Restoring Delta Streams

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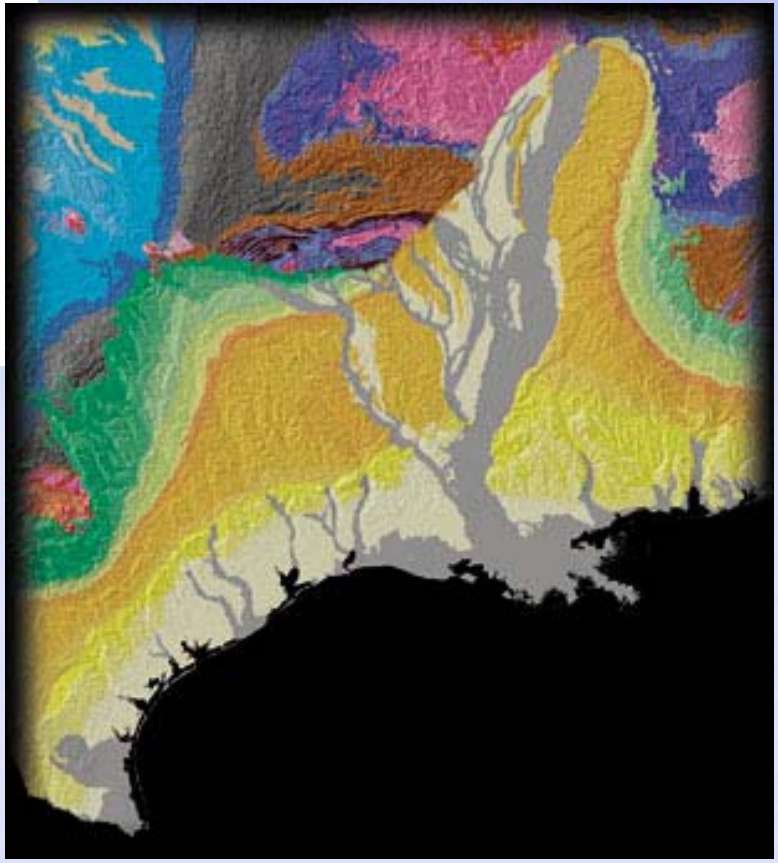
Delta Streams



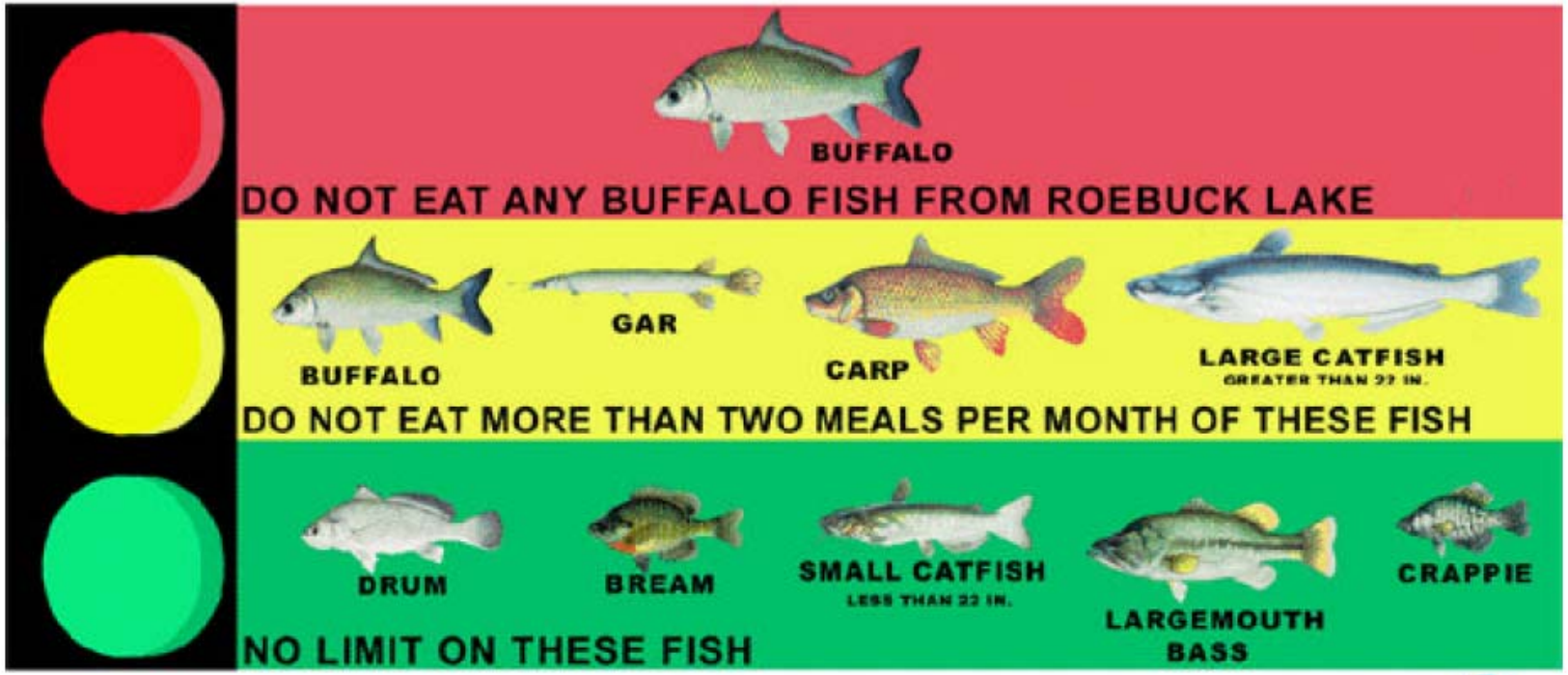
- 250 tributaries; many in agriculture
- Many streams listed as impaired
- TMDL’s have or will be established

1. Environmental History of the Delta
2. Evaluating Stressors on Fish Communities
3. Restoration Techniques
4. Conceptual Model of Expected Benefits

