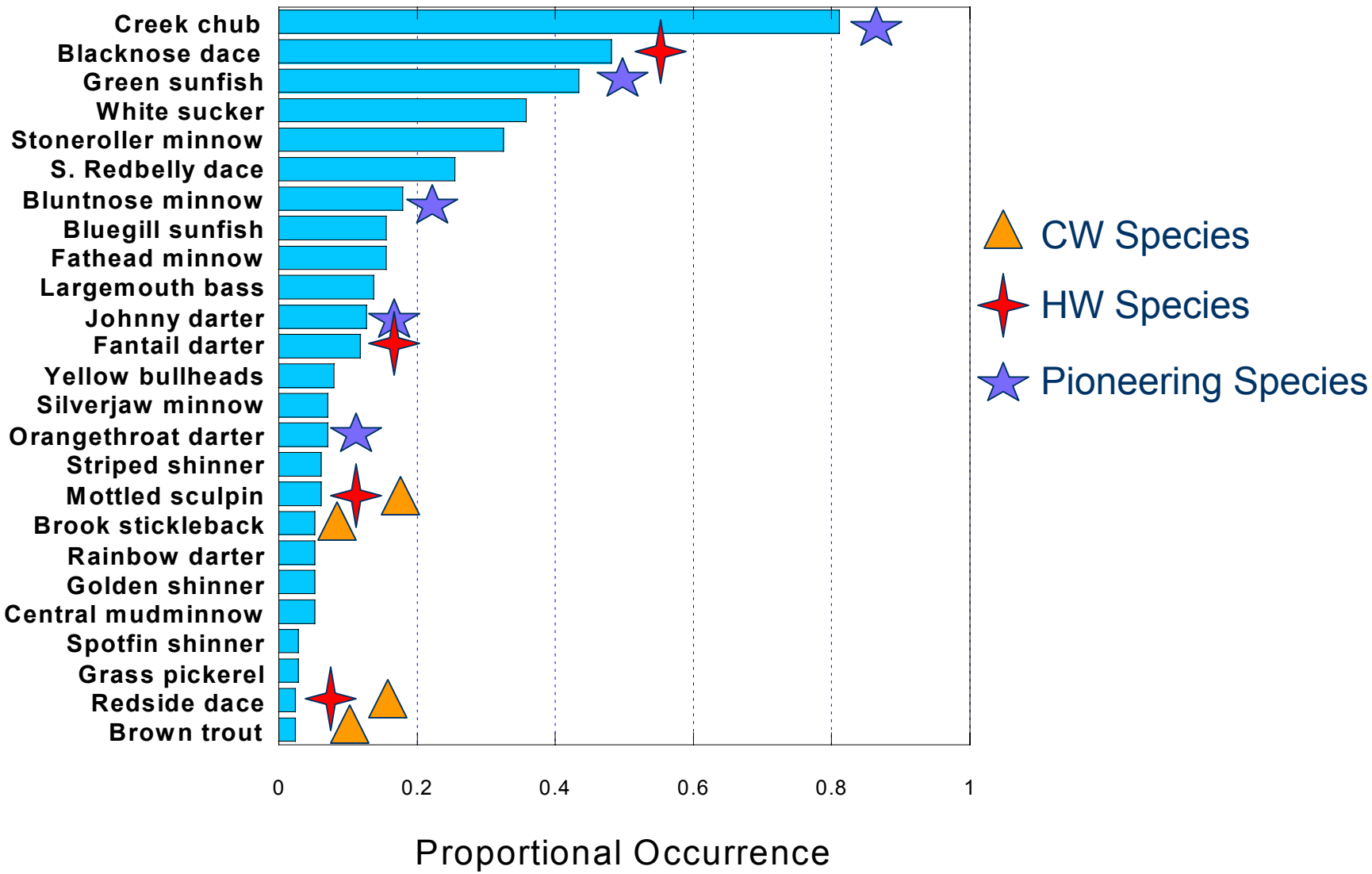
Class II Streams (Gilled larvae present seasonally)

- Ambystomatidae (Mole)
  - *Ambystoma* spp.
- Plethodontidae (Lungless)
- Subfamily Desmognathinae:
  - *Desmognathus* (2 species)

