AN INTRODUCTION TO AQUATIC INDEX OF BIOTIC INTEGRITY ASSESSMENTS

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Outline

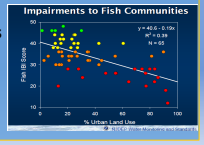
Introduction

Current Knowledge and Use

Future Direction

Introduction

- Index of Biotic Integrity (IBI)
- Developed by Dr. James Karr in 1981
- Assesses biological integrity of stream using living organisms
- Evaluate human impacts on systems
- TN 2013 pop 6.51 million
- Projected 7 million by 2025



(McQuaid 2002)
(worldpopulationreview.com)

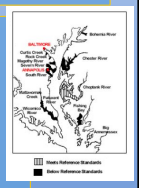
Introduction

- Original version had 12 metrics
- Metrics scored 1, 3, 5
- Summed ranging from 60 (best) to 12 (worst)
- New versions retain most original metrics

(McQuaid 2002)

Introduction

- Modified to different regions
- Adapted to ecosystems: estuaries, lakes, wetlands, coral reefs, terrestrial, benthic
- For warmwater streams (>25˚C/77 ˚F) in IL & IN
- Coldwater/coolwater IBI developed



(McQuaid 2002, Leonard and Orth 1986, Lyons et al. 1996, Roth and Kazyak 2000)

1972 Clean Water Act

- Set a new national goal

  "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters"
- Interim goals for all waters

  *Fishable

  *Swimmable where possible

Use

- Commonly used by:
  - Governmental agencies - NJ, WA, TX, NC, TN, MD, CA, OH and more!
  - NGOs - Izaak Walton League
  - Academic institutions
  - Tribes
  - Europe
- 57 of 65 surveyed "entities" have bioassessment programs
- 440,000 river and stream miles assessed using IBI

(Karr 1981, USEPA 2002, Pautasso and Fontaneto 2008)

Management Plans

- Identify stressors damaging resource
- Help states protect, restore or acquire resources
- Establish use designations for water bodies
- Develop site-specific management plans
- Save time and resources
- TWRA, TDEC, & NCDWQ post annual reports on website

(Danielson 1998)

IBI Metrics

1. # of species
2. Presence of intolerant spp
3. Spp richness and composition of darters
4. Spp richness and composition of suckers
5. Spp richness and composition of sunfish (except green sunfish)
6. Proportion of green sunfish
7. Proportion of hybrid individuals
8. # of individuals in sample
9. Proportion of omnivores (individuals)
10. Proportion of insectivourous cyprinids
11. Proportion of top carnivores
12. Proportion with disease, tumors, fin damage, other anomalies

(Karr 1981)

TN Metric Modifications

- Metrics modified for TN Valley streams high diversity
- Metric 6 now other tolerant species
- Metric 9 now includes stonerollers (#'s usually associated with nutrient enrichment)
- Metric 10 now specialized insectivores - darters, madtoms, select minnows

(TVA 2004)

Stressors Detected

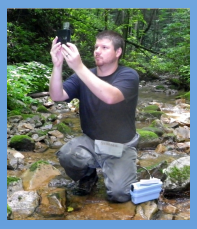
- Toxic levels of metals and other chemicals
- Changes to physical and chemical characteristics of water (e.g., pH, temperature, dissolved oxygen)
- Nutrient enrichment
- Physical changes to habitat
- Flow alteration

(Danielson 1998)

Assessments
Biological vs. Chemical

Biological
1. Collect supporting information
2. Test and measure
3. Compare to reference information/sites

Chemical
1. Collect water
2. Test for chemicals
3. Determine contaminants



- Could have chemical not tested or poor timing
- Not directly examining "patient"

(Danielson 1998)

Combining Assessments

- Montana Dept of Env Quality:
  - Macroinvertebrate metrics - more sensitive to physical changes
  - Algal metrics - nutrient enrichment
- Narrow down damaging stressor

(Danielson 1998)

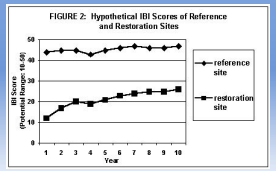
Assumptions

- Biologists trained and experienced with biota being assessed
- Standardized Methods
- Balanced fish sample
- Sample site represents geographic area

(Karr 1981)

Comparison

- Compare IBI scores to reference sites
- Track biological recovery of area following restoration activities
- Droughts/Floods in Year 4 show dip in curves



(Danielson 1998)

Why Fish?