Historical Condition

DELTA FISH ADVISORY

KEY FOR FISH BELOW



MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

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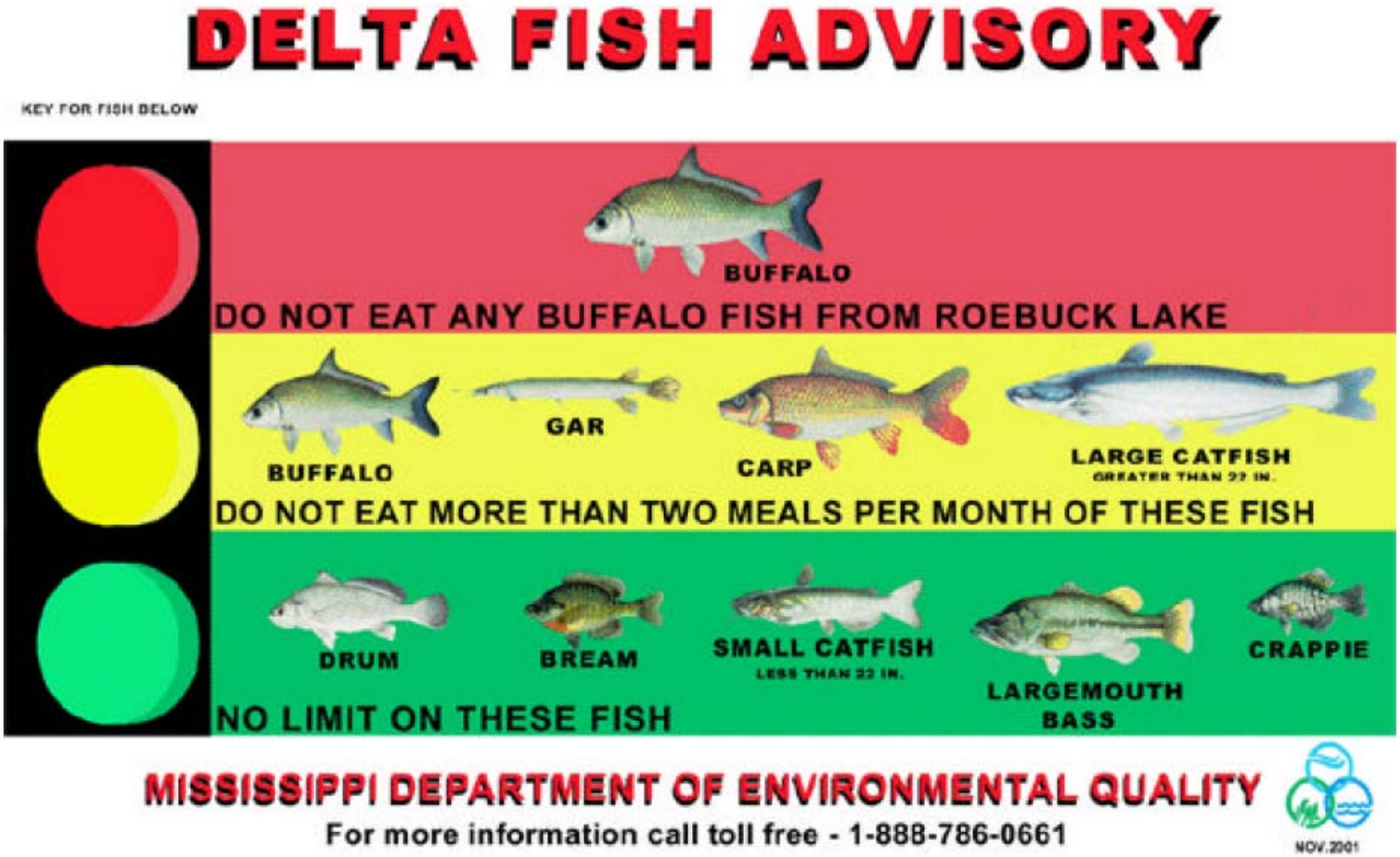
Lack of riparian cover

Sedimentation

Low Flows

Contaminants



Delta Pilot Project

Legend

- Alternate, Small - Intermittent
- Alternate, Small - Perennial
- Primary, Small - Intermittent

N
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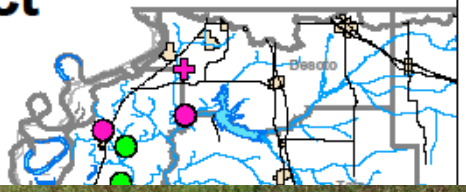
S

Scale 1:1,250,000



makes no warranties, expressed or implied, as to the accuracy, completeness, currentness, reliability, or suitability for any particular purpose, of the data contained on this map.

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CE Environmental Data Base

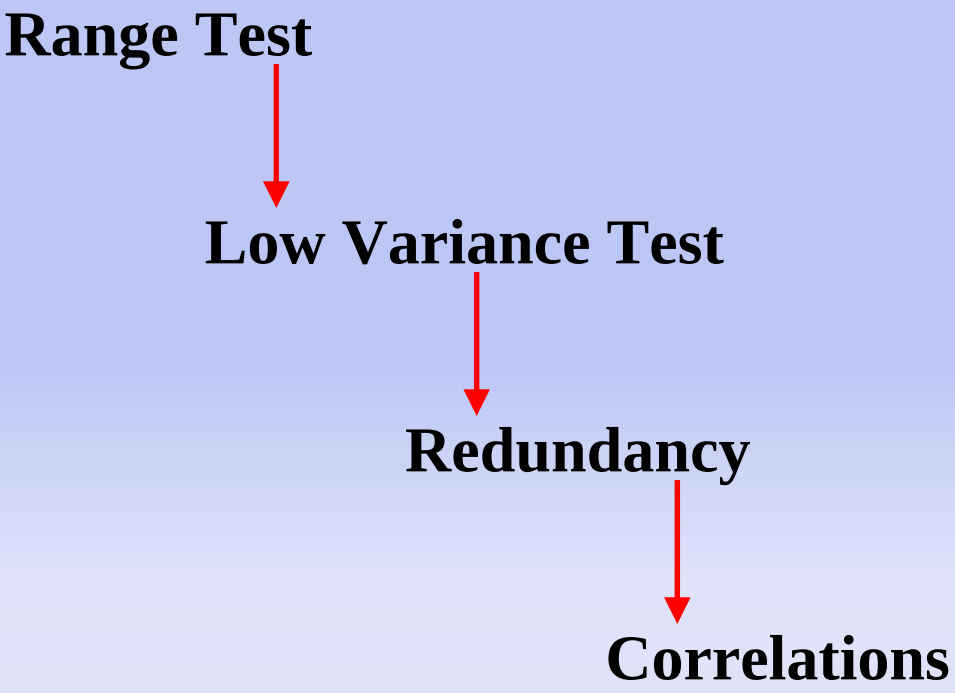
- 1990-present
- Consistent sampling protocol
- Delta and other basins within the Mississippi Embayment
- Large database (> 500 samples, >200,000 specimens, 135 species)

	White	Arkansas	Red	Yazoo	All
Samples	52	45	68	362	527
Fish	21,357	15,917	29,392	160,692	227,358
Species	94	55	72	81	135

IBI Candidate Metrics

- Taxonomic
- Trophic
- Tolerance
  - Water Quality
  - Habitat
- Affinity to Flow
- Habitat Preference
- Abundance

