Or, “The Importance of Being Earnest”

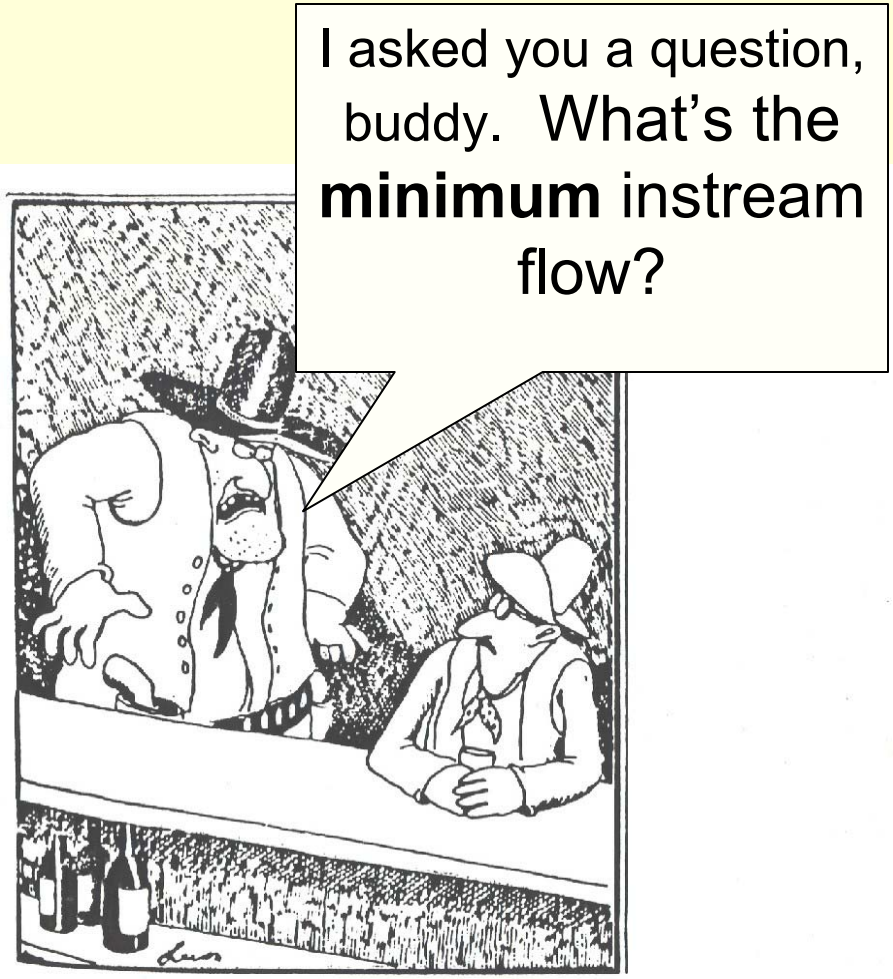
“The nation behaves well if it treats the natural resources as assets, which if must turn over to the next generation increased, and not impaired, in value.”

President Theodore Roosevelt

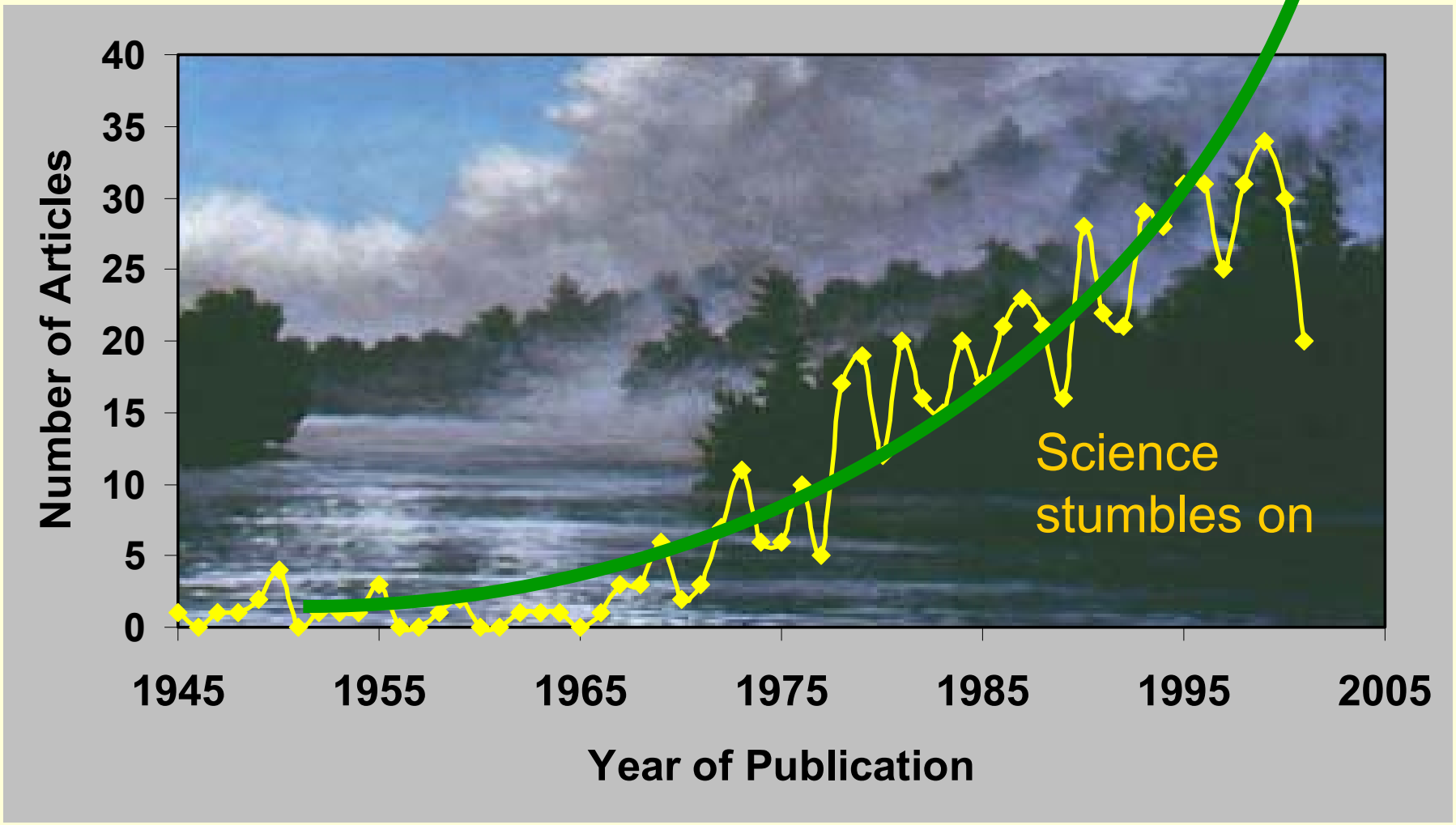
Minimum Flow Laws Cause Tension

"Chay hello to my little fren!
Quit sayin' minimum."

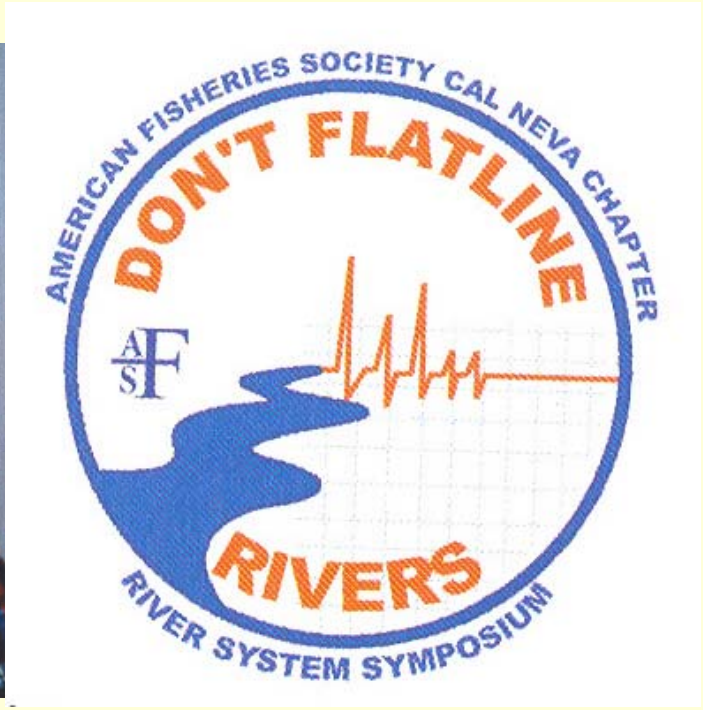
But Biologists Panic!
And do science badly.



Time is Important



People are Important



Ken Bovee, Bob Milhous, and Clair Stalnaker

Hydrologist meets Hydraulic Engineer meets Fisheries Biologist

Trends are Important

- Shift in uses away from agriculture to municipal
- Water marketing and banking
- “Improved” instream flow protection – legal and institutional mechanisms
- Rehabilitation of highly altered flows
- Dam removals (Elwah, Woolen Mills, Clyde, Edwards)

Meetings are Important -- International IFIM Users Workshop 2003

The obsession with physical habitat continues…

Get over it! Say what you really want.

