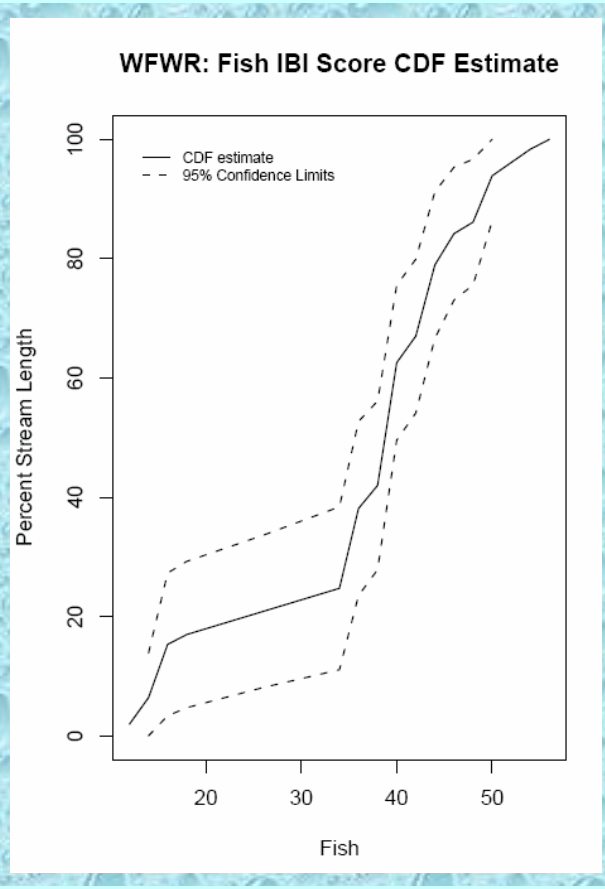
Using Fish Community Assessments to Predict Percent Stream Miles Impaired for Aquatic Life Use



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Overview of Presentation

- The "Strategy", Surface Water Quality Monitoring Strategy
- Watershed Program
- Development of Index of Biotic Integrity (IBI)
- Methods for Fish Community Sampling
- Stream Assessments Using Probabilistic Results
- Predicting Percent Stream Miles Impaired given Fish Community Results

The "Strategy"

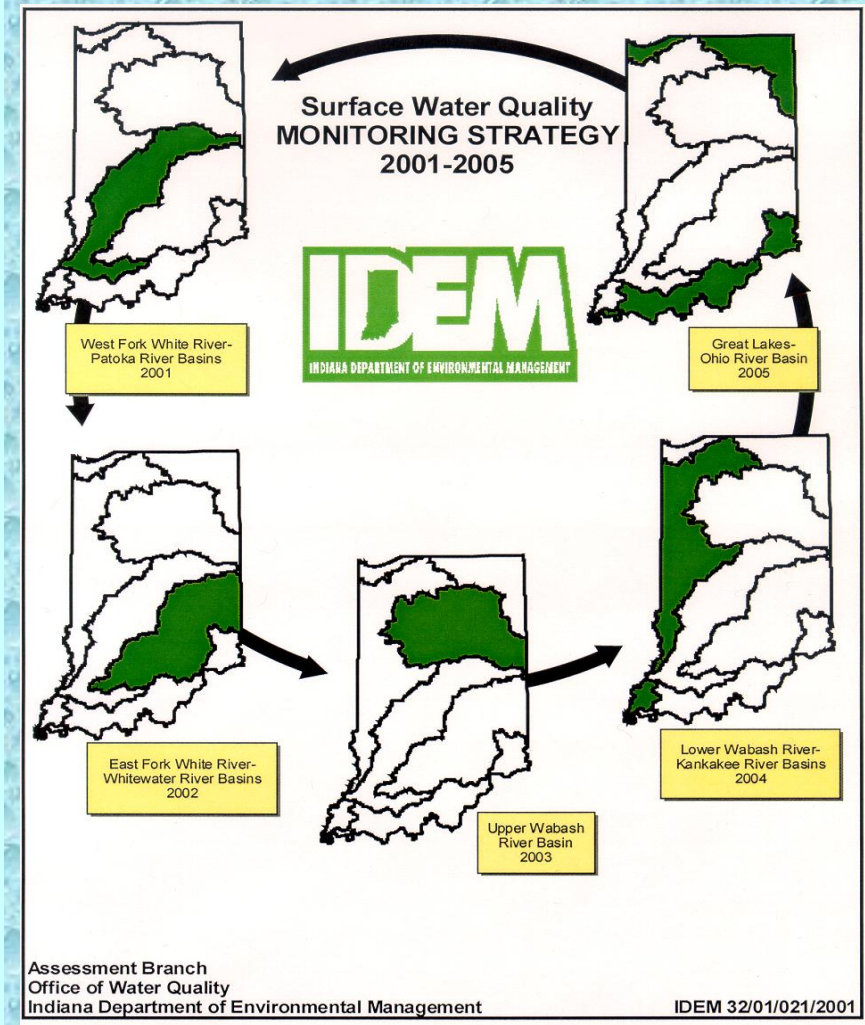
- Early 60's, sampling driven by public health concerns & responding to complaints
- Historically, targeted sites related to point source pollution
- State's Goal: "… to restore and maintain the chemical, physical, and biological integrity of the waters of the State." 327 IAC 2-1-1.5
- 1996 the "Strategy" was created, Shift to include monitoring of non-point source pollution & ALL waters of the state

The "Strategy" continued...