IBI Metric Screening Process



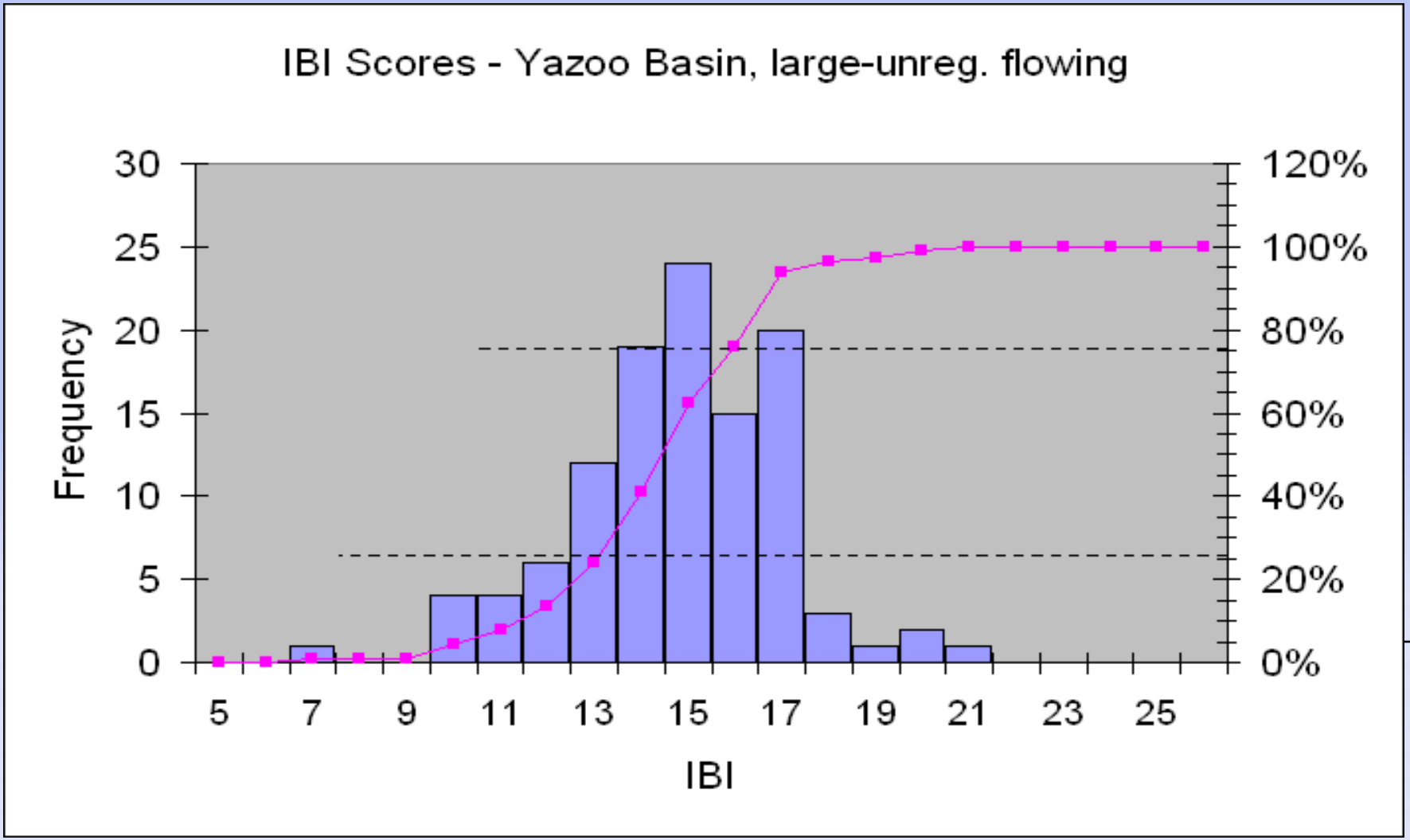
Index of Biotic Integrity

Community Characteristic	Metric
Diversity (taxonomic)	Number of fish species
Trophic composition	Proportion of invertivores
Tolerance	Number of “intolerant” species
Abundance	Catch-per-unit-effort (CPUE)
Affinity to flowing water	Proportion of rheophilic individuals

Delta Index

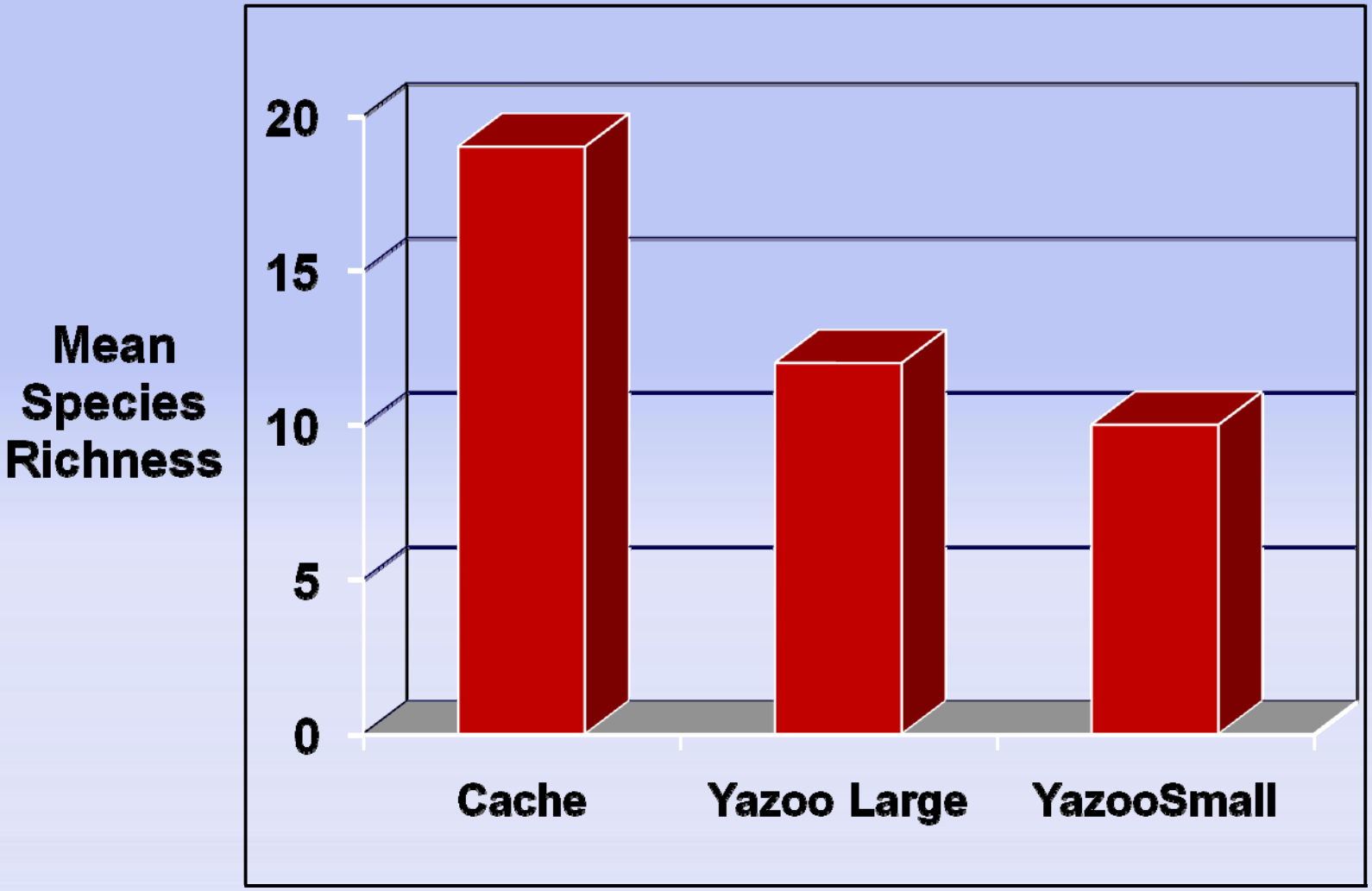
- Large unregulated flowing
- Large unregulated non-flowing
- Small flowing
- Small non-flowing

Metric	Metric score				
	1	**2**	**3**	**4**	**5**
Taxonomy Number of fish species	<7	7-9	10-12	13-15	>15
Diet Proportional abundance of invertivorous individuals	<0.059	0.059-0.111	0.112-0.542	0.543-0.663	>0.663
Tolerance Number of water quality- and habitat-intolerant species	<1	1-2	3-6	----	>6
Abundance Catch per unit effort (CPUE)	<112	112-171	172-532	533-820	>820
Rheotaxis Proportional abundance of rheophilic individuals	<0.037	0.037-0.125	0.126-0.674	0.675-0.882	>0.882



95% confidence interval of frequently sampled sites – 2 points

Problem 1
How do we determine thresholds?