Long lived = long term measurements

Easy to ID and collect

Many trophic levels

(McQuaid 2002)

Site Selection

Governed by:

1. Study objectives
2. Stream physical features
3. Stream access

(TVA 2004, Karr 1981)

Methods

- 5 people (1 data, 2 seine, 1 shocking, 1 net/bucket)
- Deplete species (riffle, run, pool, shoreline)
- Sampling effort covers 300ft² (usually 15x20ft)
- Stop = 3 consecutive runs yield no new species for habitat
- Young-of-the-year (YOY) not counted but noted
- Substrate classified

(TVA 2004, Karr 1981)

Methods

Boat Electrofishing

Backpack Electrofishing

Seine Hauls

Boat Electrofishing

- 5 minute shock run downstream
- Equal to 300ft² sample

- Alternate midchannel & shoreline
- Do not resample area

Methods

Boat Electrofishing

Backpack Electrofishing

Seine Hauls

Backpack Electrofishing

Shock into seine

- Disturb Substrate
- Count & ID Fish

Shoreline

- Shock/dip net logs, boulders, undercut banks
- Work upstream
- Area sampled is length x width (often 150 x 2 ft) for 300ft²

(TVA 2004)

Methods

Boat Electrofishing

Backpack Electrofishing

Seine Hauls

Seine Hauls

- Shallow Pools & Runs
- Smooth Substrate
- Downstream

(TVA 2004)

Sample Processing

- ID
- Count
- Note Anomalies

Scoring

- Handout
- Based on ecological information

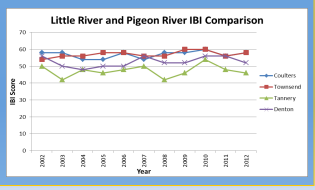
1. Balon, E. K.
2. Pflieger, W. L.
3. Smith, P. W., D.S. Lee
4. Etnier and W. Starnes

- On professional judgment of TVA biologist

(TVA 2004)

Scoring

- Estimate drainage area
- Developed from data from 268 streams in Blue Ridge Ecoregion
- Illustrated graphically
- Total Score:
  - Excellent = 58-60
  - Good = 48-52
  - Fair = 40-44
  - Poor = 28-34
  - Very Poor = 12-22
  - No Fish



(TVA 2004)

Benefits

- Effective for public communication
- Combines many ecological factors
- Inexpensive
- Relatively Fast

Limitations/Critiques

- Not suited for coldwater > 1800ft w/<10mi² watershed
- Need enough undisturbed sites for reference
- Combining factors limits pinpointing specific issues
- Scores can be misleading

(Stewart-Oaten et al.)

Limitations/Critiques

- Weather factors can distort the numbers
- Each group/org makes own metrics = comparisons difficult
- Boat shocking not same as backpack
- Depletion is not possible

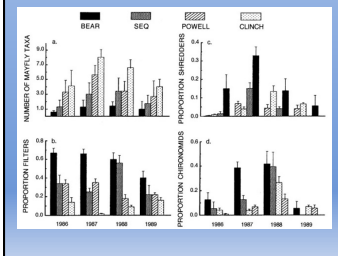
(Stewart-Oaten et al.)

Benthic Index of Biotic Integrity (B-IBI)

- Handout
- Modeled after fish IBI
- Scored by # of families/feeding groups
- Ephemeroptera, Plecoptera, Tricoptera (EPT)
- Scores of 0-5 are considered poor, 7-11 fair, and >13 good.

(Kerans and Karr 1994, Izaak Walton League 2004)

B-IBI



(Izaak Walton League 2004)

Future Direction

- Individual indicators instead of combining
- More use on terrestrial systems
- Update software
- Electronic field logger

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Picture References

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Tony Adcock	Smithsonianjourneys.org
Joyce Coombs	TVA
www.tnfish.org	Fishdeals.com
Coolchasers.com	Farcesofnature.com

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Questions?