- **Goal:** Assess the ability of Indiana waters to support designated uses within five years

- **Focus**
  - –Year 1: WFWR & Patoka
  - –Year 2: EFWR & Whitewater
  - –Year 3: Upper Wabash
  - –Year 4: Lower Wabash & Kankakee
  - –Year 5: Great Lake & Ohio R. Tribs

- **Products:**
  - –Integrated Water Monitoring and Assessment Report: Evaluation of surface water use designations, Listing the causes and sources of Indiana stream segments not meeting designated uses
  - –Provide assessments to support water quality management programs (NPDES, Fish Consumption Advisory, TMDL)



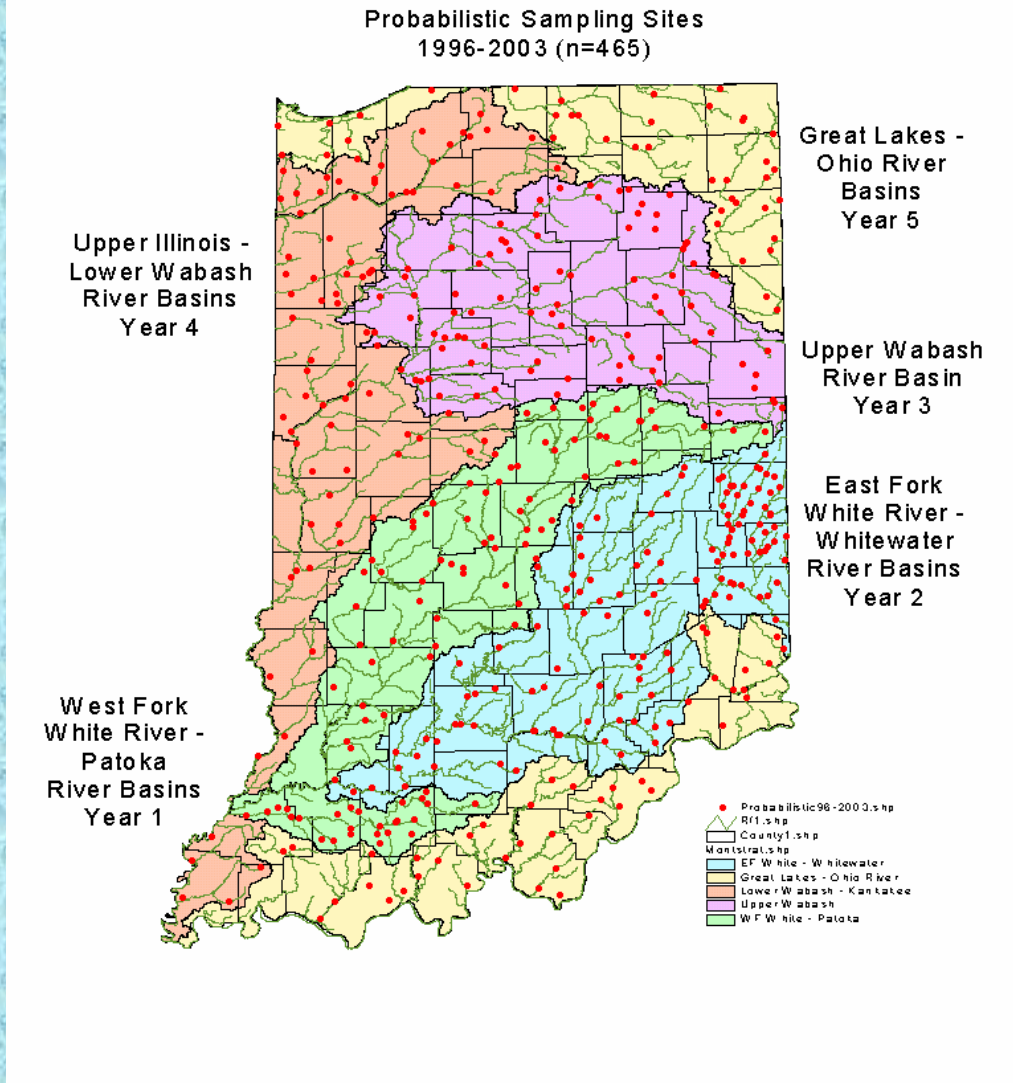
Watershed Program

- **Objective:** Provide a comprehensive, unbiased assessment of all streams for their ability to support designated uses

- **Site selection:** USEPA Western Ecology Division generated probabilistic site locations