Problem 2

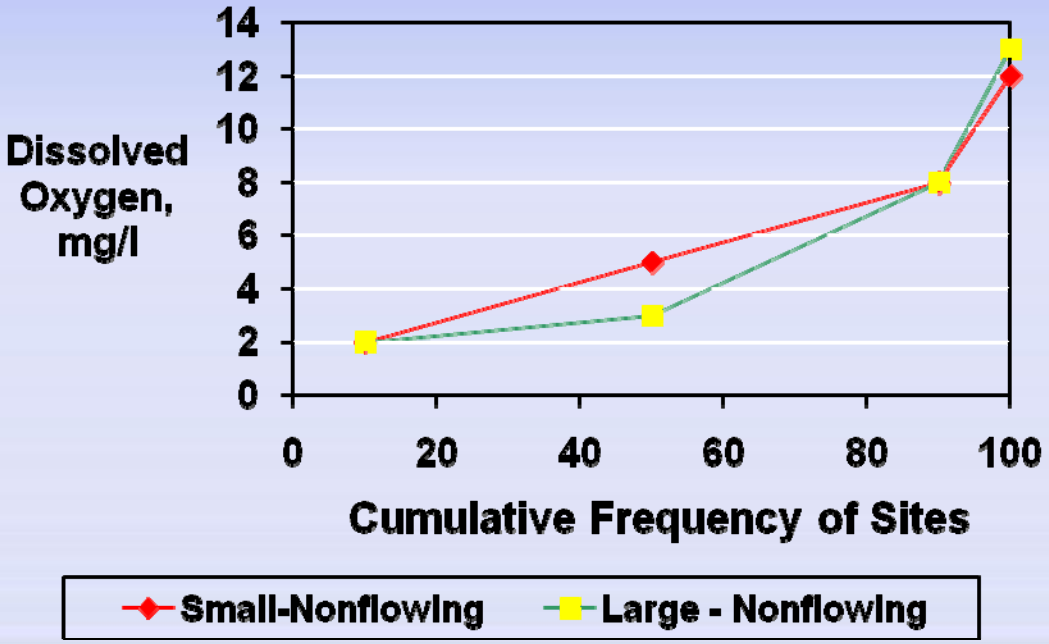
Fish metrics do not correlate with water quality variables typically used in TMDL's

IBI Metrics correlated to habitat variables:

High: Sediments (substrate, turbidity)
Instream flow/stage
Forested reaches

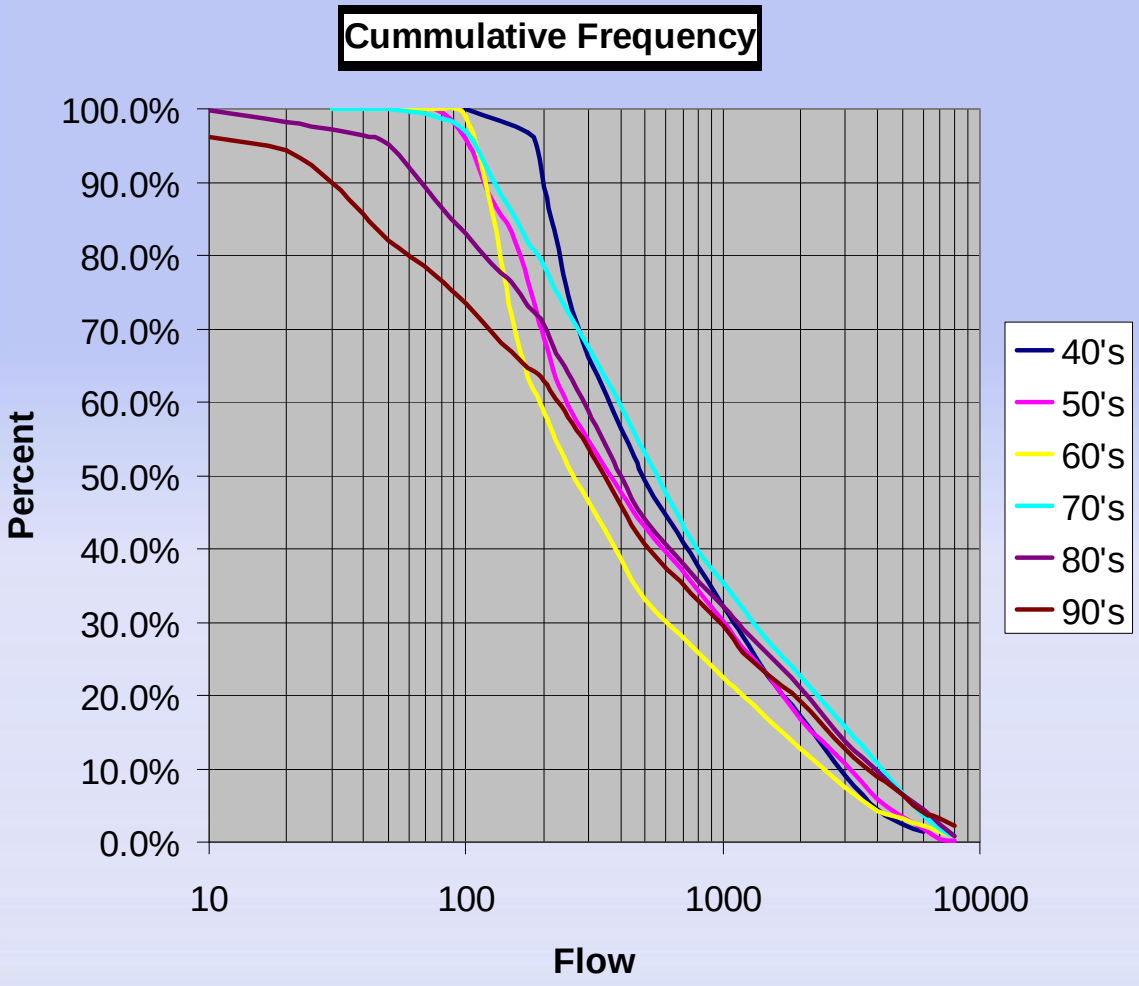
Low: Nutrients
Water quality (dissolved oxygen)

WHY?

