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

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

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

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Use

- Commonly used by:
  - Governmental agencies: NJ, WA, TX, NC, TN, MO, 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

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

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 insectivorous cyprinids
11. Proportion of top carnivores
12. Proportion with disease, tumors, fin damage, other anomalies

TN Metric Modifications

- Metrics modified for TN Valley streams high diversity
- Metric 6 now other tolerant species
- Metric 9 now includes stoners (it'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

Assumptions

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

Comparison

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

(Images of the Montana outdoors and people engaging in water-related activities are present in the document.)
Why Fish?

- Long lived = long term measurements
- Easy to ID and collect
- Many trophic levels

Site Selection

Governed by:
1. Study objectives
2. Stream physical features
3. Stream access

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
### Methods

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#### Boat Electrofishing

- 5 minute shock run downstream
- Equal to 300ft$^3$ sample
- Alternate midchannel & shoreline
- Do not resample area
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 300 ft²

Backpack Electrofishing

Seine Hauls

- Shallow Pools & Runs
- Smooth Substrate
- Downstream

Methods

Boat Electrofishing

Backpack Electrofishing

Seine Hauls

(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

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

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.

Future Direction

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


TVA. 2004. Fish protocol for conducting an Index of Biotic Integrity biological assessment


References


TVA. 2004. Fish protocol for conducting an Index of Biotic Integrity biological assessment


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Questions?