- **Data Collected:**

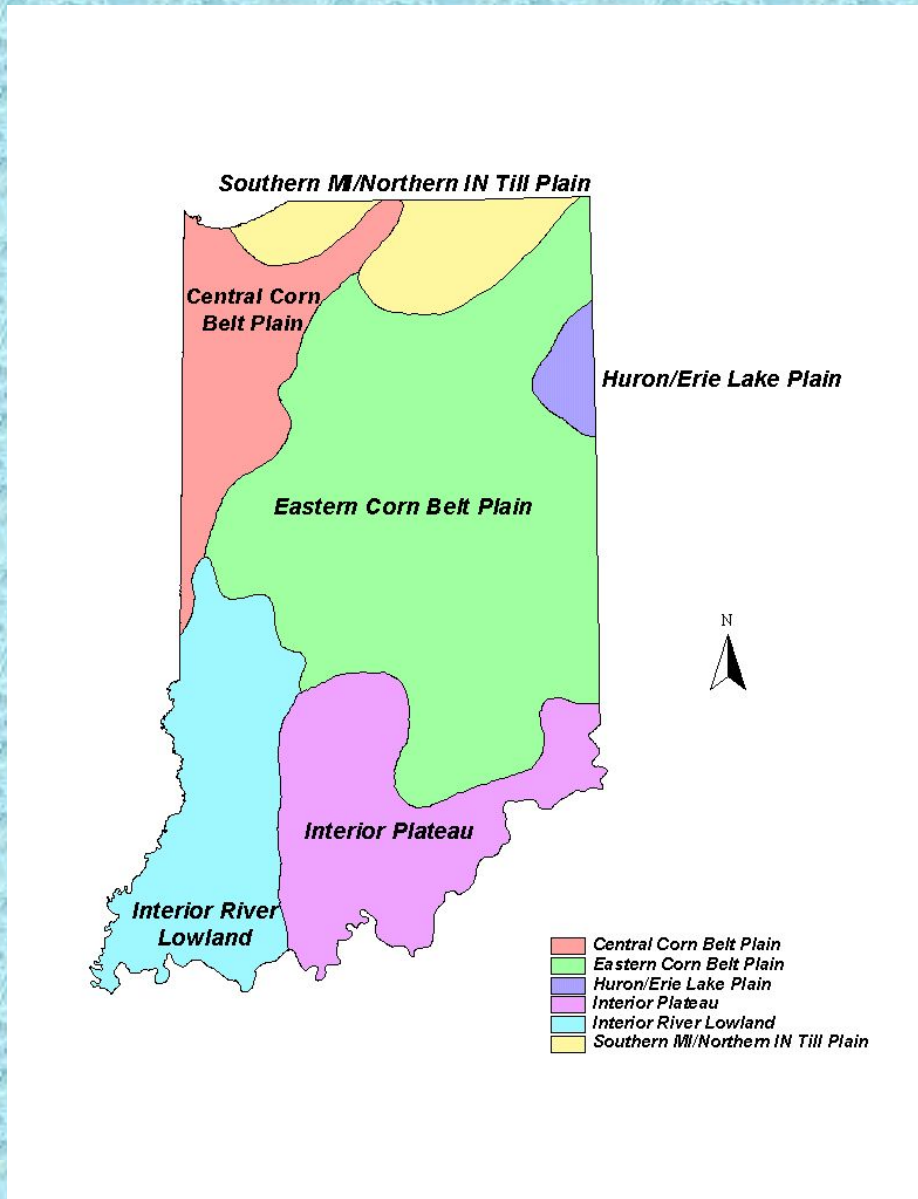
–Water, Nutrient, and Bacteriological Samples For Laboratory Analysis, Macroinvertebrate Community Assessments, Fish Community Assessments, Habitat Assessments



Development of Index of Biotic Integrity (IBI)

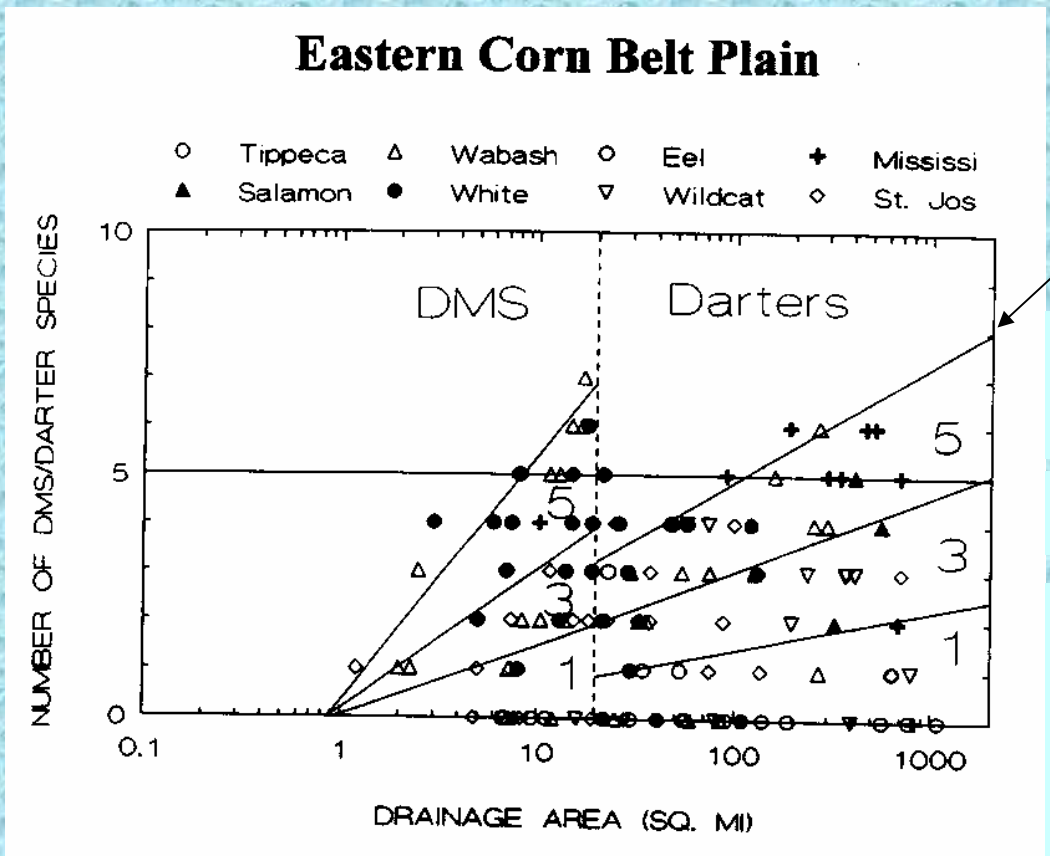
- Assess the biological integrity of the stream by comparing the species composition, trophic composition, and fish condition or health to "least impacted" sites within the same environment