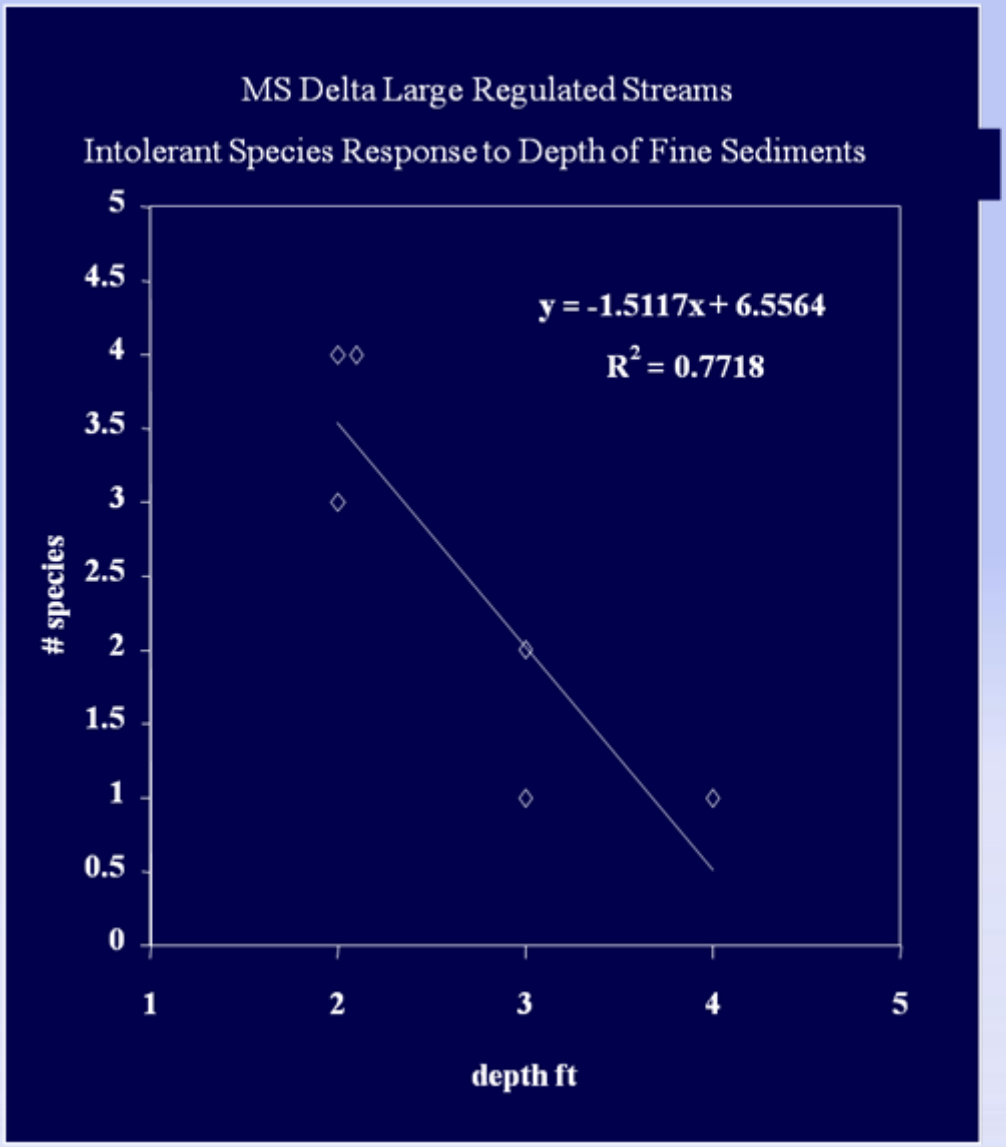


LOW FLOWS

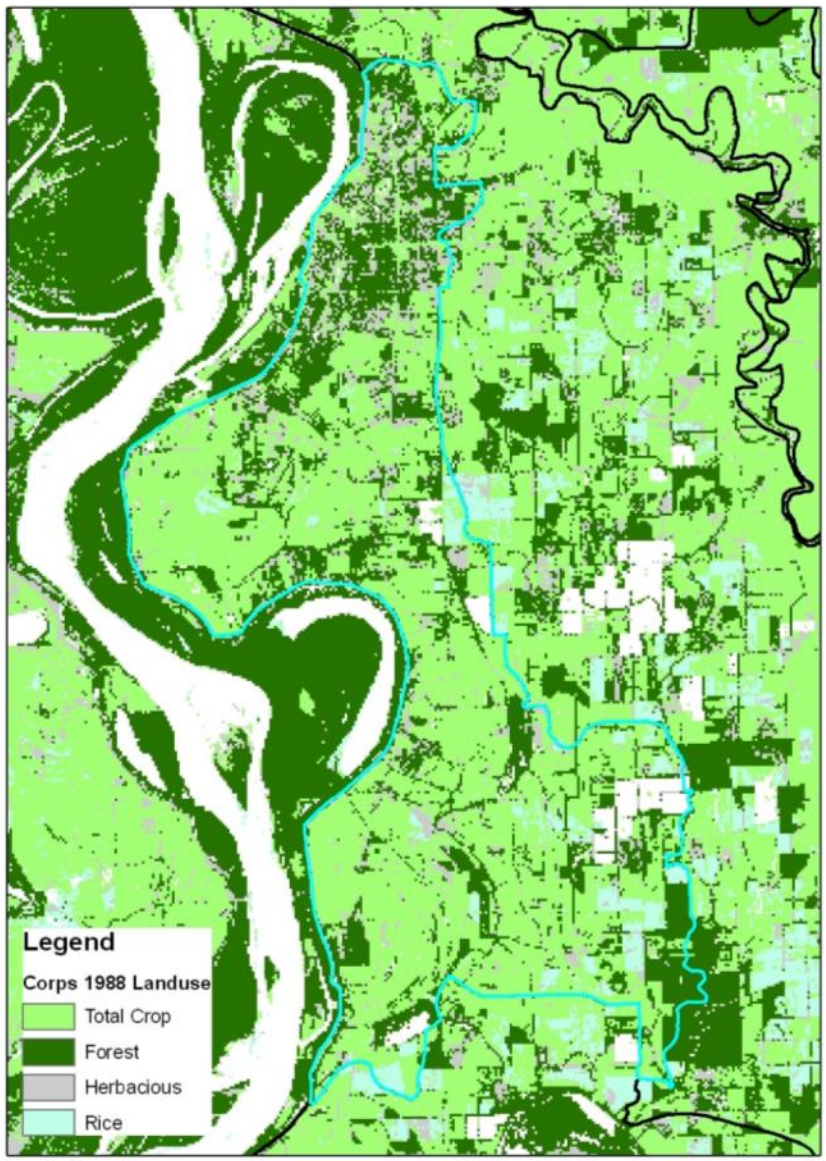
Cumulative Flow Frequency by Decade
Big Sunflower River, MS



Sediments


MS Delta Large Regulated Streams
Intolerant Species Response to Depth of Fine Sediments
y = -1.5117x + 6.5564
R2 = 0.7718
# species
depth ft
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
1
2
3
4
5