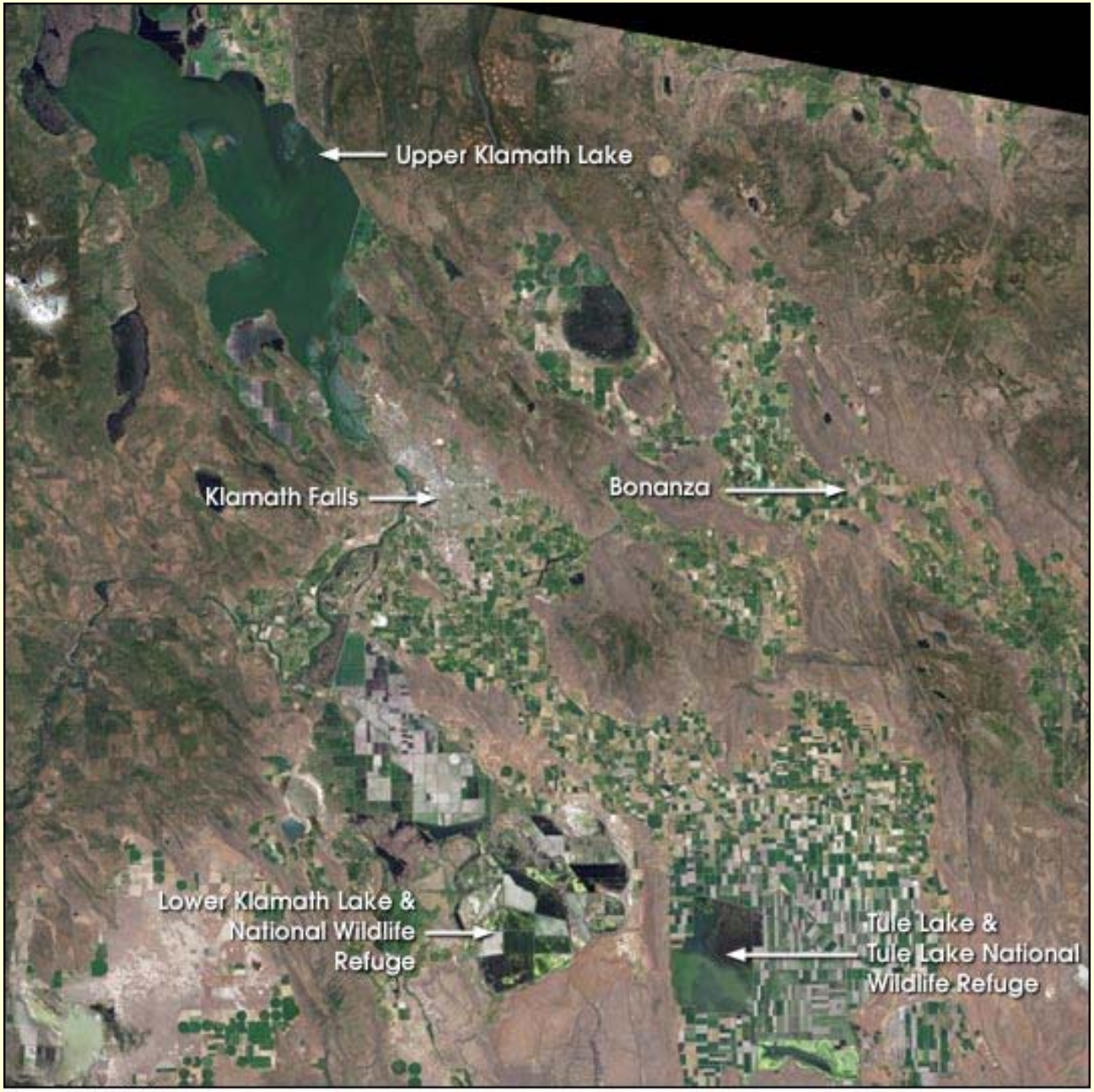
Riverine Components are Important -- IFC 2004

- Hydrology
- Geomorphology
- Physics
- Water Quality
- Connectivity
- Scale

Ability to gather data has never been easier

Hydrology

- **Flow Variability is Important**
  - Load following and peaking flows
  - Ramping regulations
  - Flood scalping
  - Vegetation change
  - Fish recruitment
  - Processing of organic matter and nutrients

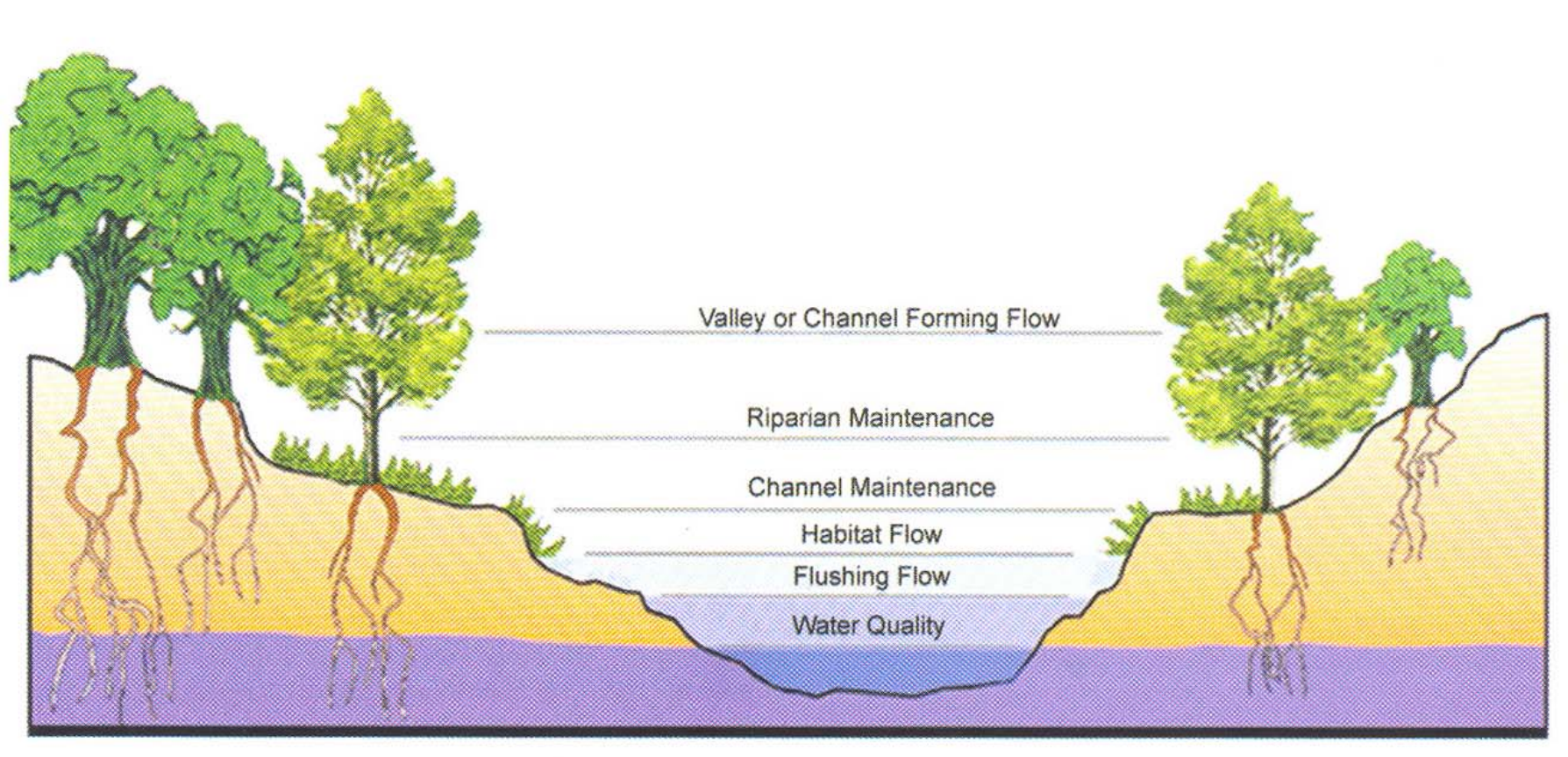

Upper Klamath Lake
Klamath Falls
Bonanza
Lower Klamath Lake &
National Wildlife
Refuge
Tule Lake &
Tule Lake National
Wildlife Refuge

June 14, 2000

Experimental Floods To Test Hypothesis!