- 1990-1995, USEPA Region V & IDEM sampled several hundred sites in Indiana to develop IBI expectations for 6 Indiana Ecoregions & special criteria for Large/Great Rivers



Development of Index of Biotic Integrity (IBI)

- **12 candidate metrics for each ecoregion**
- **Development of maximum species richness lines (MSR) for each metric**



Maximum Species Richness Line

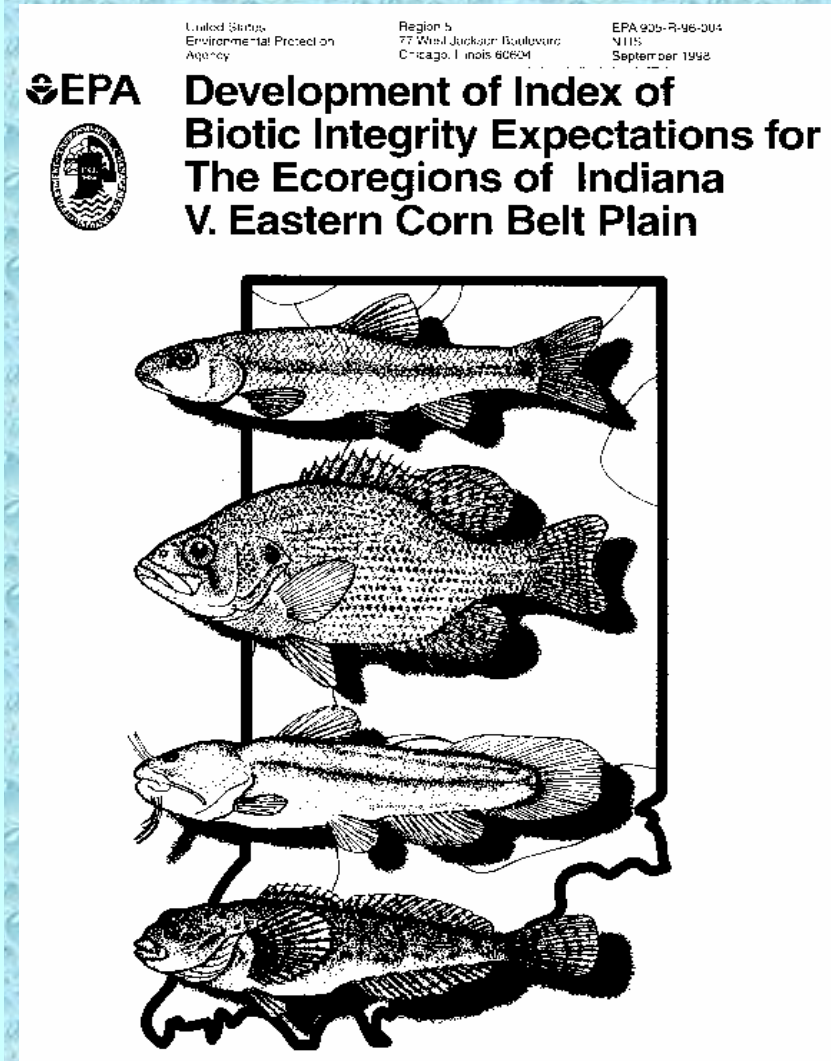
5 = value similar to fish community with little human influence

3 = an intermediate value

1 = value similar to that expected for a fish community that departs significantly from the reference condition

Development of Index of Biotic Integrity (IBI)

- **Determine Drainage Area to select document for IBI scoring**
  - **–≥1000 sq. miles mainstem Wabash or White R.**
  - **–All other determine Ecoregion**
- **Ecoregion, Watershed**
- **Headwater (≤20 sq.miles) or Wadeable (>20 sq. miles)**
- **IBI: 12 metrics score 1,3,5**
  - **–1. # species**
  - **–2. # darter species/ #dms species**
  - **–3. % headwater ind./ # sunfish sp.**
  - **–4. # minnow sp./ # sucker sp.**
  - **–5. # sensitive sp.**
  - **–6. % tolerant ind.**
  - **–7. % omnivore ind.**
  - **–8. % insectivore ind.**
  - **–9. % pioneer ind./% carnivore ind.**
  - **–10. Total # ind.**
  - **–11. % simple lithophils**
  - **–12. % DELT anomalies**
- **Total IBI (Range 6-60)**