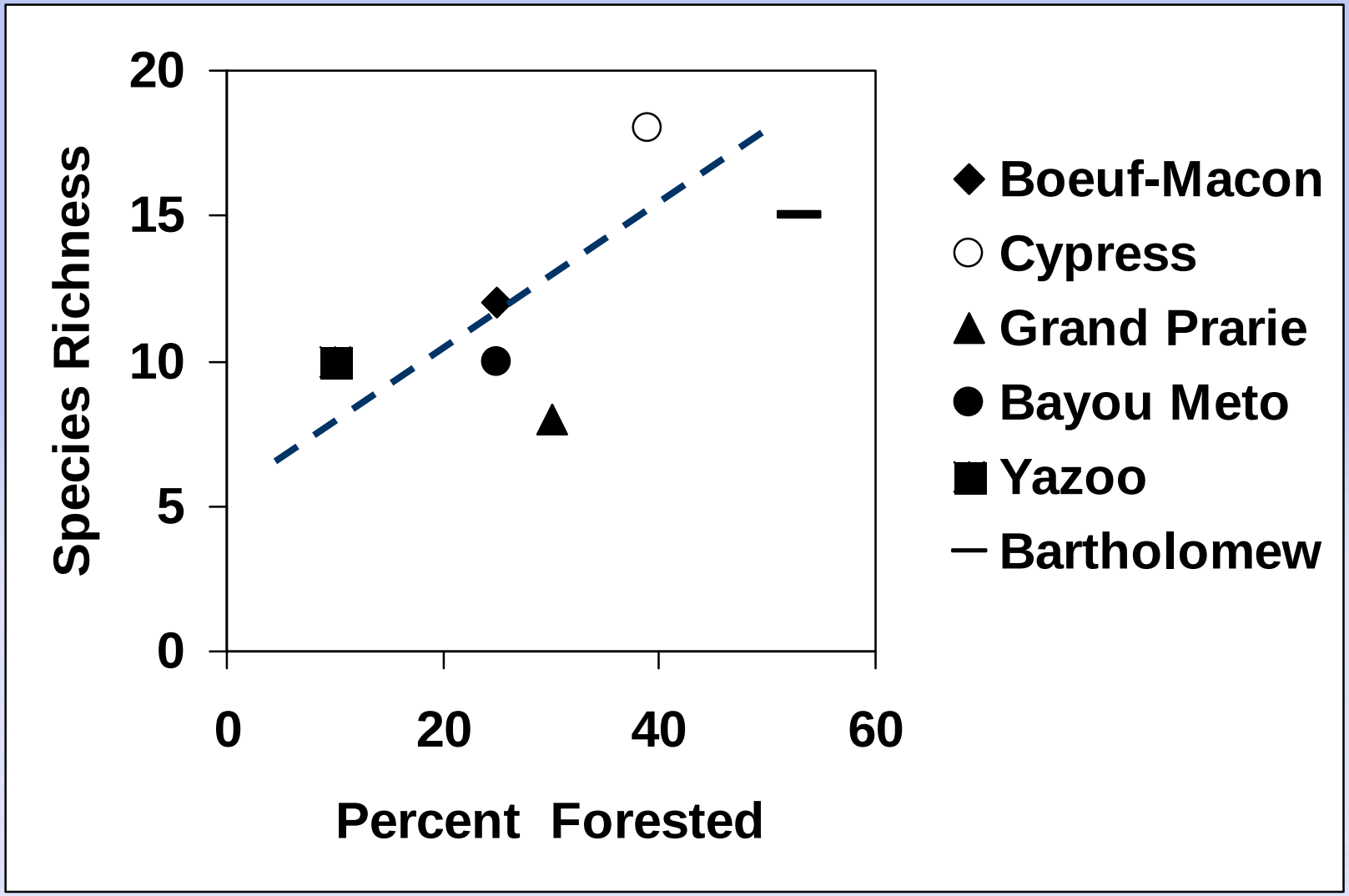
Landscape and Hydrologic Variables



Hydrologic and Landuse Indices

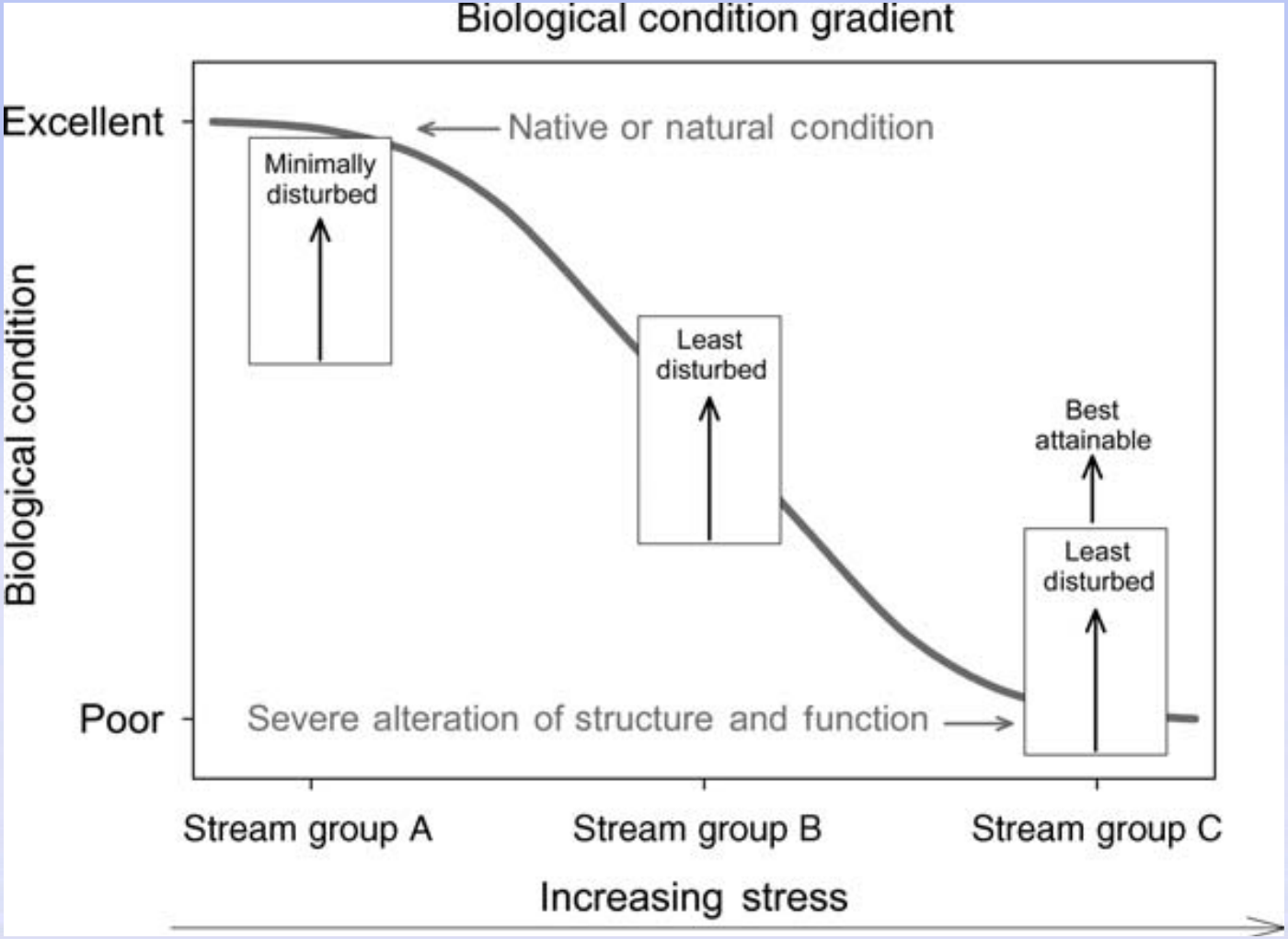
- Magnitude
- Frequency
- Duration
- Timing
- Rate of Change
- Low Flow events
- Percent Forested

Gulf Coastal Plain Physiographic Province
Lower Mississippi River Basin



Reference Conditions

Based on Stoddard et al. 2006



Historical Condition or Minimally Disturbed Sites - condition of habitat determined *for some point* in the past.

- Low flows occurred - more rheophils
- Less sedimentation – more benthic fishes

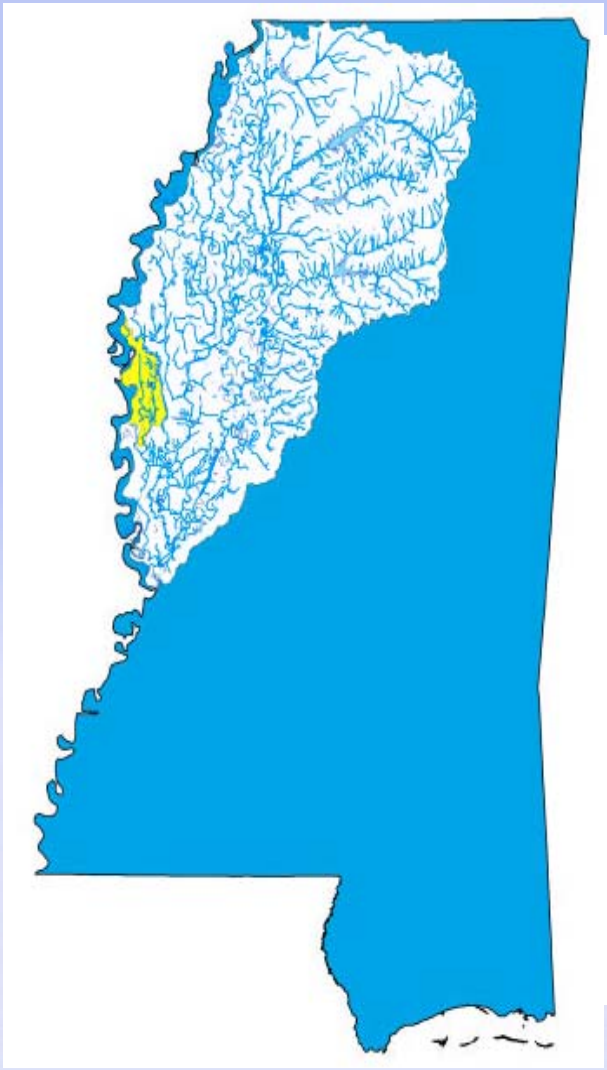
Inspection of Certain Lakes in Mississippi, July 3-15, 1936
by Dr. Samuel F. Hilderbrand
U.S. Bureau of Fisheries