Glen Canyon Dam discharging 45,000 cfs, March 26, 1996

Environmental Flows are tied to functions – think of these linkages as provisional hypotheses that needed to be tested



From *Instream Flows for Riverine Resource Stewardship*, IFC 2004

Smith River Tailwater below Philpott Dam

Army Corps of Engineers Dam

Built in 1953

Flood Control

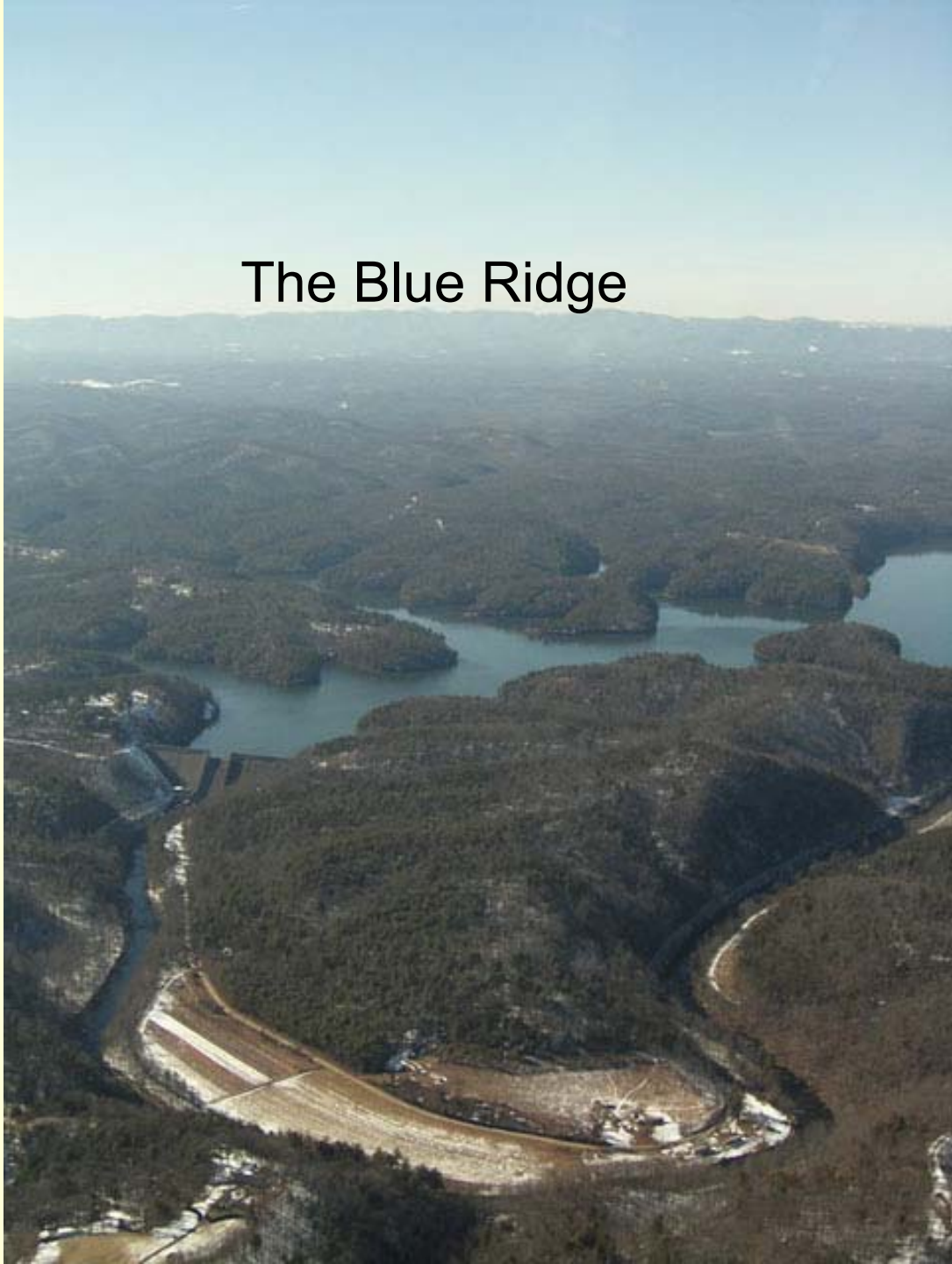
Peak Power Generation

No operational changes in 50 years

Deep, cold release

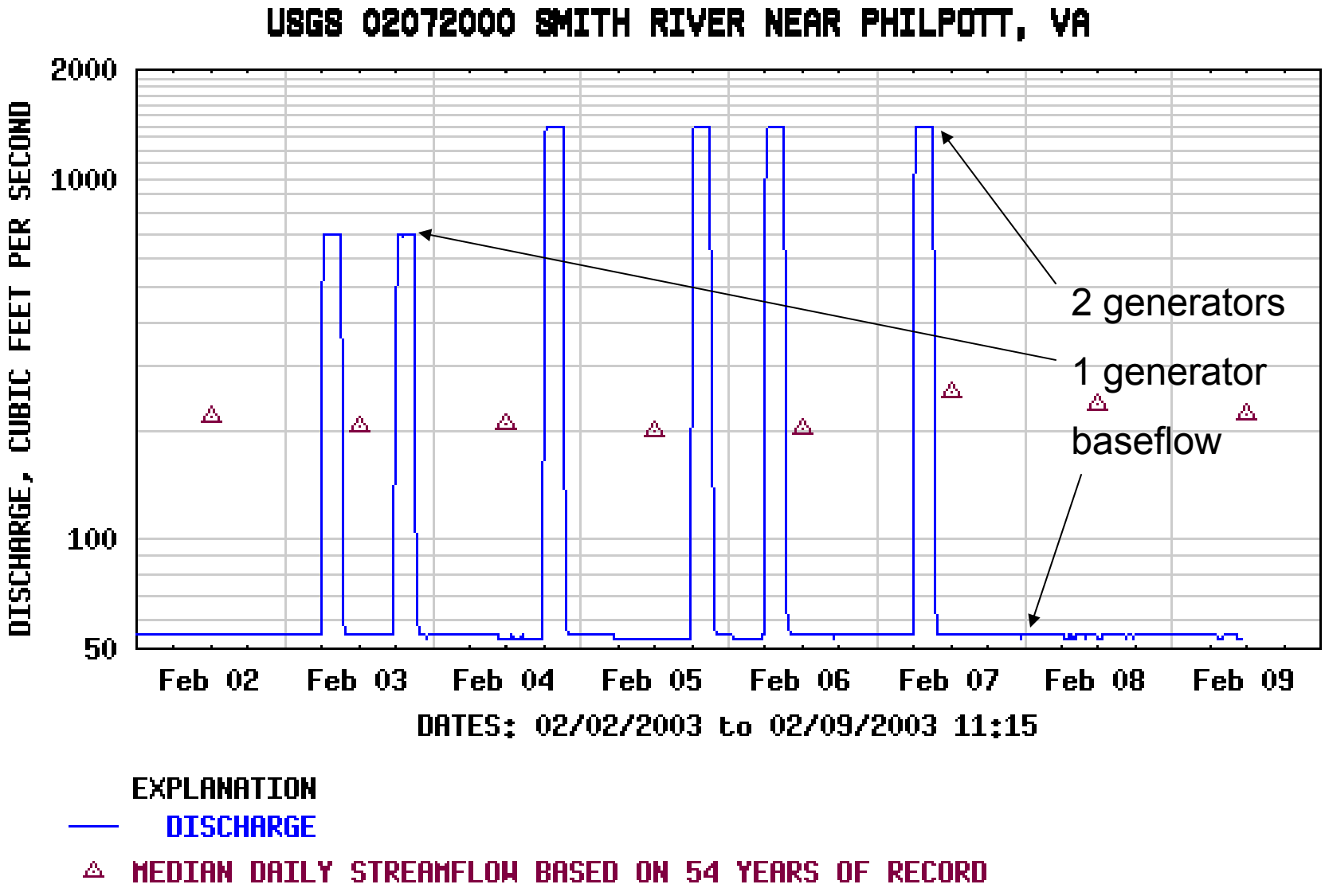