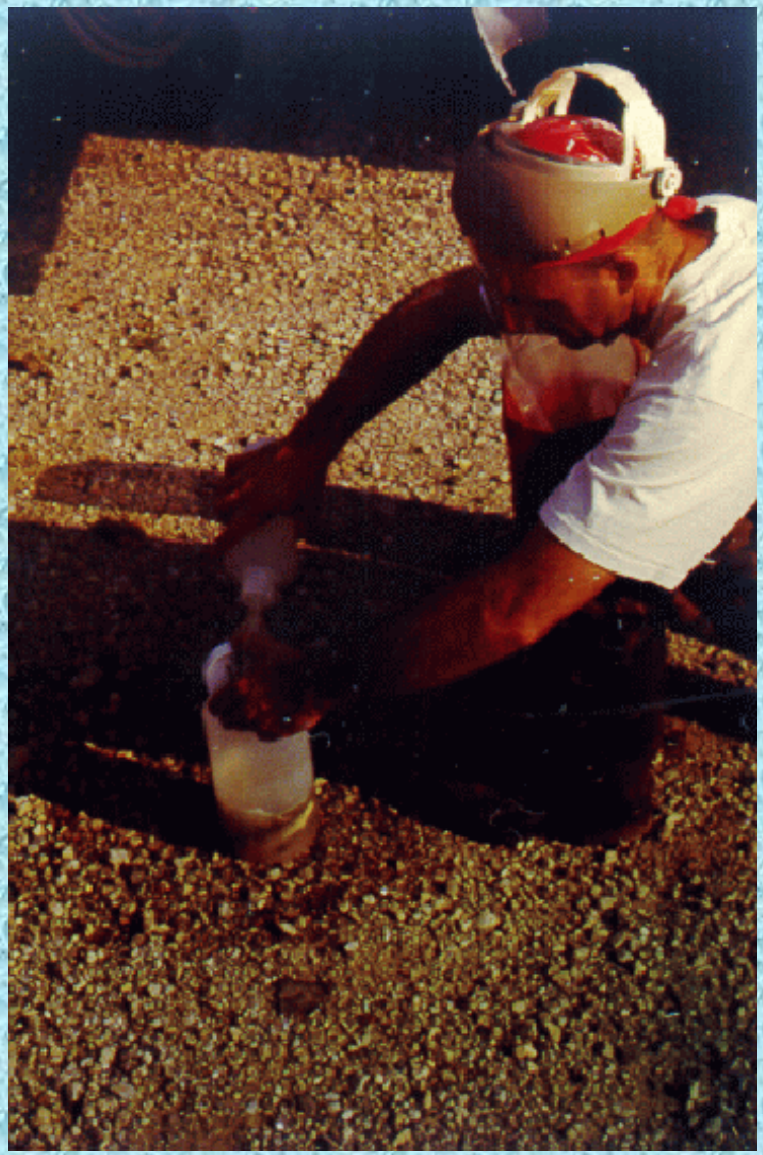


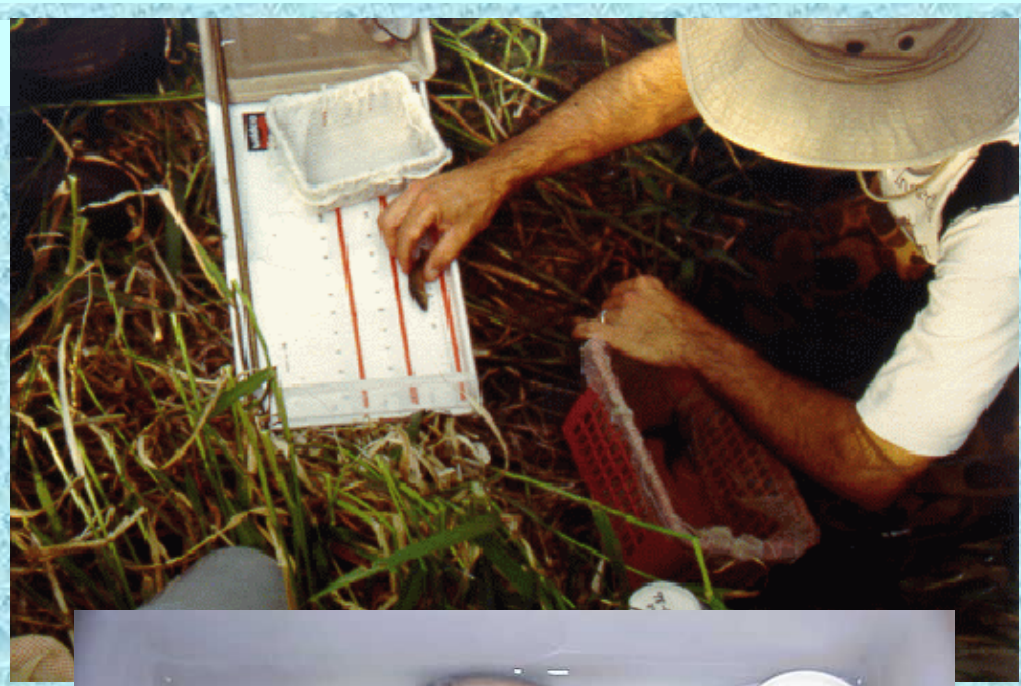
Methods for Fish Community Sampling

- **15 x the wetted stream width**
  (50 meter minimum, 500 meter maximum, all habitats sampled)
- **All stream sizes included**
- **Backpack, Scanoe w/ totebarge equipment, Boat**

Methods for Fish Community Sampling

- Species Level Identification





Stream Assessments Using Probabilistic Results

1. Any violations chemical or biological

–For chemical impairment:
Water Quality Standards [327 IAC 2-1-6]

–For biological impairment:

"all waters, except those designated as limited use, will be capable of supporting a well-balanced, warm water aquatic community."

[327 IAC 2-1-3(2)]

"well-balanced aquatic community" is "an aquatic community which is diverse in species composition, contains several different trophic levels, and is not composed mainly of strictly pollution tolerant species"

[327 IAC 2-1-9(49)].