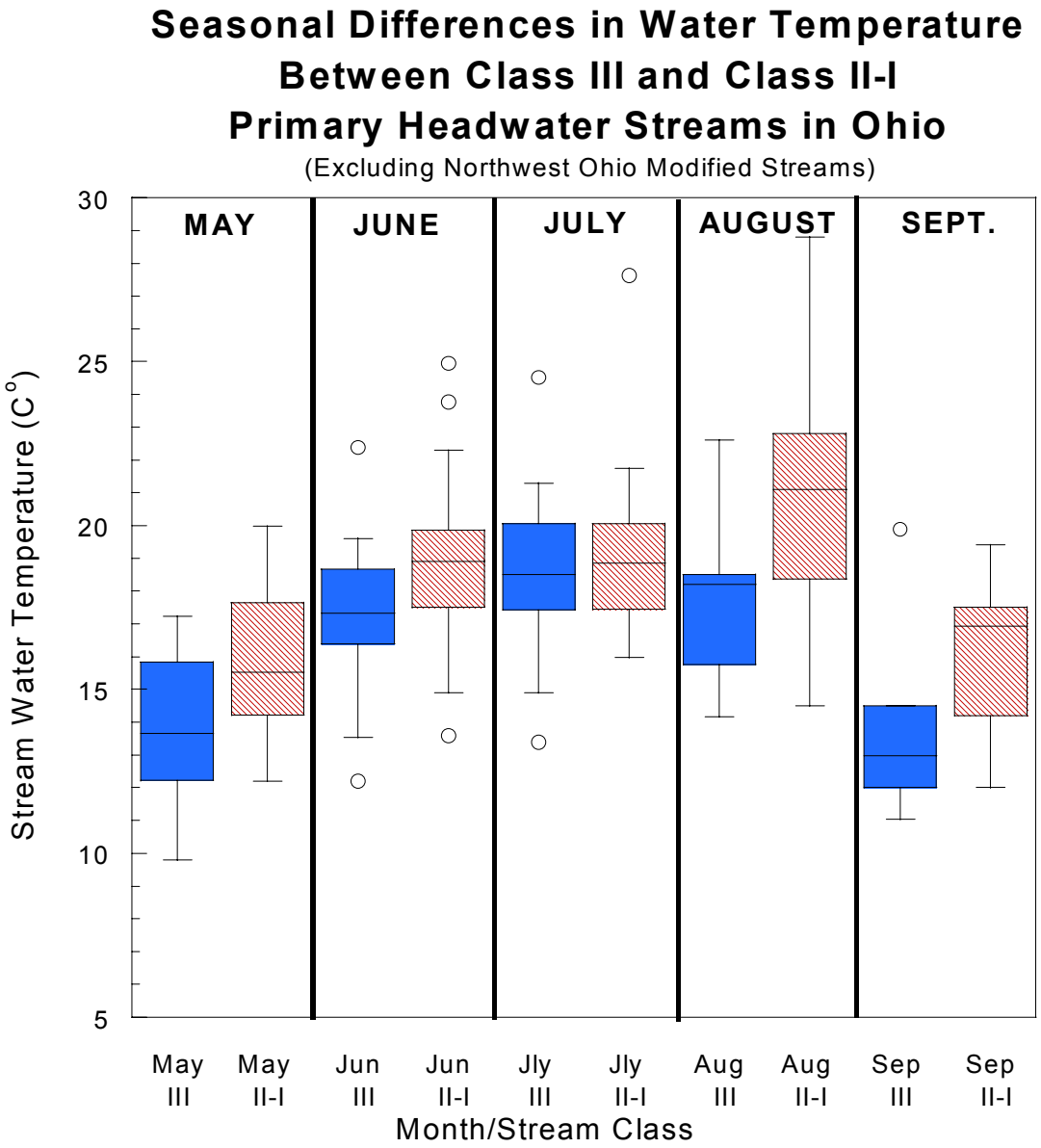


Distribution of Class III PHWH Indicator Salamander Species



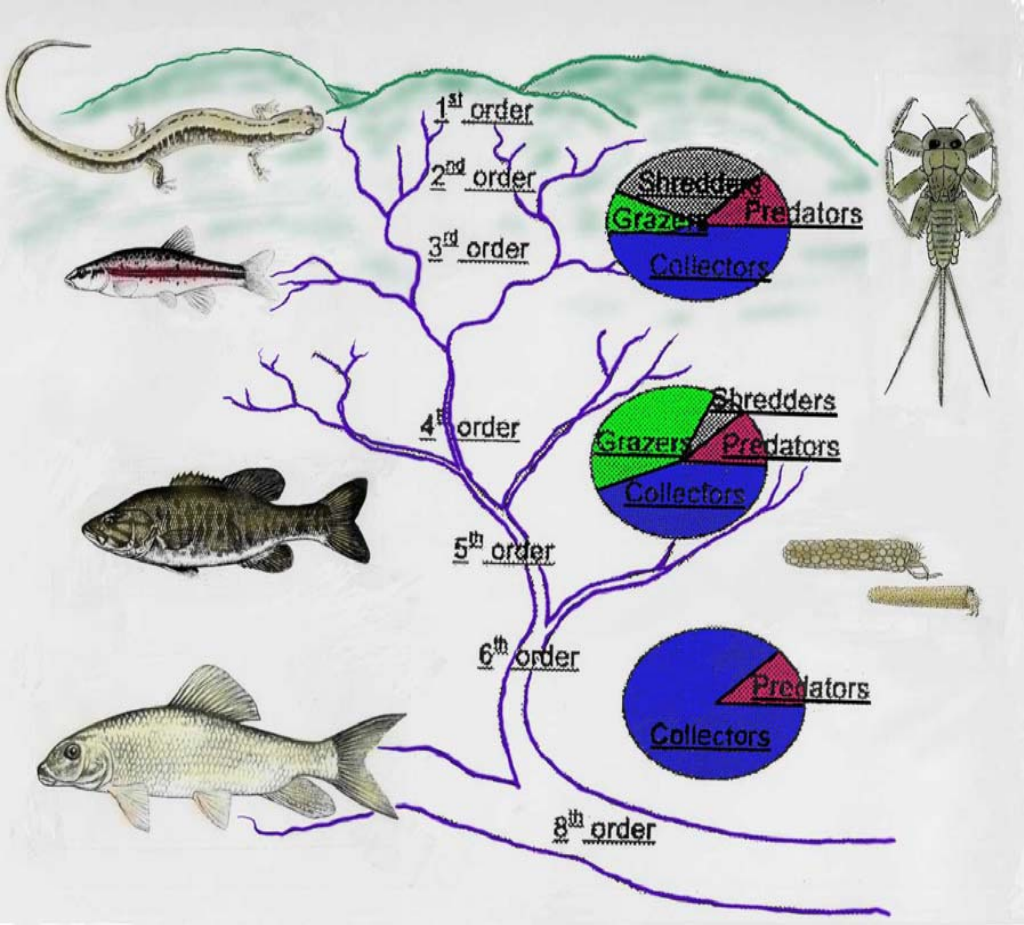

25 Most Common Fish Species in
Primary Headwater Streams (< 1 sq. mi)
from Ohio EPA Electrofishing Surveys
(N=212 Sample Events from 144 Streams)
Creek chub
Blacknose dace
Green sunfish
White sucker
Stoneroller minnow
S. Redbelly dace
Bluntnose minnow
Bluegill sunfish
Fathead minnow
Largemouth bass
Johnny darter
Fantail darter
Yellow bullheads
Silverjaw minnow
Orangethroat darter