Wild brown trout

Depauparate native fish assemblage

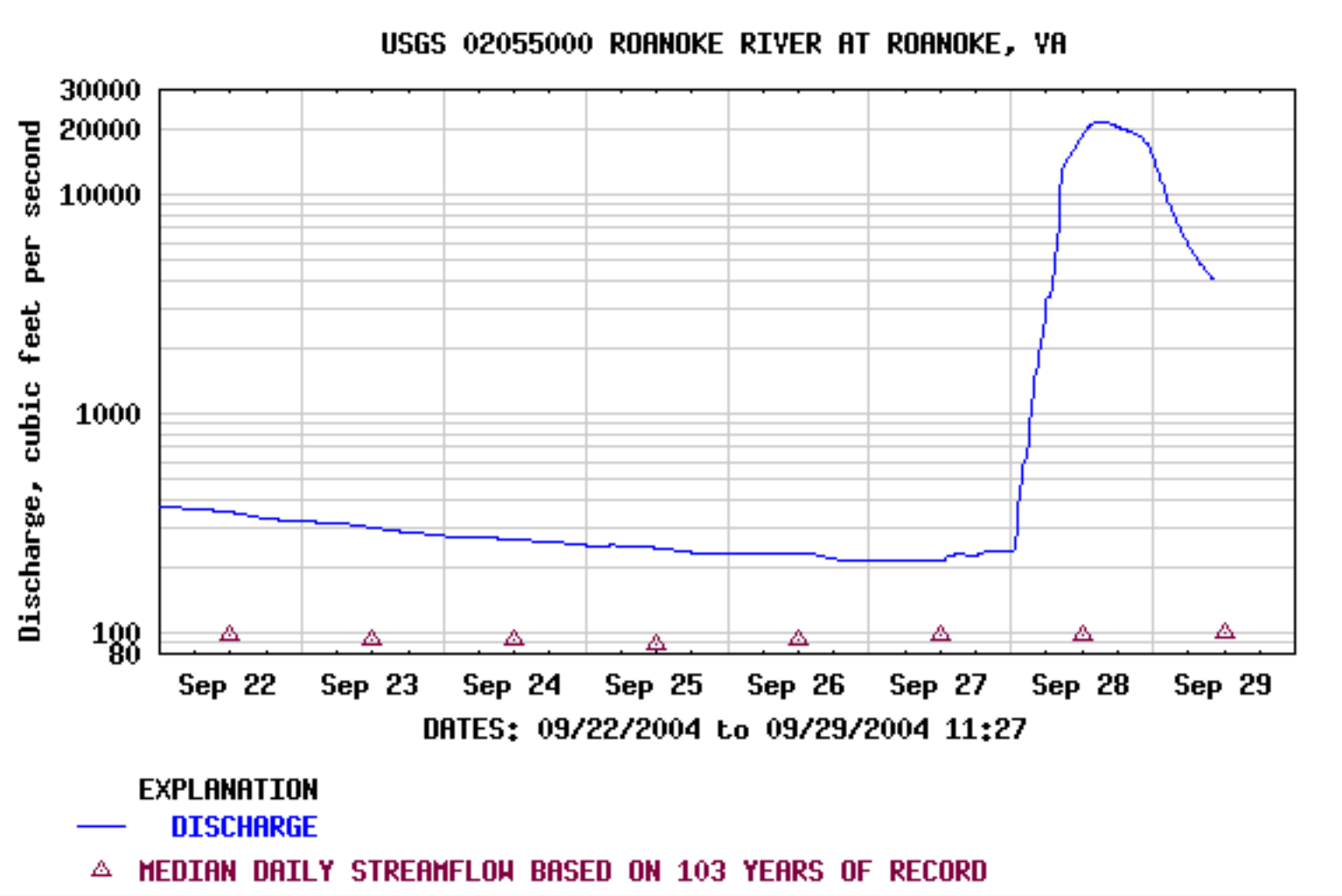


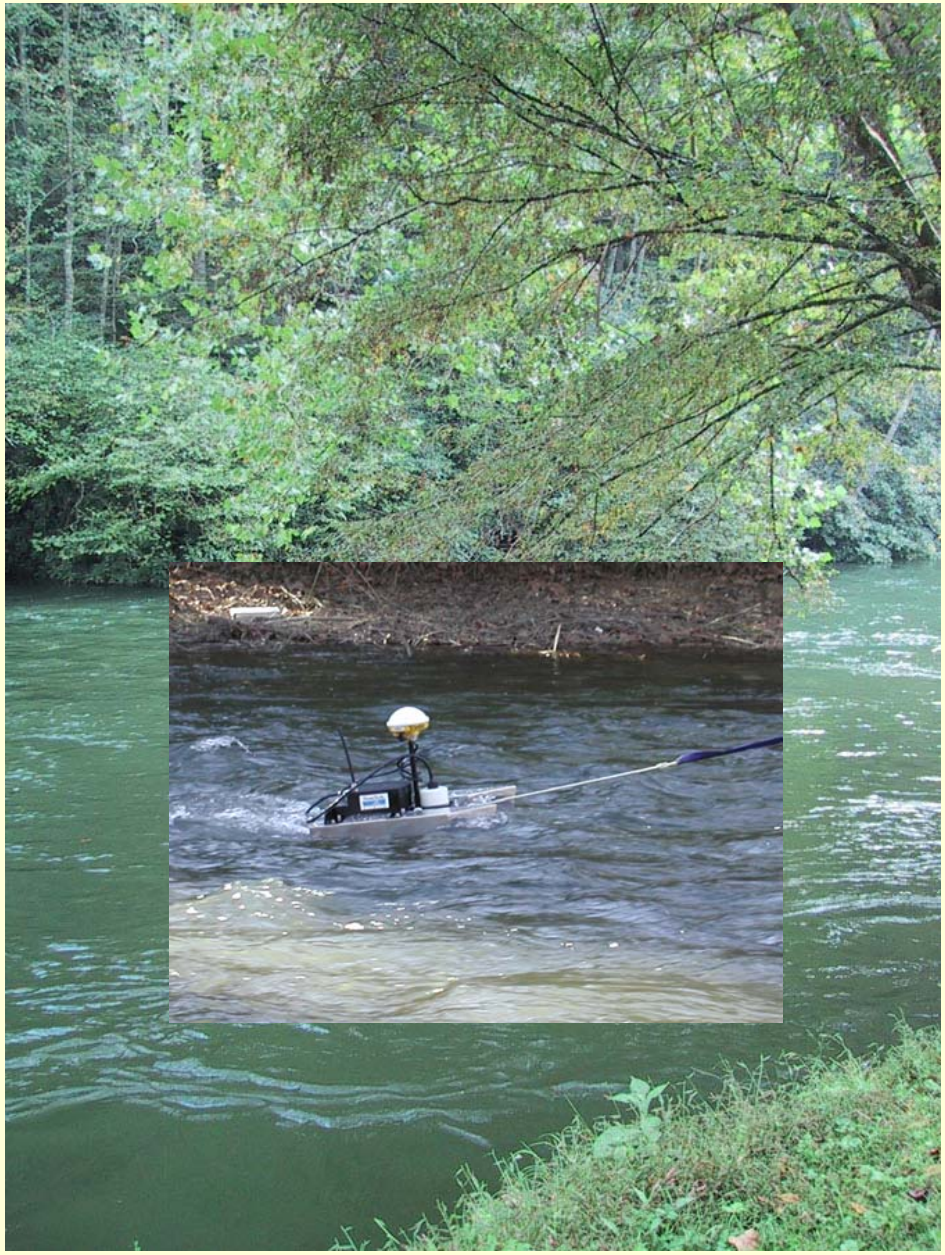
Which one of you
is Biodiversity?

USGS

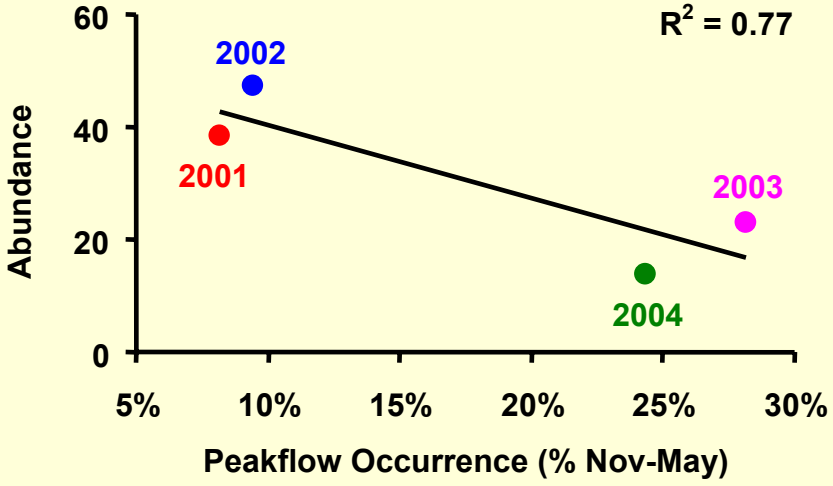

USGS 02072000 SMITH RIVER NEAR PHILPOTT, VA
DISCHARGE, CUBIC FEET PER SECOND
2000
1000
100
50
Feb 02
Feb 03
Feb 04
Feb 05
Feb 06
Feb 07
Feb 08
Feb 09
DATES: 02/02/2003 to 02/09/2003 11:15
2 generators
1 generator
baseflow
EXPLANATION
DISCHARGE
MEDIAN DAILY STREAMFLOW BASED ON 54 YEARS OF RECORD