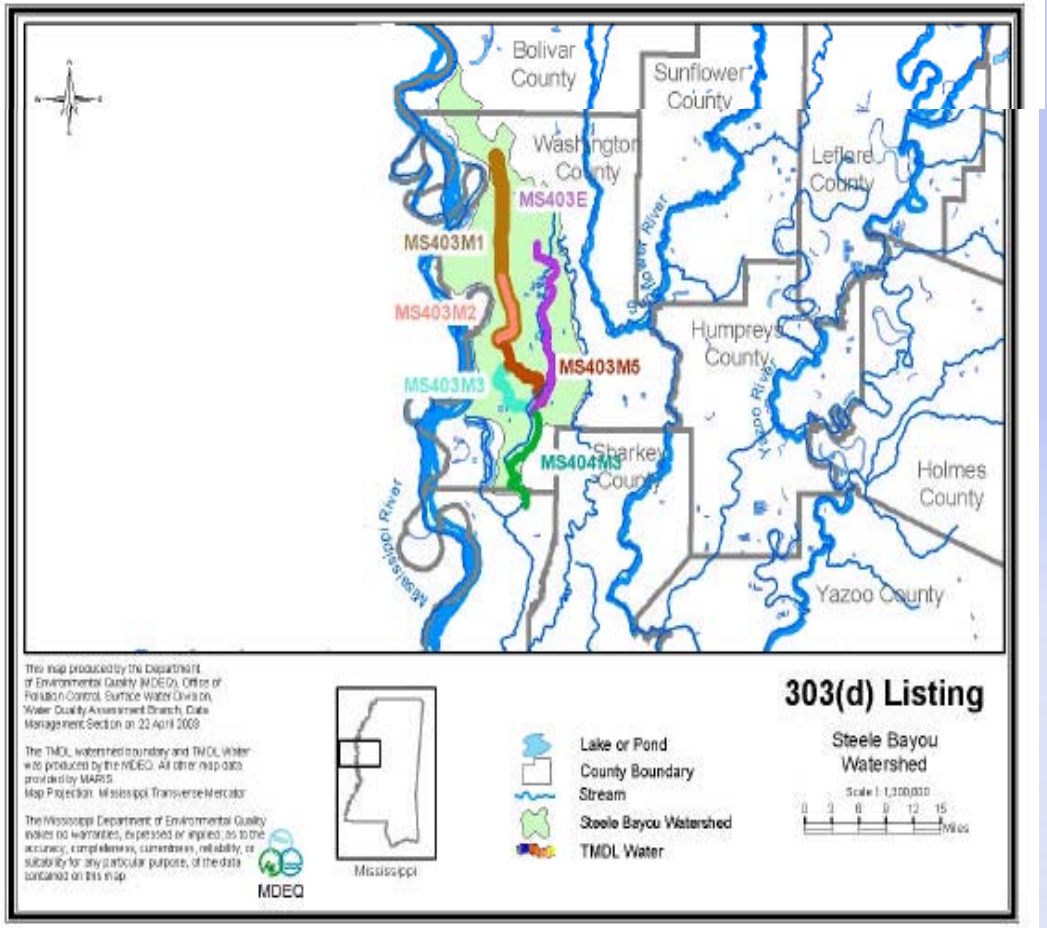
- Removal of forests increased rate of runoff
- Causes great fluctuations in water level
- High turbidity prevents vegetation from getting established
- Sediment accumulation hinders spawning
- Accumulation of organic matter lowers DO levels
- Fish do not produce their own food

Reference Conditions

Best Attainable Condition (BAC) – can be achieved at Least Disturbed Sites if best possible management practices are in place for some period of time.

Prescription to Restore Delta Streams





MDEQ

Project

- Channel cleanout
- Drop pipes
- Weirs

Benefits of Project to the Fish Assemblage

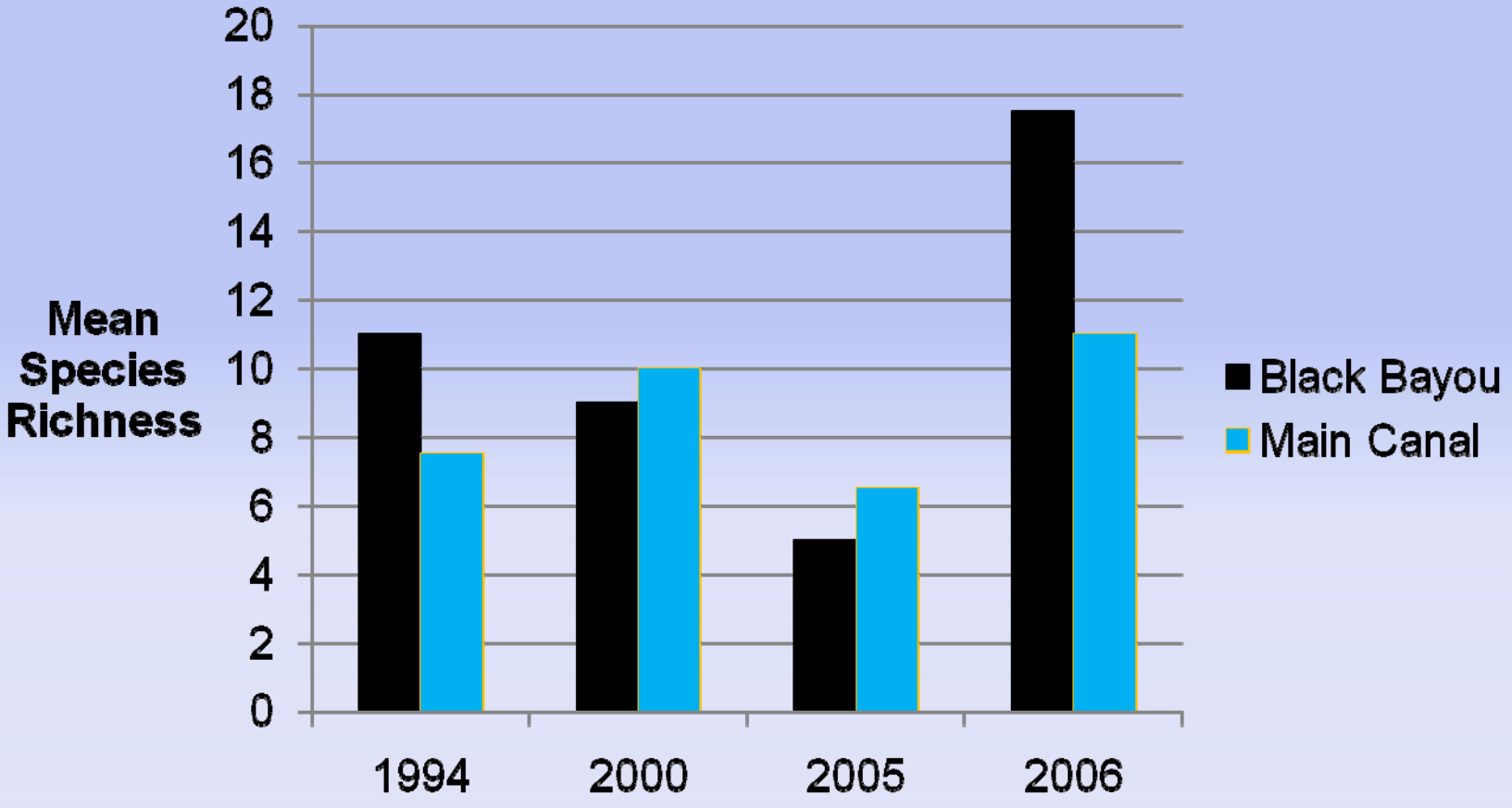
Pre-Project: Depauperate, > 75% of the fishes dominated by three sediment-tolerant species:

- Mosquitofish
- Orangespotted sunfish
- Red shiners

Post-Project: Species richness almost doubled (46%), and more species typically intolerant to habitat degradation were collected:

- Mississippi silvery minnow
- Speckled chub
- Golden topminnow
- Dollar sunfish
- Bantam sunfish
- Largemouth bass
- Slough darter

Upper Steele Bayou



Other Signs of Recovery

- Bryozoans
- Shoreline and littoral vegetation
- Gastropods
- Exploitable and Recreational Fish
- Firmer Substrate

DELTA FISH ADVISORY

KEY FOR FISH BELOW

BUFFALO

DO NOT EAT ANY BUFFALO FISH FROM ROEBUCK LAKE

BUFFALO

GAR

CARP

LARGE CATFISH
GREATER THAN 22 IN.