Striped shinner
Mottled sculpin
Brook stickleback
Rainbow darter
Golden shinner
Central mudminnow
Spotfin shinner
Grass pickerel
Redside dace
Brown trout
0
0.2
0.4
0.6
0.8
1
Proportional Occurrence
CW Species
HW Species
Pioneering Species

Stream Water Temperature



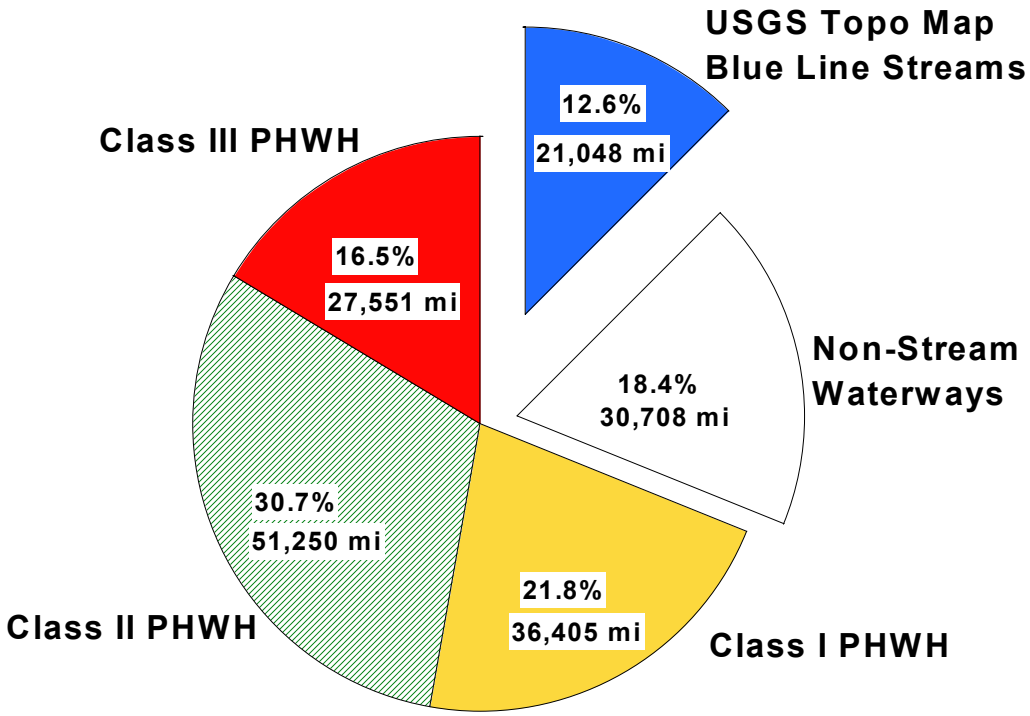
River Continuum Concept

- Salamanders replace fish as the top vertebrate predator in primary headwater streams.
- Shredder functional group of benthic invertebrates is most common in primary headwater streams.