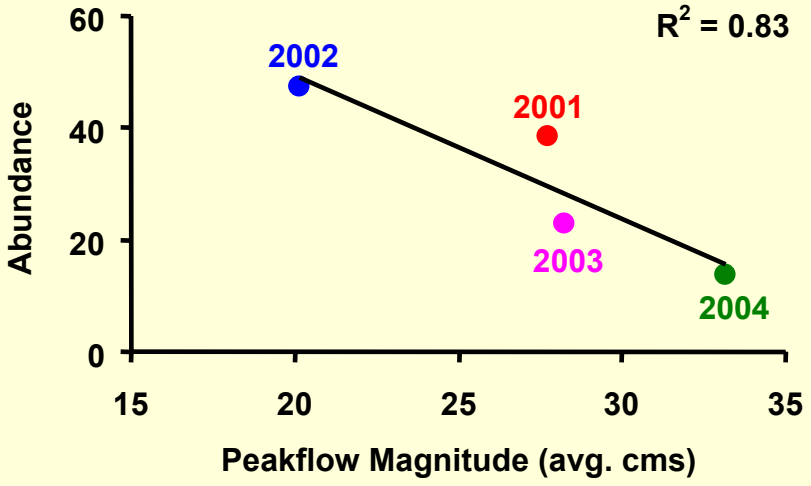
Hurricane Jeanne was natural





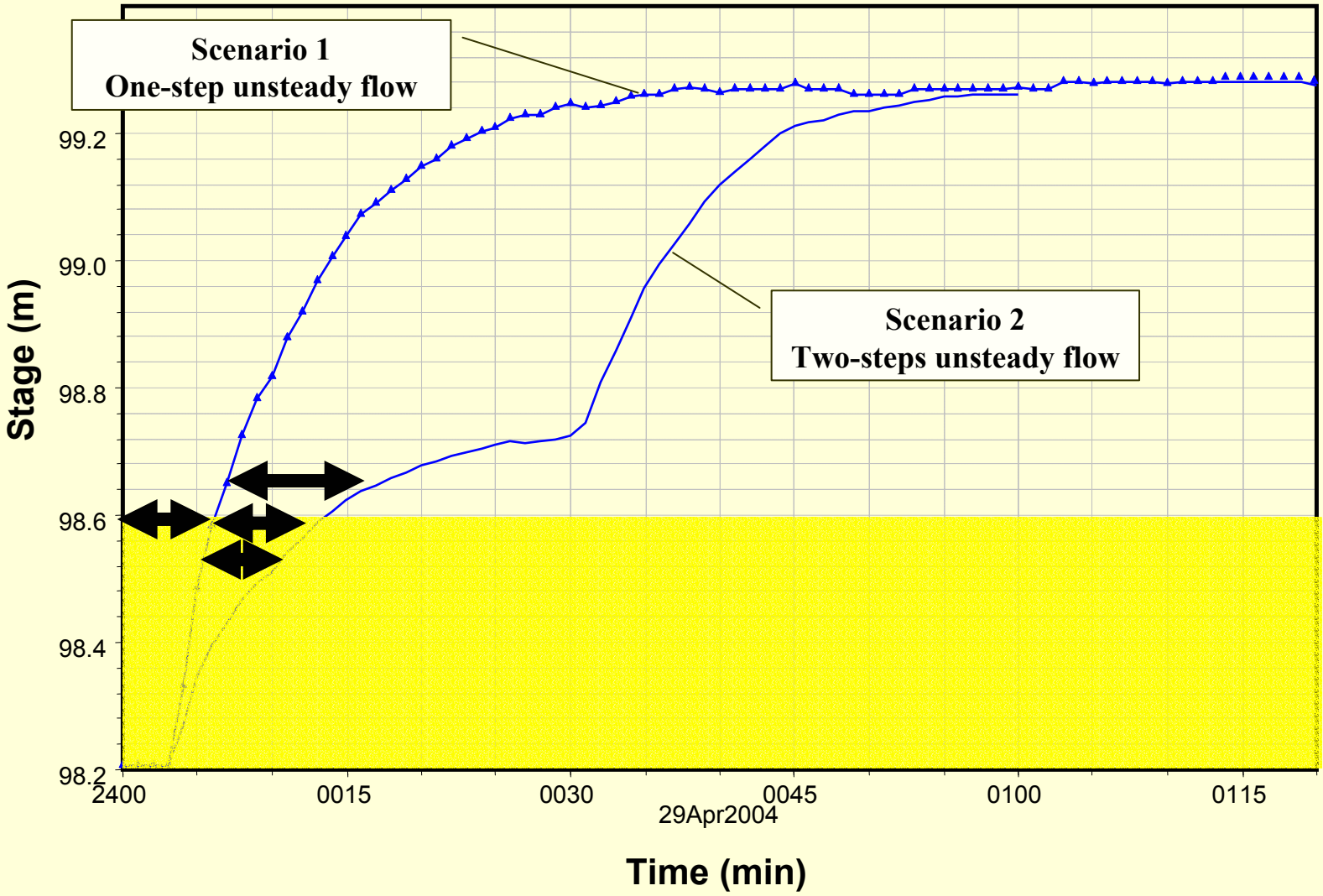
Age-0 brown trout abundance declines with peakflow occurrence and magnitude



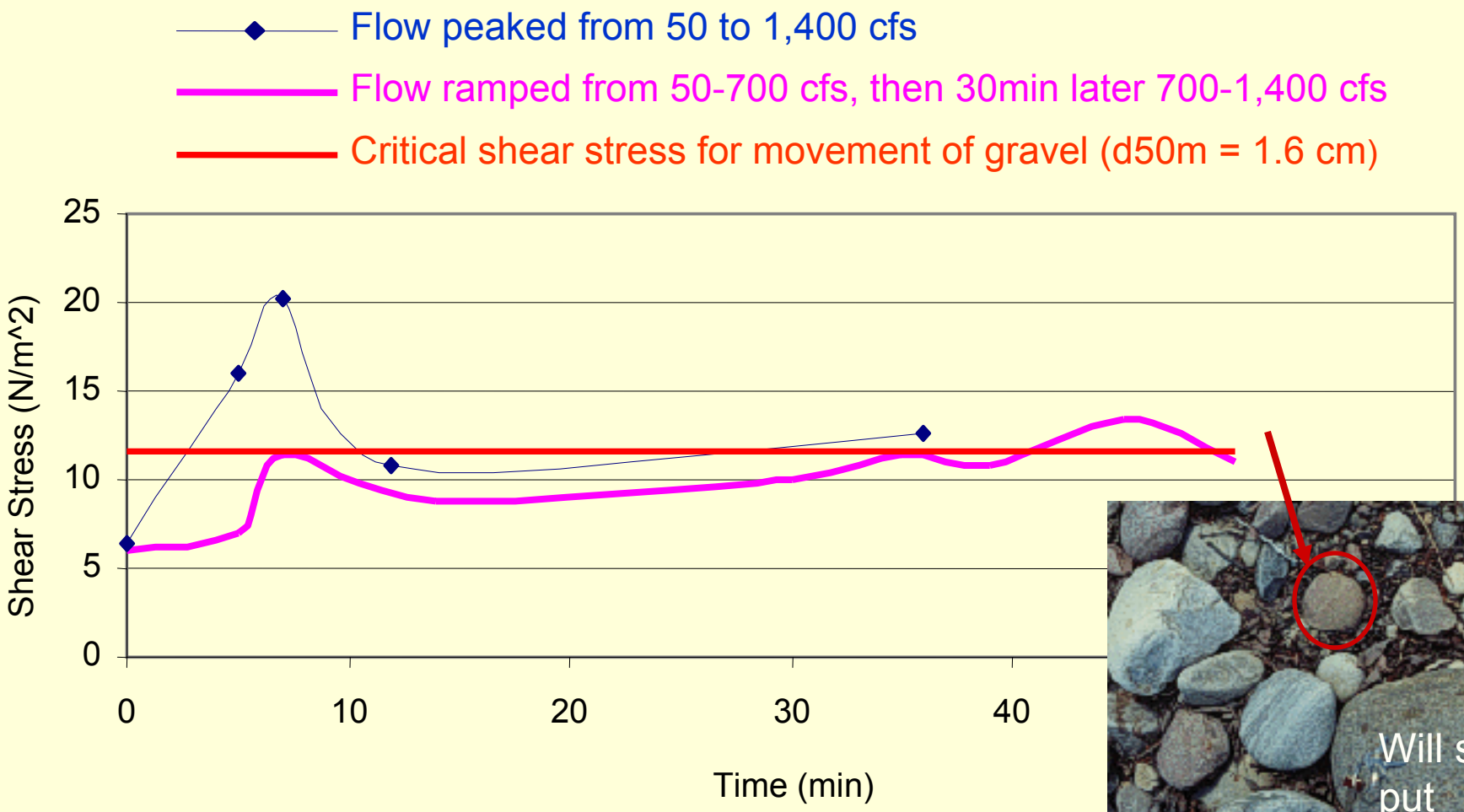


Relationship for native fishes is so tight, you wouldn't believe it.

A two step release increases adaptation time

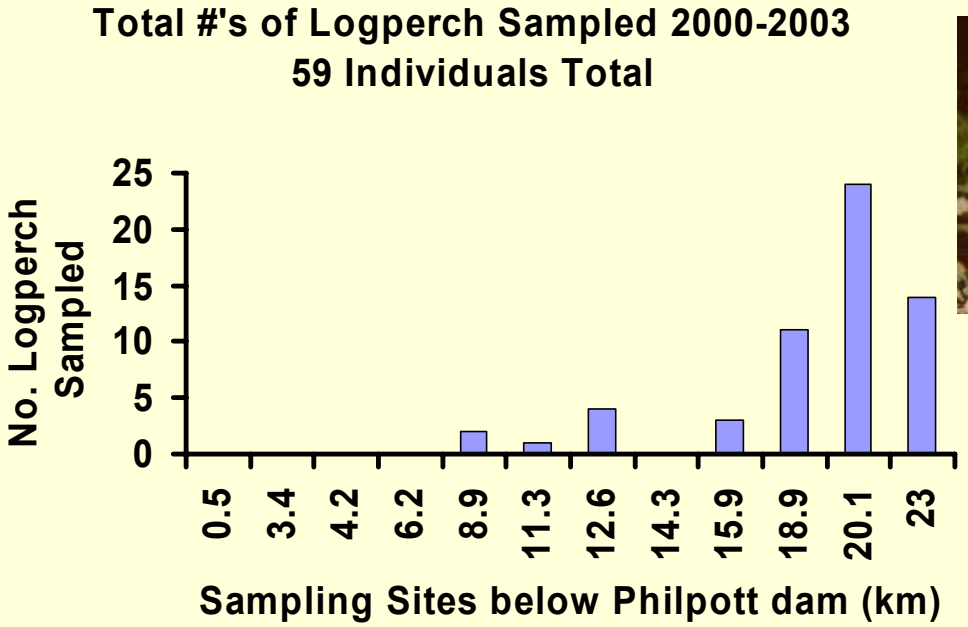


Shear stress is reduced when flow is ramped up in two steps instead of instantaneously