DO NOT EAT MORE THAN TWO MEALS PER MONTH OF THESE FISH

DRUM

BREAM

SMALL CATFISH
LESS THAN 22 IN.

LARGEMOUTH BASS

CRAPPIE

NO LIMIT ON THESE FISH

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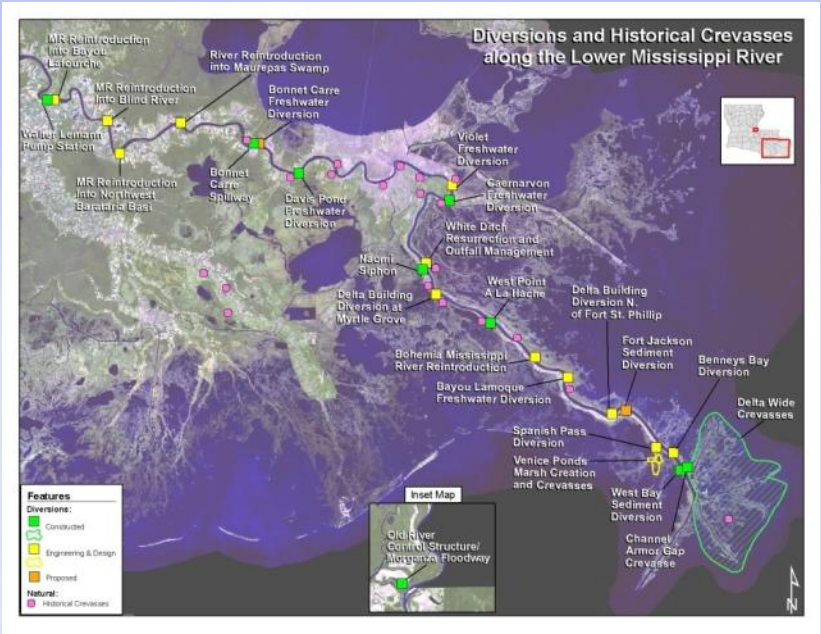
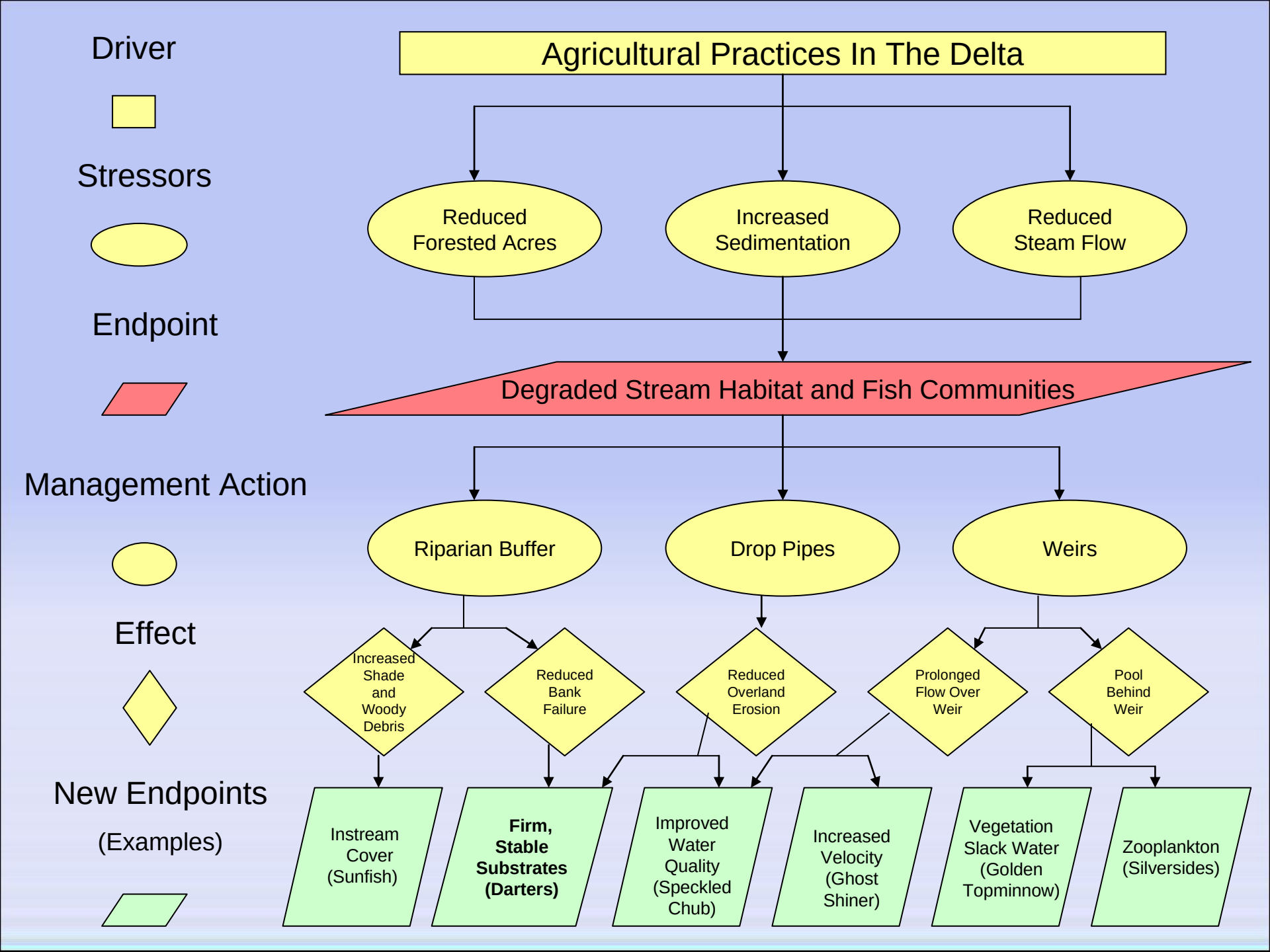
Establishing Riparian Buffers

The Ultimate Solution

Environmental Flows




Driver
Stressors
Endpoint
Management Action
Effect
New Endpoints
(Examples)
Agricultural Practices In The Delta
Reduced Forested Acres
Increased Sedimentation
Reduced Steam Flow
Degraded Stream Habitat and Fish Communities
Riparian Buffer
Drop Pipes
Weirs
Increased Shade and Woody Debris
Reduced Bank Failure
Reduced Overland Erosion
Prolonged Flow Over Weir
Pool Behind Weir
Instream Cover (Sunfish)
Firm, Stable Substrates (Darters)
Improved Water Quality (Speckled Chub)
Increased Velocity (Ghost Shiner)
Vegetation Slack Water (Golden Topminnow)
Zooplankton (Silversides)

Key Points

- In agricultural landscapes, historical and minimally disturbed conditions do not exist as reference sites for most basins.
- Best attainable conditions are more realistic, but restoring streams that are highly impaired is expensive and long-term.
- TMDL’s need to consider local conditions rather than using national standards.
- In restoring delta streams, physical variables need to be addressed first, then water quality variables.

Other Waterbodies

- Oxbow Lakes
- Large *regulated* streams

Acknowledgements

USACE Vicksburg District

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MDEQ

USGS

Neil Douglas

Discussion