PHWH Stream Assessment Results

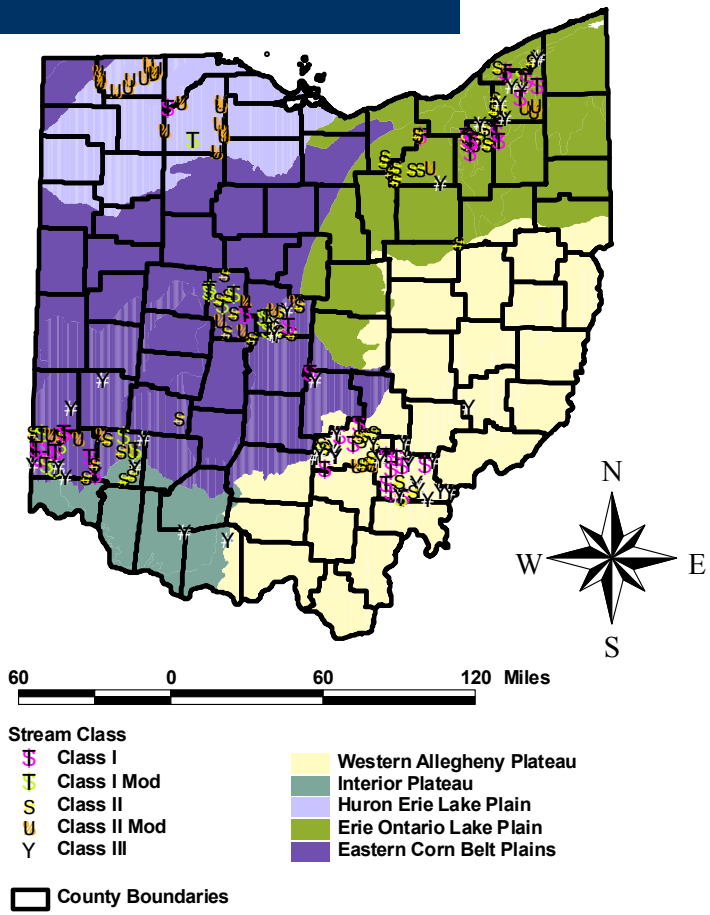
- Sampling of randomly chosen sites used to estimate the miles of various stream categories.
- Ratio of PHWH streams to streams delineated on USGS topo maps = 5.5:1



Total for PHWH Streams = 115,206 mi (69.0%)

Development of a Headwater Habitat Evaluation Index (HHEI) to Predict PHWH-Stream Classes

- A Headwater Habitat Evaluation Index (HHEI) was developed to provide a rapid assessment tool to predict PHWH stream classes.
- Data from 213 sites state-wide was used to develop the index.
- The approach was similar to that used to develop the QHEI, an index of fish habitat quality in use in Ohio for over 20 years.



The Headwater Habitat Evaluation Index (HHEI): Metrics

Initial Data Set →	Qualitative Screening →	Discriminant Analysis →	Sensitivity Analysis: Final Metrics
Stream Order	Stream Order	Stream Order	
Flow Regime	Flow Regime	Flow Regime	
In-Stream Cover	In-Stream Cover		
Substrate	Substrate	Substrate	Substrate
Development			
Pool Depth	Pool Depth	Pool Depth	Pool Depth
Riffle Depth			
Riparian Width	Riparian Width		
Riparian Land Use	Riparian Land Use		
Gradient	Gradient		
Watershed Area	Watershed Area		
Sinuosity	Sinuosity	Sinuosity	
Bankfull Width	Bankfull Width	Bankfull Width	Bankfull Width
Bank Erosion			
Embeddedness			
Cover Types	Cover Types		
Water Chemistry			

