Progress on Trend Assessment in ECBP and HELP Ecoregions: Applications to Fish Creek and the St. Joseph River Systems

Midwest Biodiversity Institute
Broad Study Objectives

• Explore trends in biological response variables such as IBI and ICI, their metrics and certain key fish and macroinvertebrate taxa in Eastern Corn Belt Plains (ECBP) and Huron Erie Lake Plain (HELP) ecoregions
• Relate, where possible, changes in biology to the predominant stressors in these watersheds
• Assess trends in Fish Creek and the Saint Josephs River watersheds in relation to changes elsewhere in these ecoregions to determine whether the patterns of change in these watersheds are stable, likely to improve, or at risk of decline.
Ohio EPA Macroinvertebrate Methods: Field Procedures

Artificial Substrates are Set for a Six-Week Exposure (July - September Index Period)

Artificial Substrates are Placed in Run Habitat With Constant Current

The Artificial Substrates are Retrieved, Preserved, and Returned to the Laboratory for Processing

A Qualitative Dip Net/Hand Pick Method is Used to Supplement the Artificial Substrates or as a Stand Alone Evaluation
Fish are a widely identifiable component of aquatic systems and are valued for their recreational uses. Most species, however, are more obscure, and comprise the second most endangered group.
The Linkage From Stressor Effects to Ecosystem Response

This model is an explicit statement of multiple causation.

STRESSORS → EXPOSURE → RESPONSE
Watershed Scales:

Subbasin: 93 in Ohio

Huc Watershed: 330 in Ohio
Trends in Water Quality

Aquatic Life Use Attainment in Ohio Streams
(Based on Biocriteria)

\[ y = -2572.7 + 1.3127x \quad R^2 = 0.68456 \]
Change in Sensitive & Intolerant Fish Species Distributions
Matched Sites, pre-1988 and post-1993

Percent Change in Locations Collected

ECBP and HELP Ecoregions

- Headwater Streams
- Small Rivers
- Wadeable Streams
- Large Rivers
Change in Tolerant Fish Species Distribution
Matched Sites, pre-1988 and post-1993

- COMMON CARP X GOLDFISH
- BROWN BULLHEAD
- YELLOW BH X BROWN BH
- FATHEAD MINNOW
- YELLOW BULLHEAD
- BLACKNOSE DACE
- CENTRAL MUDMINNOW
- BLUNTNOSE MINNOW
- GREEN SUNFISH
- WHITE SUCKER
- EASTERN BANDED KILLIFISH
- CREEK CHUB
- GOLDFISH
- GOLDEN SHINER
- COMMON CARP

Percent Change in Locations Collected
Auglaize River

- Substantial improvement in Auglaize basin associated with point and nonpoint sources
- Exceptional biological scores
- Surpass Fish Creek
- Many fewer poor and very poor sites
Sandusky River

- Sandusky River - Recovery from point sources, especially in mainstem segments
- Little change in mean condition
- Reduction in very poor sites
Linking Changes or Spatial Variation in Biological Condition to Stressors
Data by Subbasin - 1994-2001
Overlay: 1979-1987 data
ECBP & HELP Ecoregions

\[ \text{IBI} = 9.03 + 0.46 \times \text{QHEI} \]

\[ R^2 = 0.63 \]
Data by Subbasin - 1994-2001
ECBP & HELP Ecoregions

\[ \text{IBI} = 9.03 + 0.46 \times \text{QHEI} \]
\[ R^2 = 0.63 \]

Data by Subbasin - 1994-2001
ECBP & HELP Ecoregions

\[ \text{IBI} = 10.27 + 0.44 \times \text{QHEI} \]
\[ R^2 = 0.46 \]

Data by Site All Years
ECBP & HELP Ecoregions
Reference Sites ONLY

\[ y = 13.434 + 0.39688x \]
\[ R^2 = 0.51944 \]
Data by Subbasin - 1994-2001
ECBP & HELP Ecoregions

\[ \text{Sens. Sp} = -5.39 + 0.17 \times \text{QHEI} \]

\[ R^2 = 0.70 \]

Mean Sensitive Species vs. Mean Subbasin QHEI

1979-1987 Trend
Data by Date, All Years
ECBP & HELP Ecoregions
Reference Sites ONLY

Creek Chub
River Chub
Bigeye Chub
Rosyface Shiner

Site Specific QHEI
IBI and Total Phosphorus in Headwater Streams

Data by Site 1994-2001
ECBP & HELP Ecoregions
Headwaters Only

Fish Cr & St Joe
All Size Waters

Site Specific
IBI Score
Other Stressors: D.O. and Ammonia


- More Sites with High Sensitive Species
- Fewer High Un-Ionized Ammonia Values


- Fewer Low D.O. Values
- More EWH

- Site Specific IBI
- Site Specific Dissolved Oxygen
- Site Specific Un-ionized Ammonia
**Good Stream Habitat**

Nutrients & Sediment Are Intercepted by Riparian Biomass

- Leaves, Woody Debris
- Bacteria, Fungi
- Sunlight is Limited By the Riparian Vegetation

Erosion:
- Particulate P
- Dissolved P

Two-Way Movement of Sediment & Nutrients

Woody Debris Slows Export of Sediments & Increases Conversion of Nutrients to Desirable Biomass

- Invertebrates (Shredders, Scrapers)
- Algae
- Inverts, Predators
- Insectivorous Fish
- Bird, Mammal Predators

Inverts, Predators

- Fish Predators
- Herbivores

Major Downstream Exports:
I. Desirable Biomass (e.g., fish, plants, birds, mammals, sensitive species)
II. Low Sediment Delivery
III. Water Quality Suitable for ALL Uses

Humans

Two-Way Movement of Sediment & Nutrients

- Riparian Width

Riparian Width

Good Stream Habitat

- Good Stream Habitat
- Good Stream Habitat
One-Way Movement of Sediment & Nutrients Into Streams

Erosion: Sediment with Particulate P & Dissolved P

Fine Sediment Bedload with Algae & Detritus

Lack of Woody Debris Increases Export & Conversion of Nutrients to Undesirable Biomass

Direct Sunlight Affects 100% of Channel; Light is Not a Limiting Factor

Grasses Comprise Majority of Riparian “Buffer”

Eutrophication

Predators: Invertebrates

Rapid Turnover of Nutrients (“Short Spirals”) is a Key Characteristic

External Energy is Required to Maintain Altered State and Support Agricultural Productivity

Major Downstream Exports:

I. Nutrients & Undesirable Biomass (e.g., algae, detritivores, tolerant species)

II. High Sediment Delivery
End
Substantial Improvement of mean biological condition

Substantial reduction in very poor and poor sites
Ohio Biocriteria Reference Sites
Headwater Streams

Least Impacted Fish
Modified Sites
Fish
Macros
Measuring and Managing Environmental Progress: Hierarchy of Indicators

**Indicator Levels**

1: Management actions
2: Response to management
3: Stressor abatement
4: Ambient conditions
5: Assimilation and uptake
6: Biological response

**Administrative Indicators**
[permits, plans, grants, enforcement]

**Stressor Indicators**
[pollutant loads, land practices]

**Exposure Indicators**
[pollutant conc., habitat, ecosystem process, fate & transport]

**Response Indicators**
[biological assemblage indices, other attributes]

The “Health” Endpoint