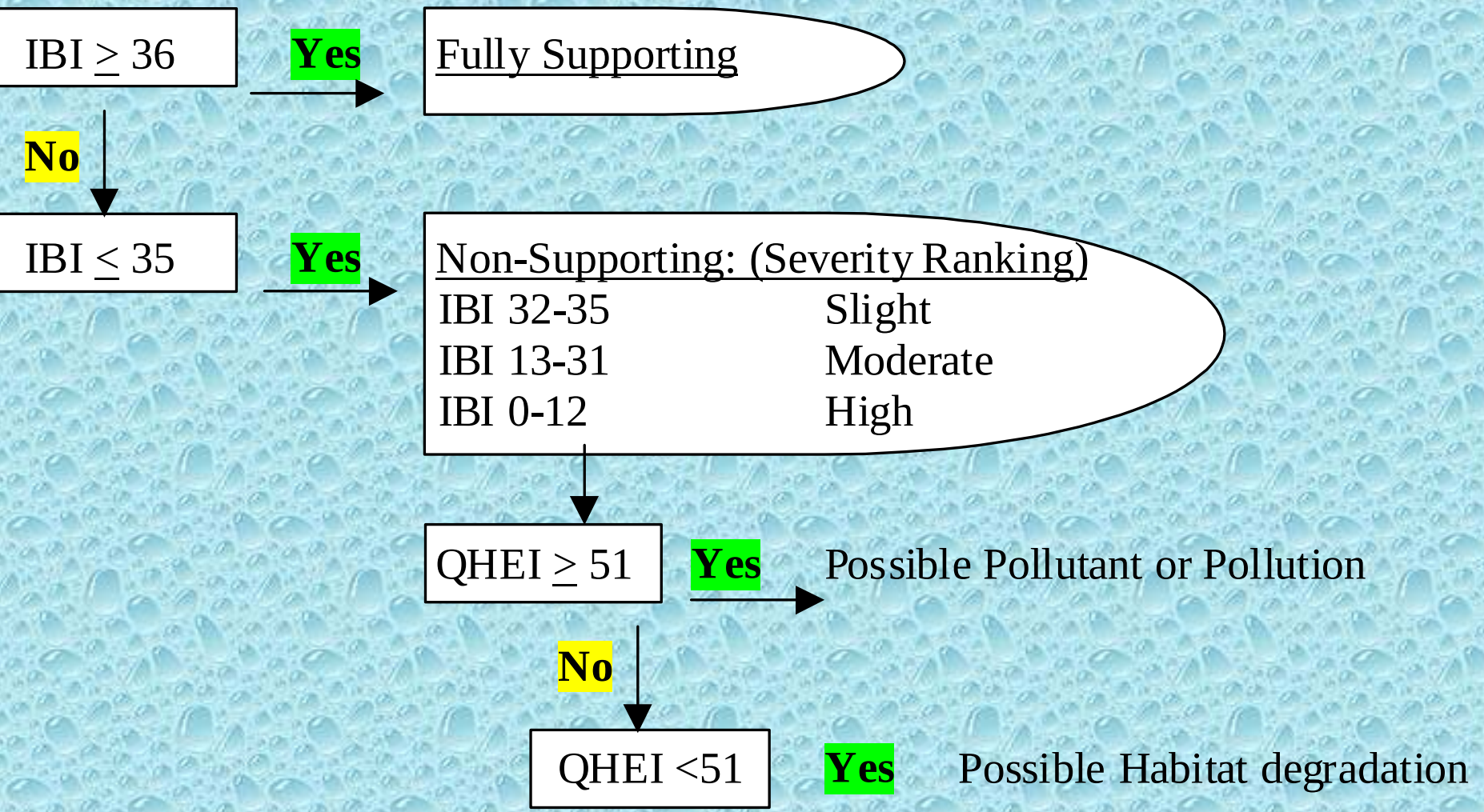
Chironomid Photo by Dale Parker, AquaTax Consulting

Central stoneroller, *Campostoma anomalum*

Stream Assessments Using Probabilistic Results

Total IBI Score	Integrity Class	Attributes
58-60	Excellent	Comparable to best condition present in ecoregion conditions, exceptional assemblage of species.
48-52	Good	Decreased species richness (intolerant species in particular), sensitive species present. Deviation Minor.
40-44	Fair	Intolerant and sensitive species absent, skewed trophic structure. Deviation Slight.
28-34	Poor	Top carnivores and many expected species absent or rare, omnivores and tolerant species dominant. Deviation Moderate.
12-22	Very Poor	Few species and individuals present, tolerant species dominant, diseased fish frequent. Deviation severe.
<12	No Fish	No fish captured during sampling. Deviation very severe.

Stream Assessments Using Probabilistic Results



Stream Assessments Using Probabilistic Results

1. Any violations chemical or biological:

–Fish Community: Impaired IBI ≤ 35

–Macroinvertebrate:

Impaired KICK mIBI < 2.2

Impaired Hester-Dendy < 1.4

2. Look for possible cause/source:

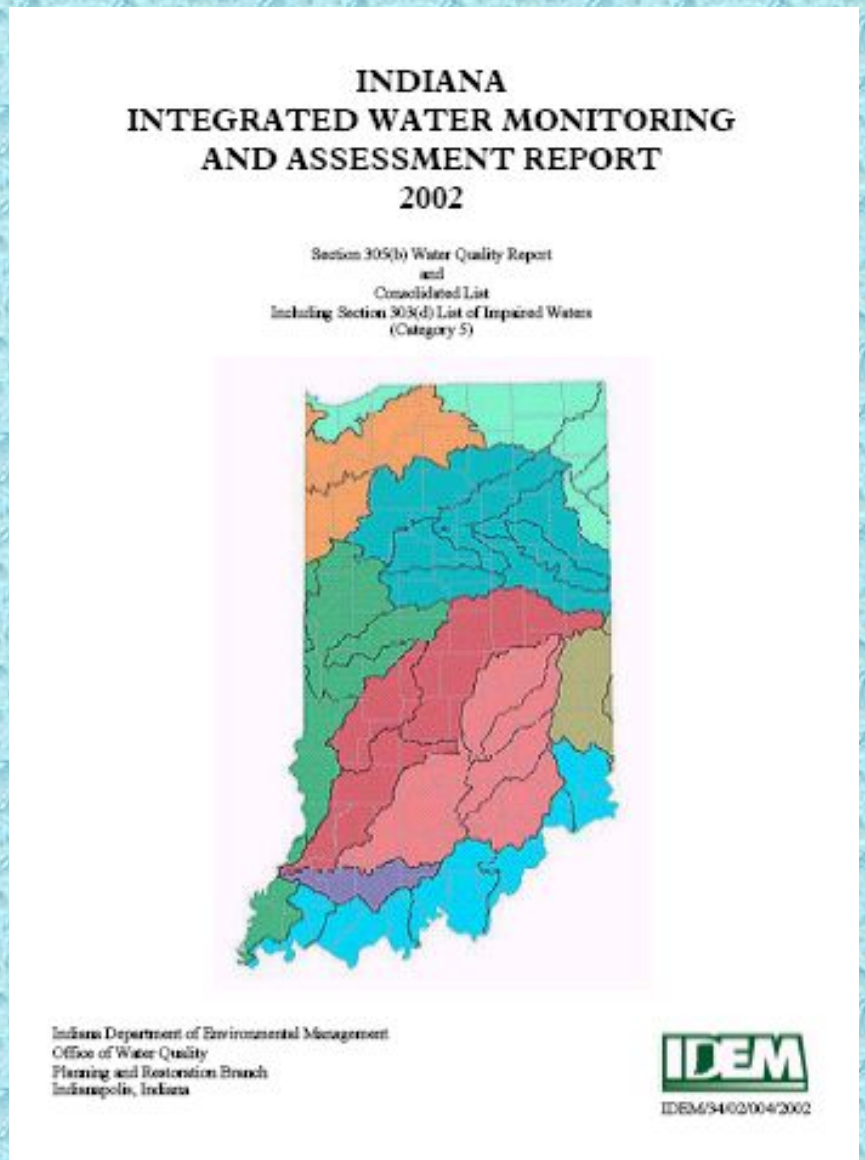
–habitat, type of chemical violation, likely source

3. How far to apply impairment:

–tributary influence, land use characterization, confined feeding operations, permitted facilities

Stream Assessments Using Probabilistic Results

1. Any violations chemical or biological
2. Look for possible cause/source
3. How far to apply impairment
4. **Refer impaired sites for Source ID**
5. **Assess sites for Indiana's Integrated Water Monitoring and Assessment Report**
6. **Predict % Miles Attaining Aquatic Life Use Technical Reports Data Requests**



Predicting Percent Stream Miles Impaired given Fish Community Results

- **Targeted population:**

–all perennial stream in Indiana specified by 8 digit HUC

–sites weighted by Strahler order in design file to include all stream sizes in sample

- **For each site in the original design file:**

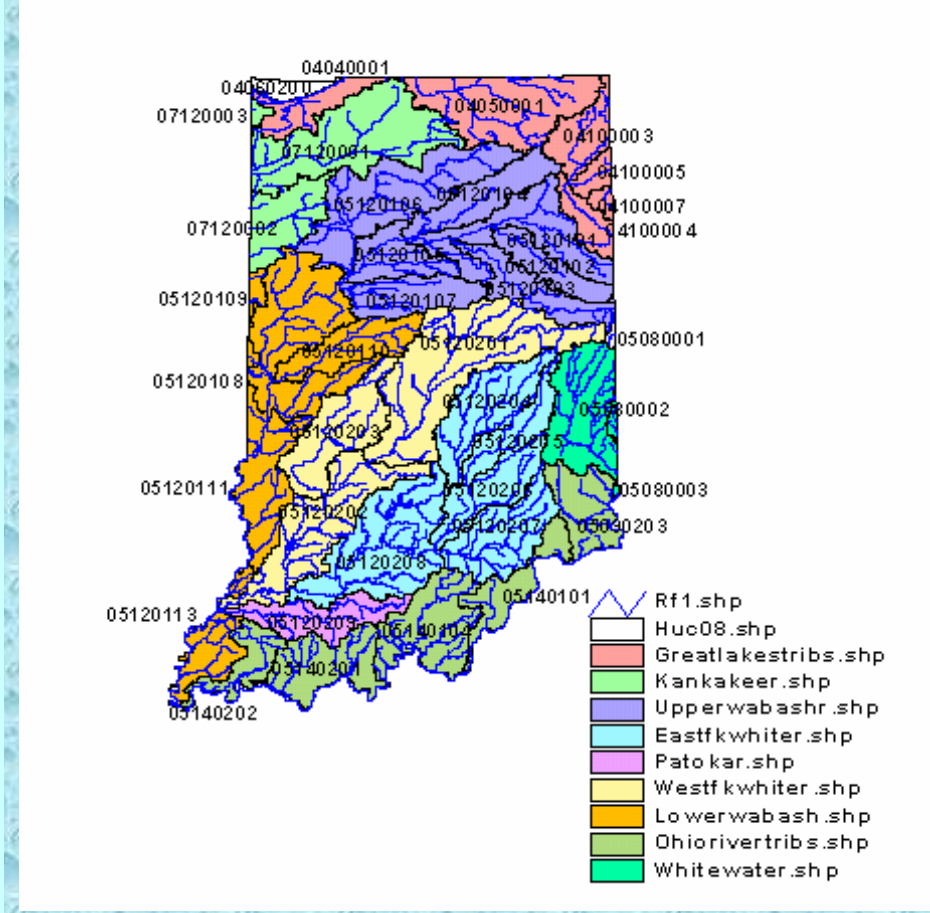
–a status code must be assigned (sampled, not sampled including the reason)

–the site must be evaluated as impaired or non-impaired for it's designated use

- **"R" software:**

–free software (http://cran.us.r-project.org/).