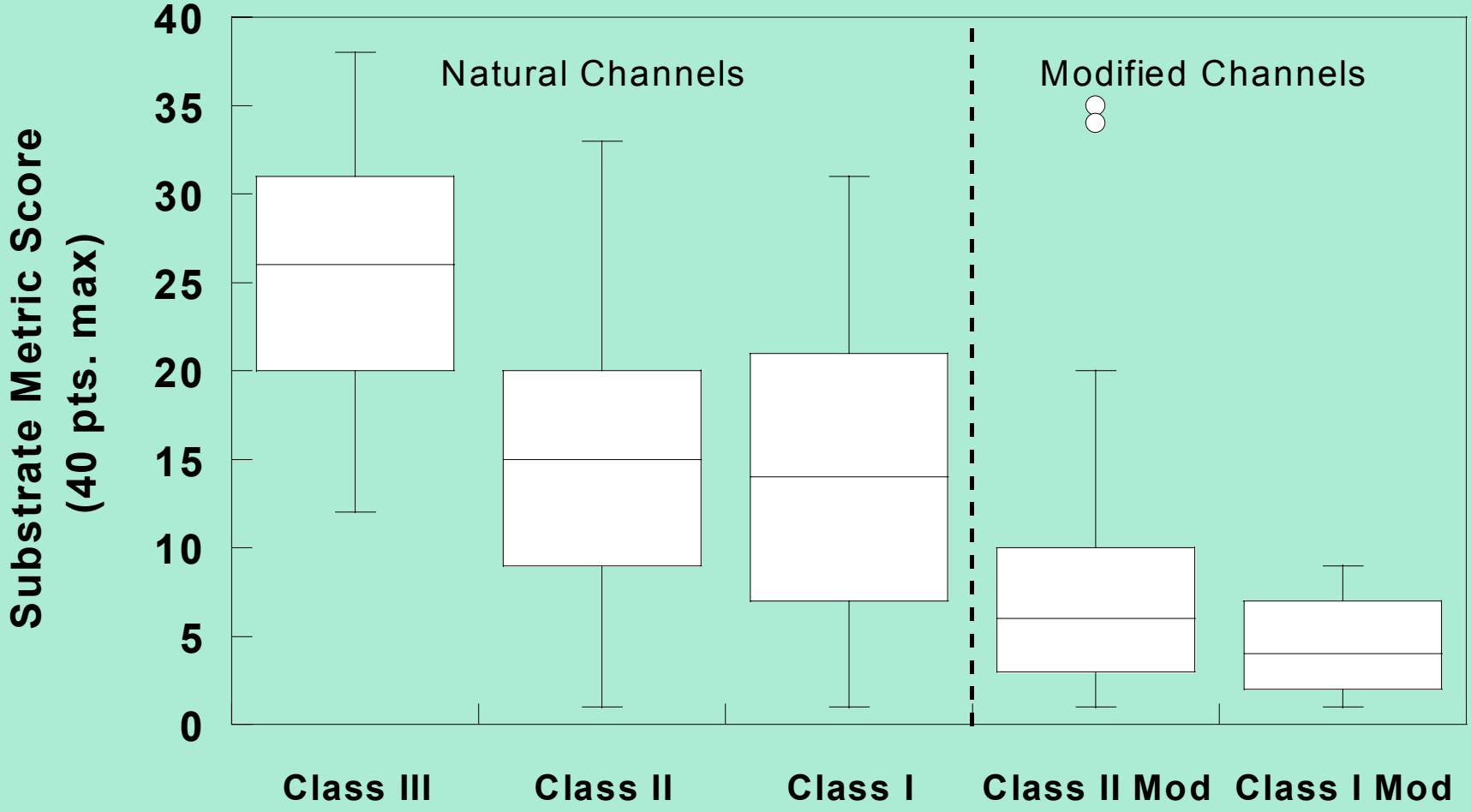
The Headwater Habitat Evaluation Index (HHEI): Metrics

Final HHEI based on three metrics:

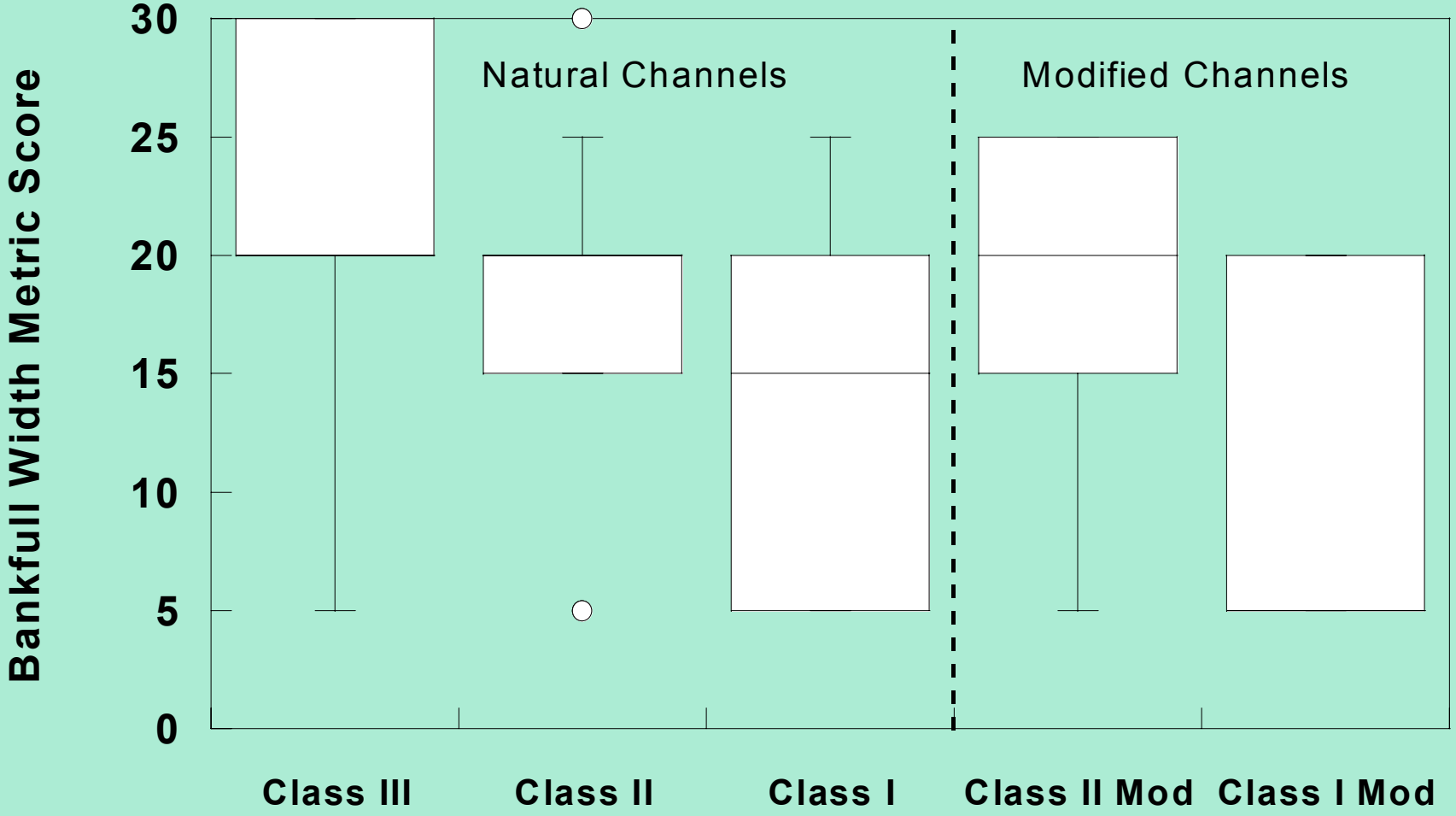
- **Substrate Metric (40 points)**
  - Based upon predominant channel substrate types and the number of substrate types present.
- **Bankfull Width (30 points)**
  - Based upon average bankfull width.
- **Maximum Pool Depth (30 points)**
  - Based upon a single measure of maximum pool depth.