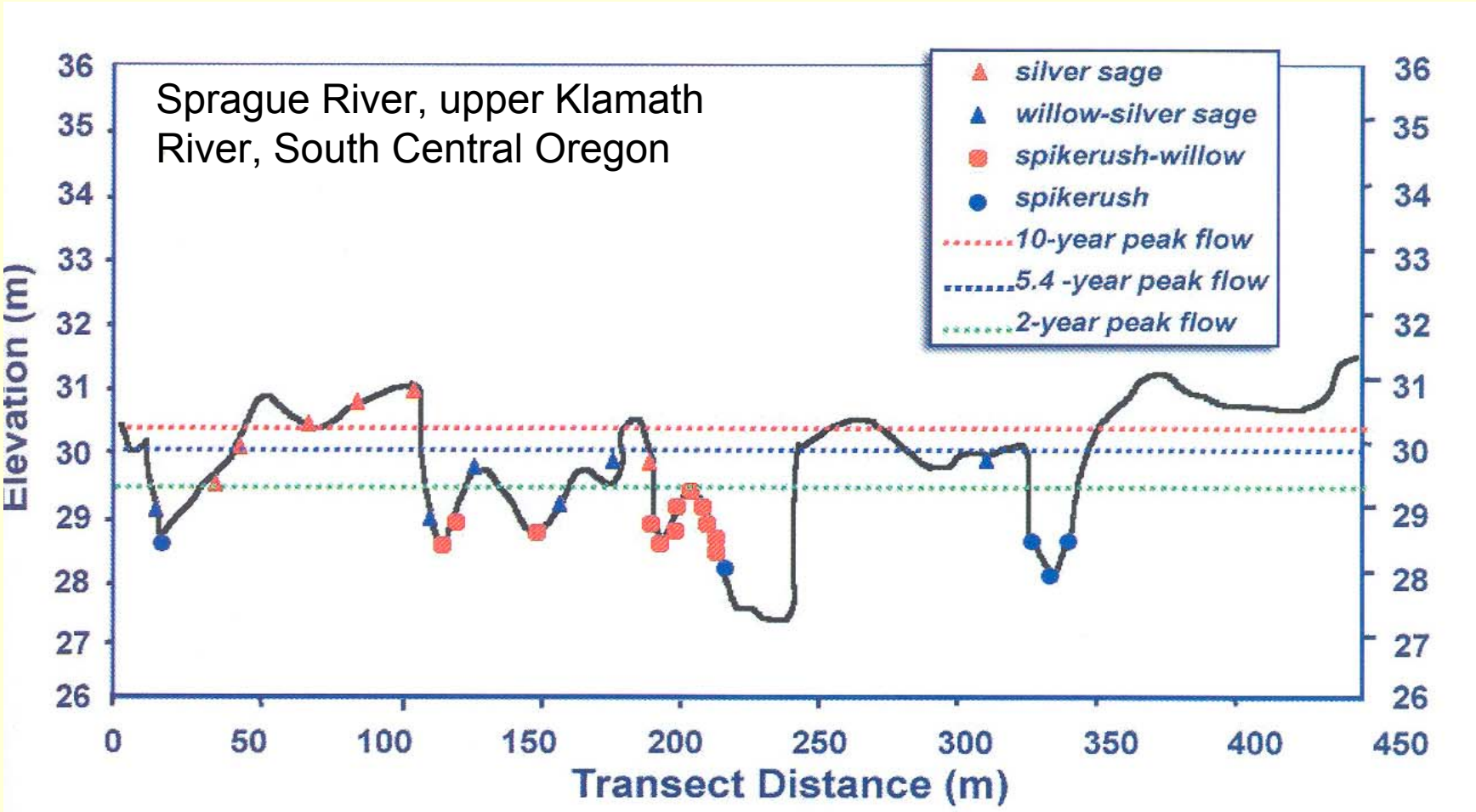
Flow pulsing affects egg scatterers more than egg attachers

Endangered Roanoke Logperch is an egg scatterer, prefers to deposit eggs in coarse or medium sand



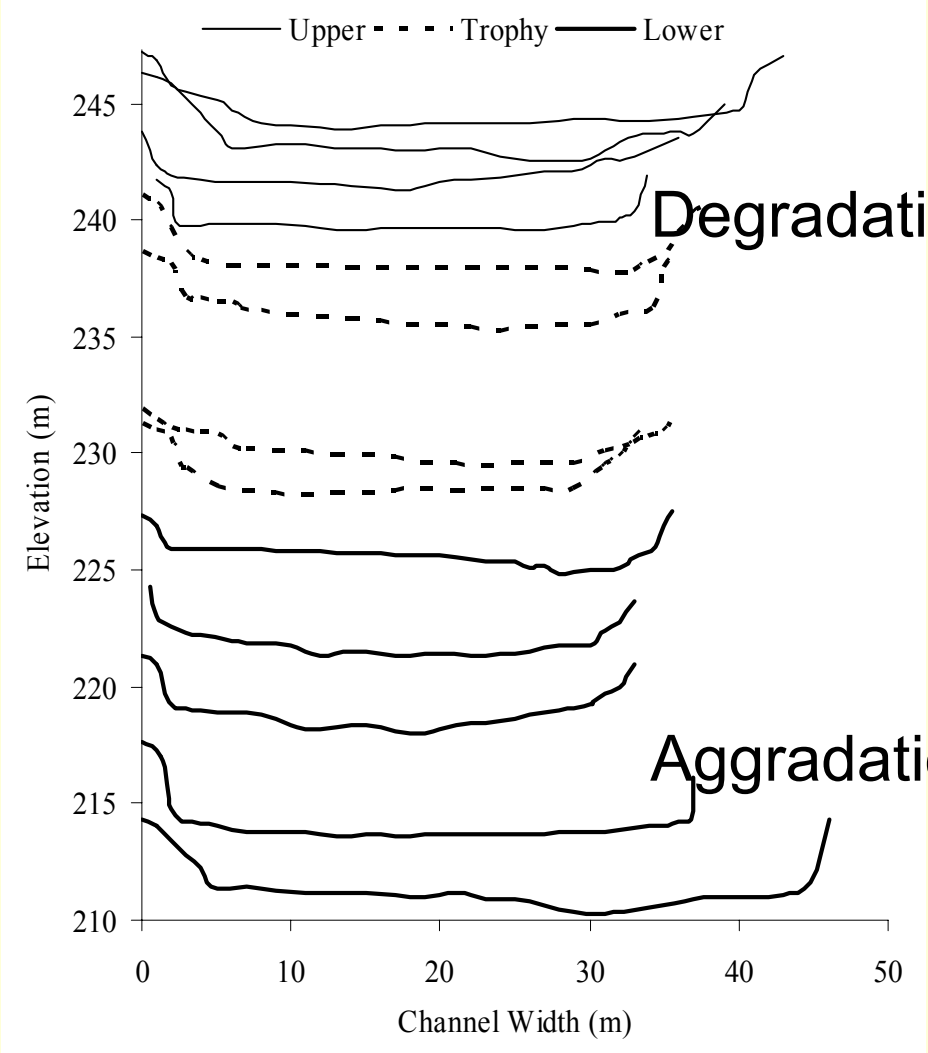
More common fantail darter is an egg attacher and uses large cobbles for spawning

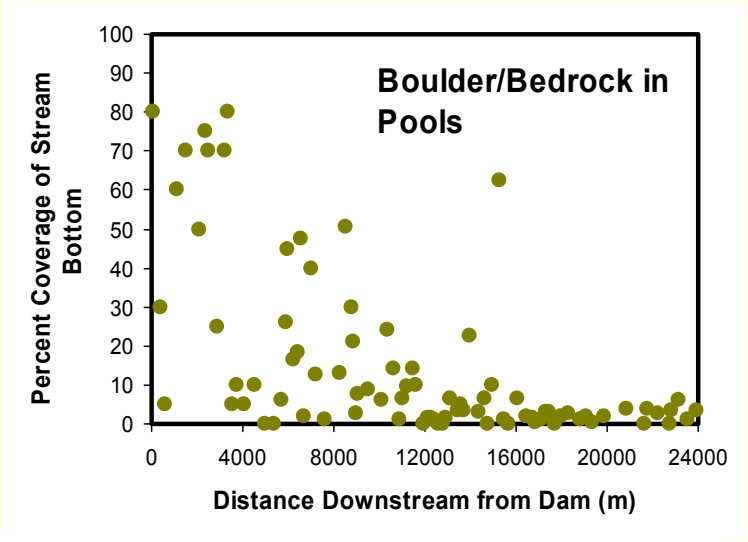
Plant communities respond to flow change – research in eastern US?