- **Adjust weight function**



Predicting Percent Stream Miles Impaired given Fish Community Results

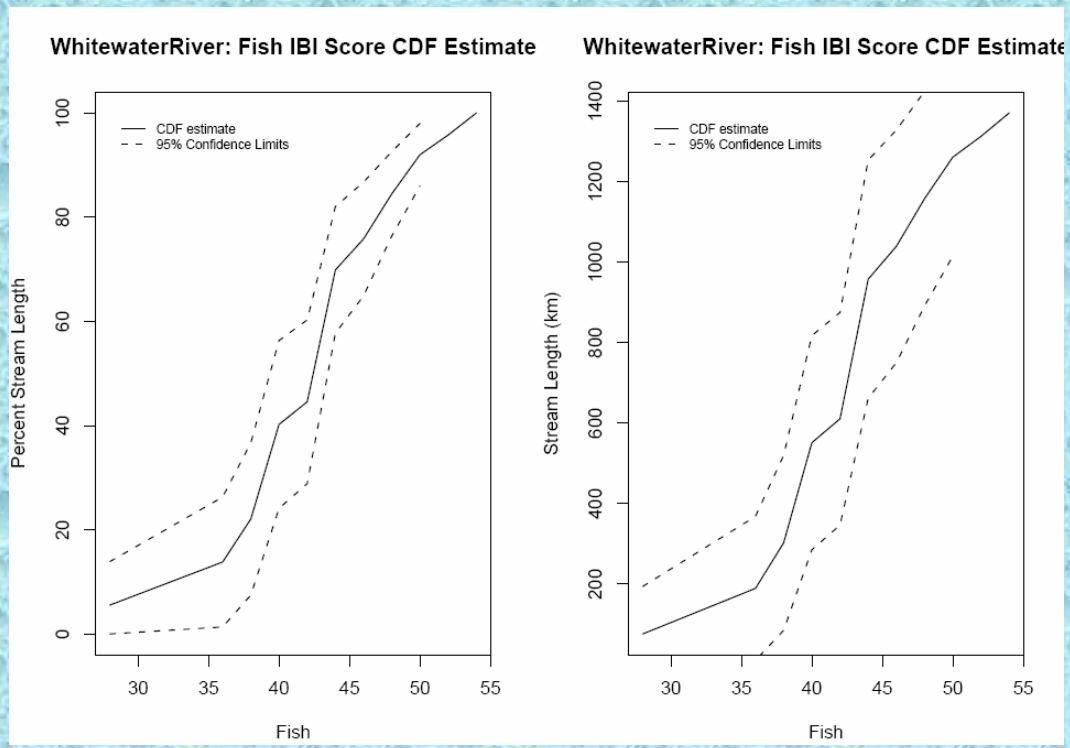
- **Output from "R"**

–Basic Statistics (mean, variance, std.deviation)

–Cumulative distribution of stream length for a numeric value (i.e. IBI score)

–Percent of stream length attaining with confidence levels

	Type	Subpopulation	Indicator	Statistic	NSites	Estimate.U
1	Basin	Whitewater	Fish	Total	38	58646.26952
2	Basin	Whitewater	Fish	Mean	38	42.784295
3	Basin	Whitewater	Fish	Variance	38	35.059992
4	Basin	Whitewater	Fish	Std. Deviation	38	5.921148



Indicator	Category	NSites	Estimate.P	StdError.P	LCB95Pct.P	UCB95Pct.P	Estimate.U	StdError.U	LCB95Pct.U	UCB95Pct.U
Fish.Community	I	1	5.55	4.26	0.00	13.90	113.23	87.03	0.00	283.80
Fish.Community	NI	37	94.45	4.26	86.10	100.00	1928.76	87.03	1758.19	2041.99
Fish.Community	Total	38	100.00	NA	NA	NA	2041.99	NA	NA	NA

Predicting Percent Stream Miles Impaired given Fish Community Results

- **Assessment for River Basin given Fish Community Results**

Project Name	Target Population	*%Attainment*	*%Non-Attainment*	Confidence Level	*Confidence Interval*
West Fork	05120201	77%	23%	95%	±13.33%
White River	05120202				
n=36 (2001)	05120203				
Patoka River	05120209	50%	50%	95%	±15.87%
n=26 (2001)					
East Fork	05120204	79%	21%	95%	±14.09%
White River	05120205				
n=38 (2002)	05120206				
	05120207				
	05120208				
Great Miami	05080001	94%	6%	95%	±8.35%
River	05080002				
n=38 (2002)	05080003				

Target population = 8 digit HUC

%Attainment = fish community IBI Score >35

%Non-Attainment = fish community IBI Score nonsupporting of aquatic life use (<or=35)

The Confidence Interval is the %Non-Attainment +/- the value for 95% and 90% Confidence Level.

* These are values produced with S-Plus by USEPA National Health and Environmental Effects Research Laboratory, Corvallis, Oregon.

Conclusions

- **Key Points**
  - **–Narrative biological criteria developed in Indiana Environmental Rules**
  - **–USEPA & IDEM developed IBI calibrations for Indiana streams**
  - **–IDEM has monitored 100% of Indiana waters using a probabilistic design**
  - **–IDEM has been able to predict the number of miles impaired for each major basin in Indiana**
- **Future Research**
  - **–Determine cause and source for Impaired Biotic Communities already listed**
  - **–Watch for trends in the the predicted percentage of resources impaired**
  - **–Refinement of designated uses (Tiered Aquatic Life Uses)**
  - **–Develop numerical biocriteria for Indiana Water Quality Standards**
  - **–Model to predict where impairments might occur**

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