Total HHEI Score ranges from 0 to 100

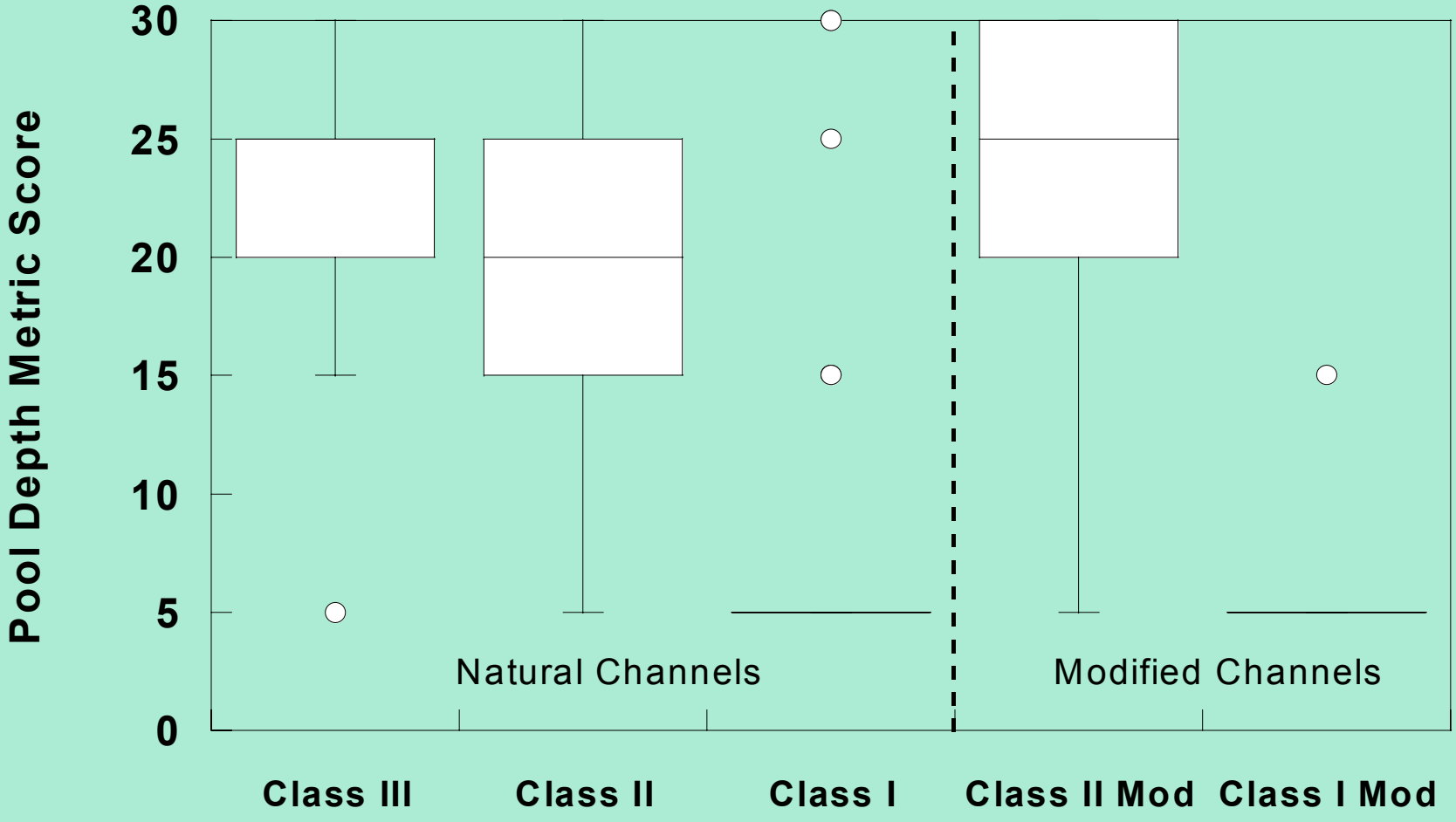
Substrate Metric Scores



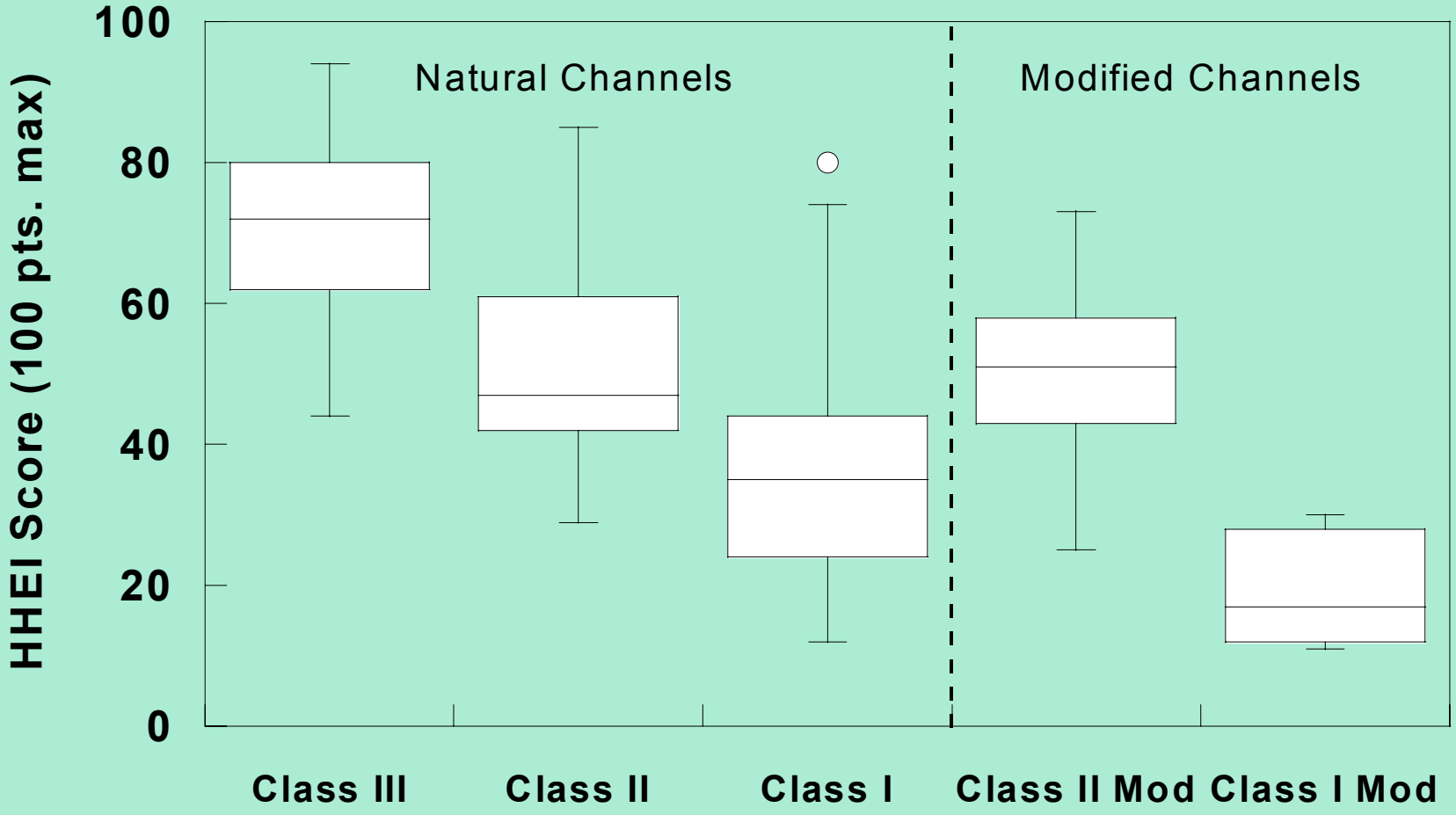
Bankfull Width Metric Scores



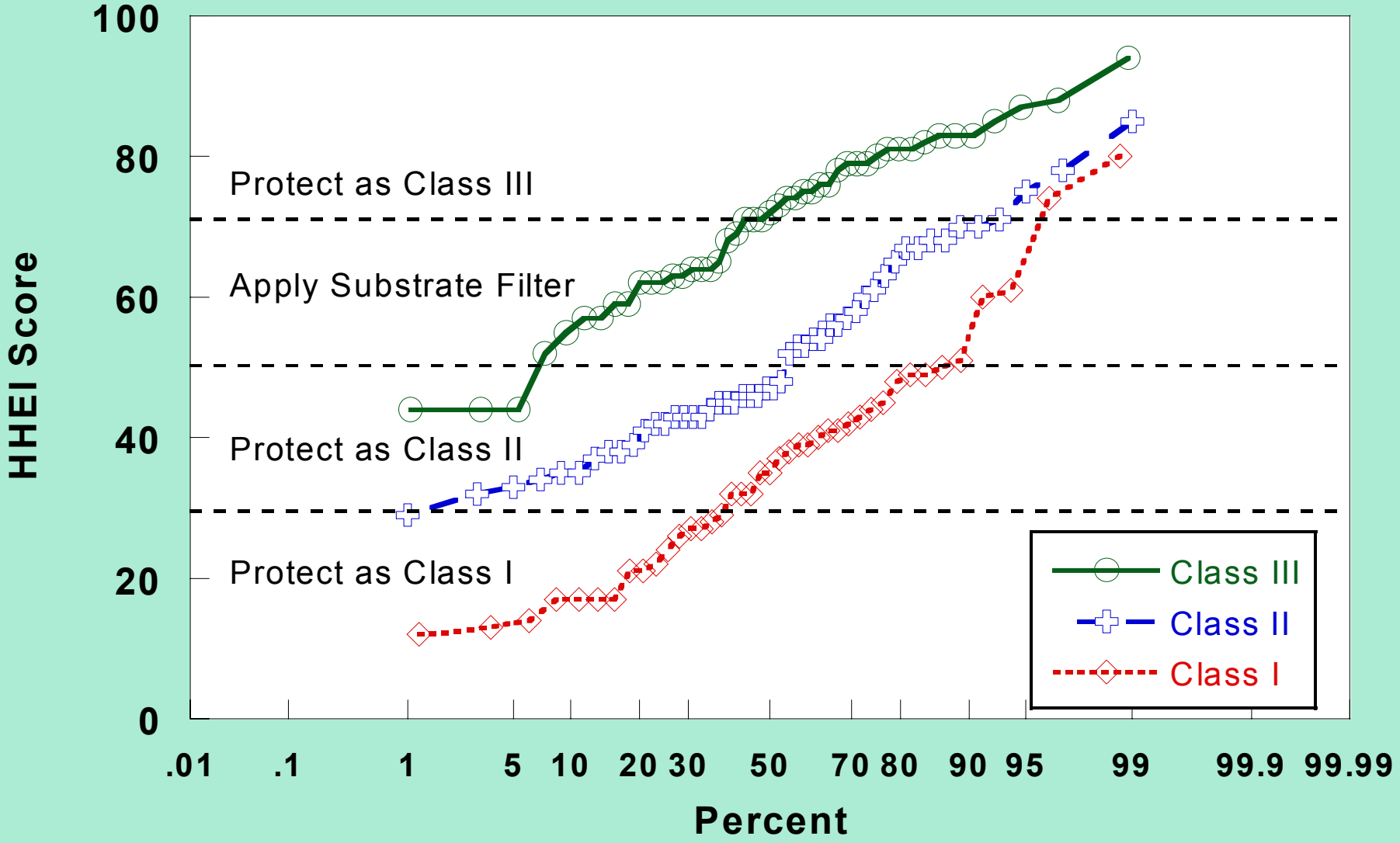
Pool Depth Metric Scores



Total HHEI Scores



Use of the HHEI to Predict Headwater Stream Classification



Advantages to HHEI Approach

- Provides rapid assessment which can be conducted in 15-20 minutes.
- Provides immediate insight into stream classification.
- Can be learned with minimal training.
- Does not require rigorous biological evaluation.
- Can be conducted at any time of the year.
- Independent of factors which are not within OEPA's regulatory authority.

Three-Tiered Evaluation Approach

- 1st Tier: HHEI scoring and flow chart (required for all sites)
- 2nd Tier: Rapid bio-assessment using HMFEI (common)
- 3rd Tier: Salamander survey (10 meter zone), fish survey, macroinvertebrates identified to lowest taxonomic level (very rarely needed)

What we are losing ……..

1999

Unnamed Class III tributary
to Tinkers Creek: HHEI Score = 55

2001