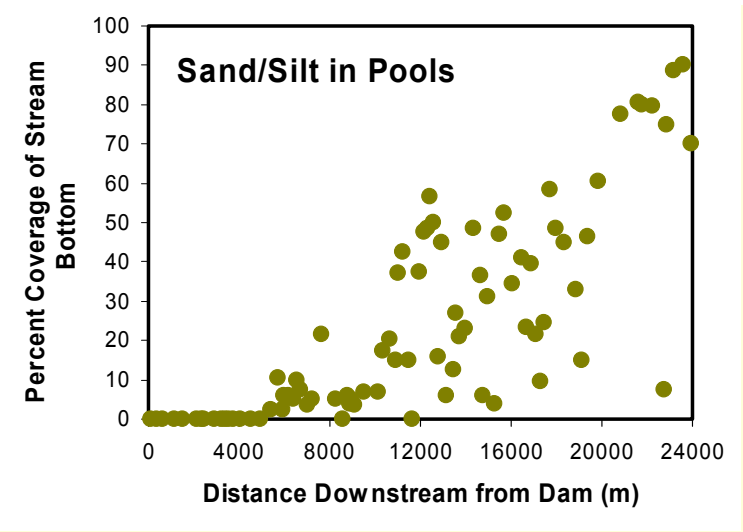


From *Instream Flows for Riverine Resource Stewardship*, IFC 2004

Geomorphological Change

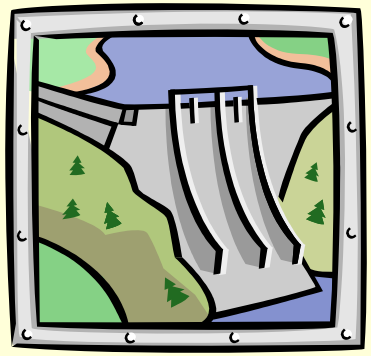






Conceptual model for sediment changes over 10-100 years

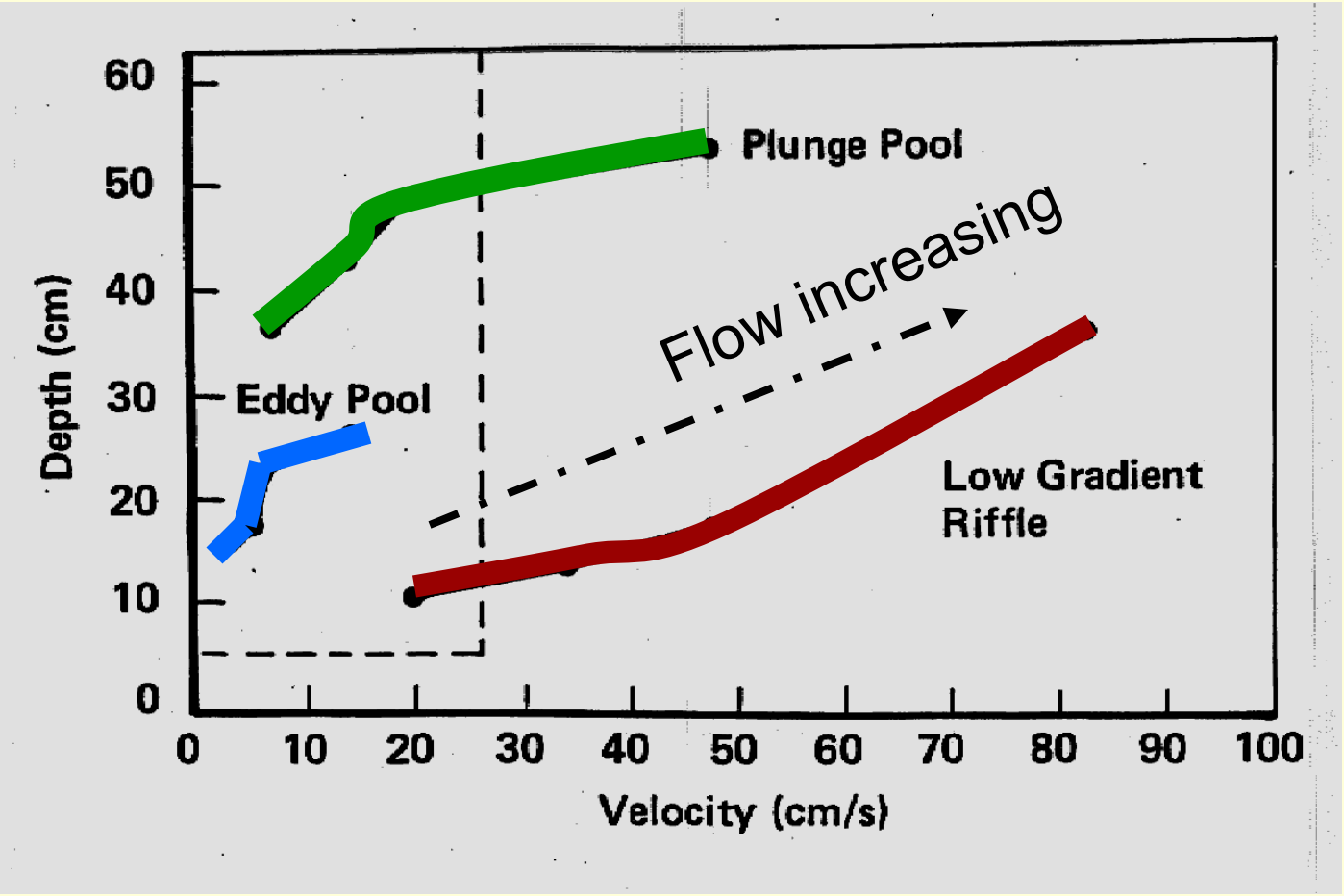
Barrier effect → Trap & reduce sediment load → Degrade & armor channel bed → Increase sediment size



Degrade & armor channel bed → Lower effective base level → Degrade tributary channels

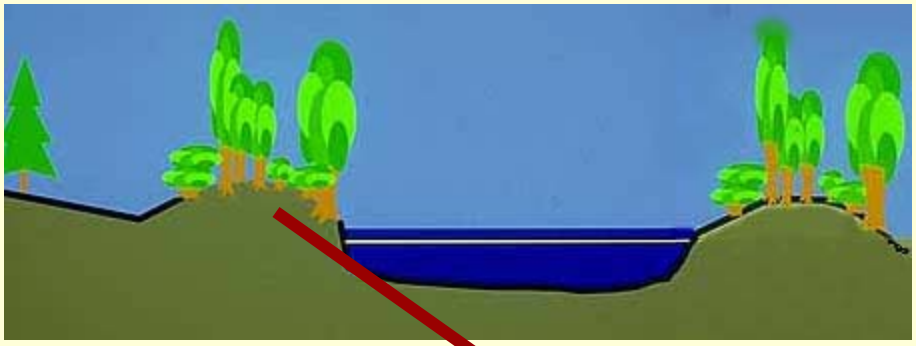
Pulsed flow → Increase bank erosion → Increase fine sediment load → Reduce channel capacity downstream → Increase local flood risk

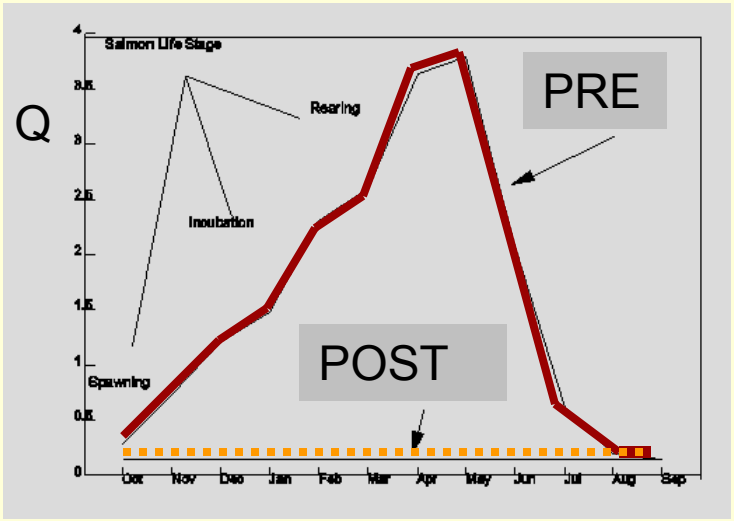
Geomorphological units show different hydraulic responses



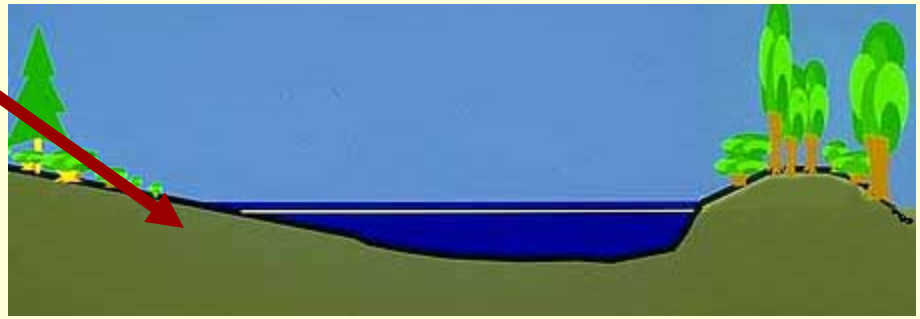
Sullivan 1986

Trinity River lacks shallow slow microhabitats due to decades of flood scalping





Berm removal and feather edging to create juvenile salmonid habitat



Source: www.krisweb.com/krisweb_kt/ trtour/restor3.htm

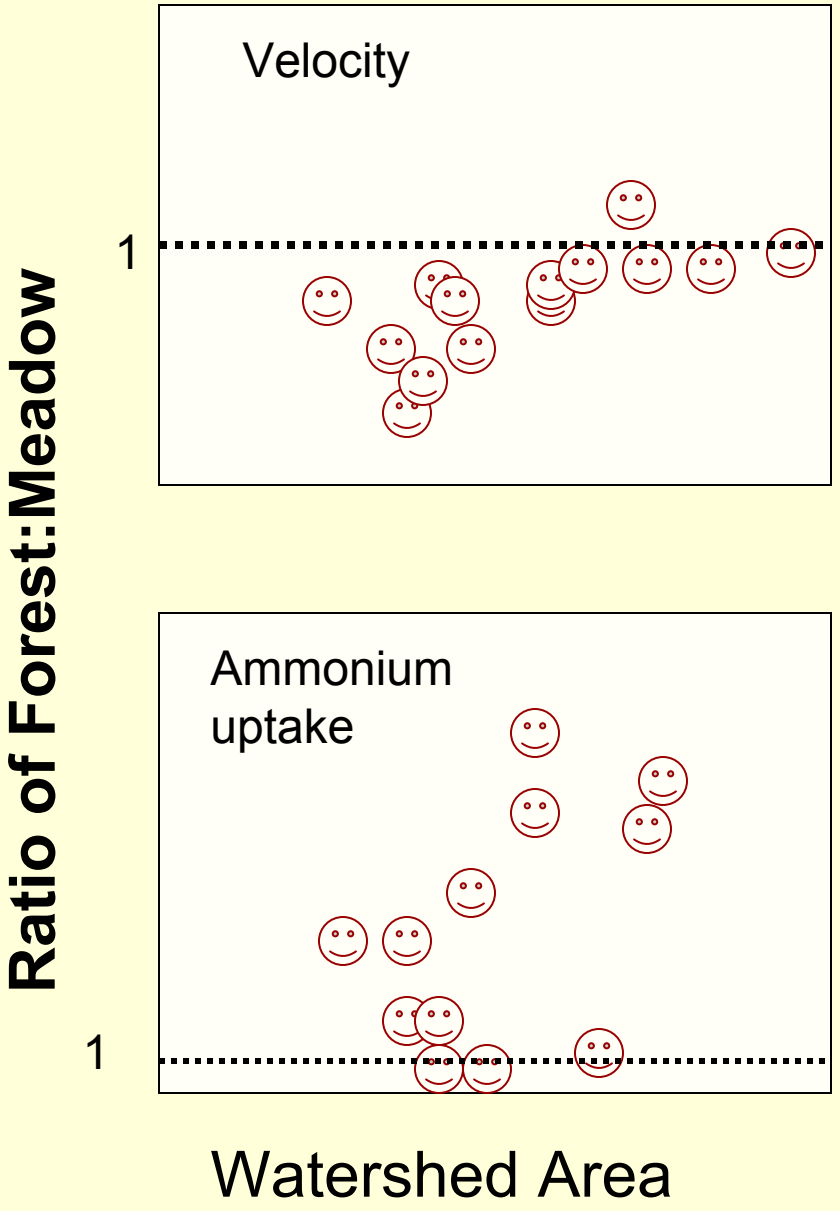
Geomorphological responses to channel narrowing via deforestation in Piedmont streams results in ecological responses to ecosystem processes,

including

Ammonium uptake

Contaminant degradation

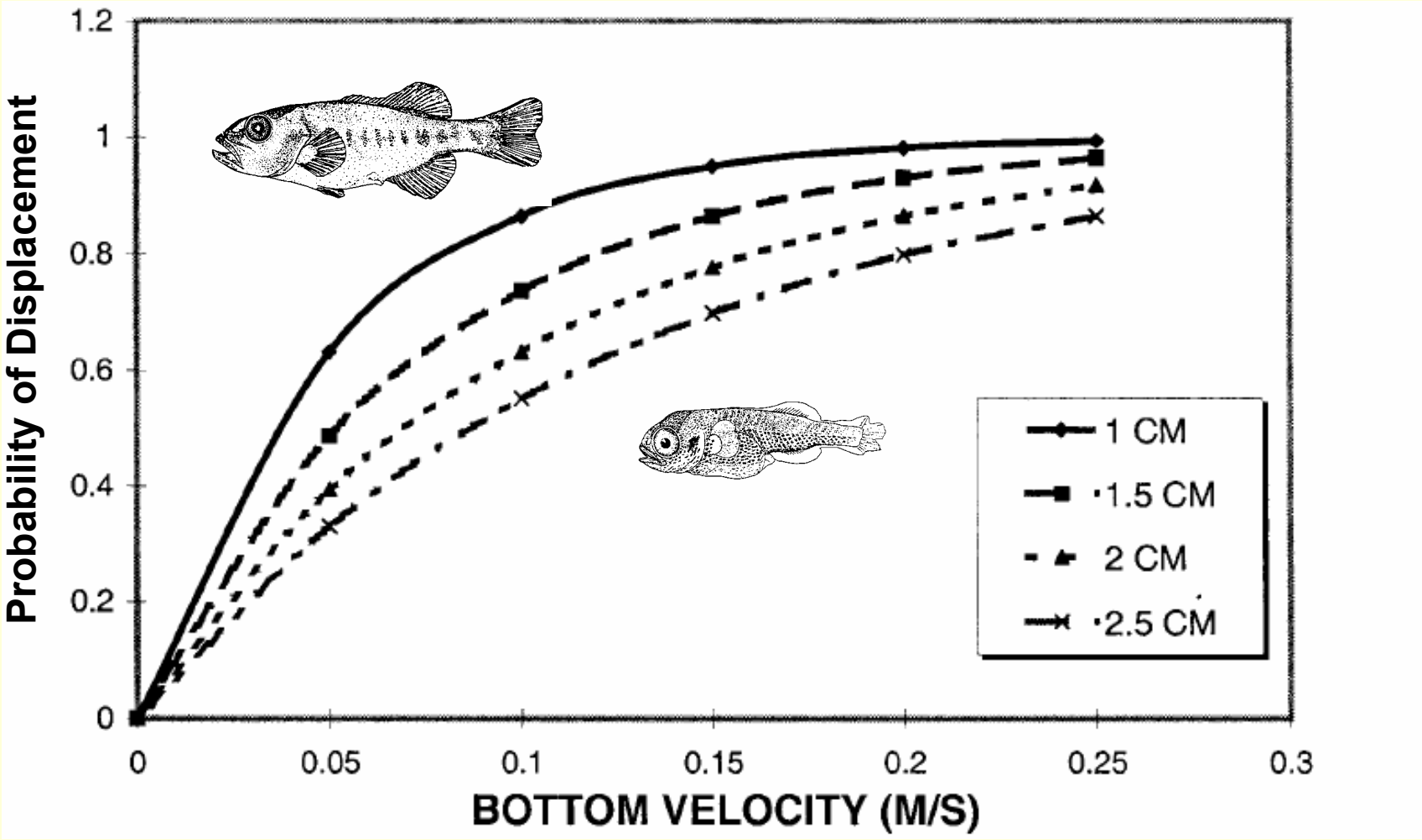
Sample results from Sweeney et al. Proceedings of the National Academy of Sciences 2004



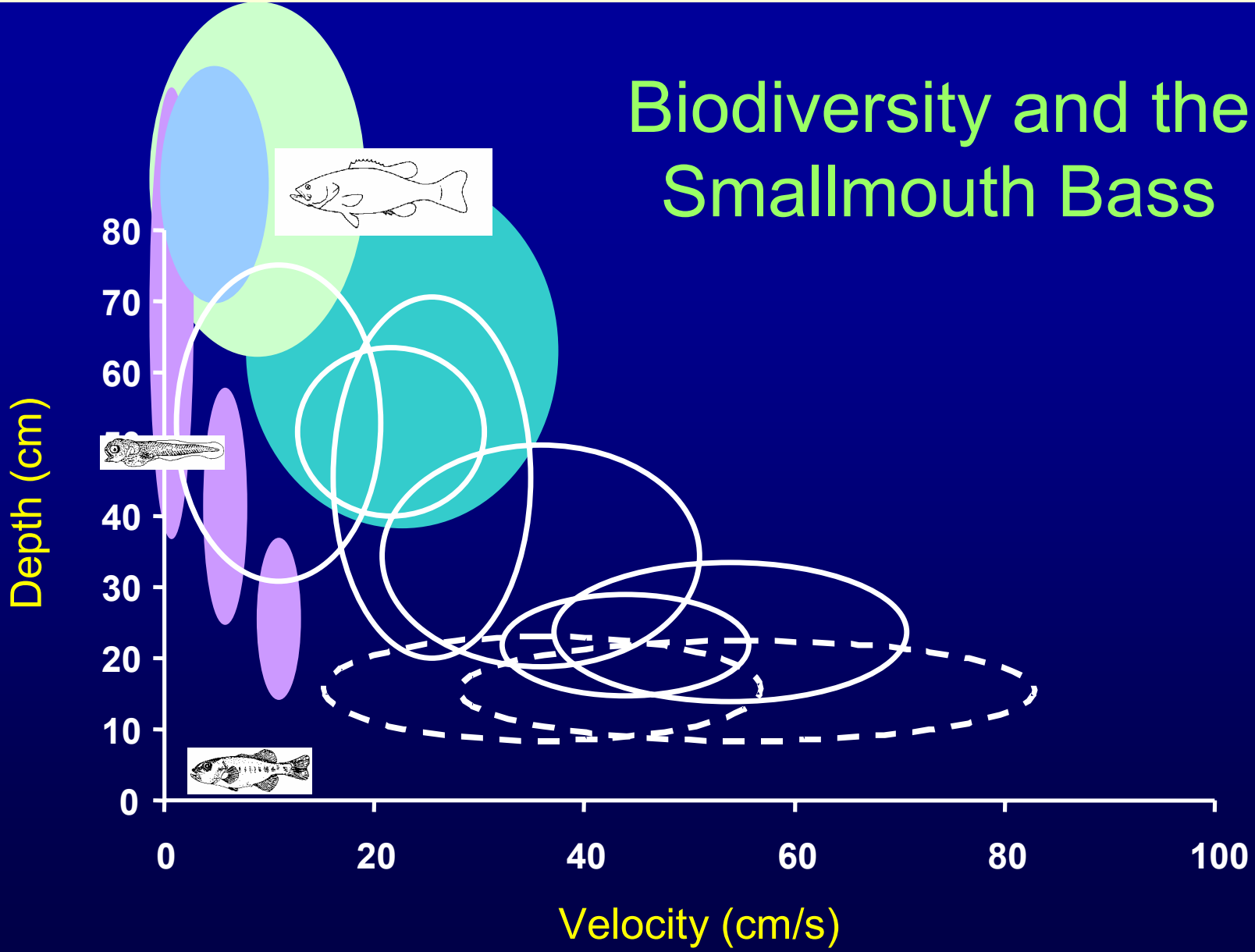
Biology - let's be earnest

- We stand on the asses of those who have gone before us
- Everything is indirect
- Expect nonlinearity, complexity, error, and plenty of grueling field work
- Experiments are rare
- No unifying theory

Know your life history

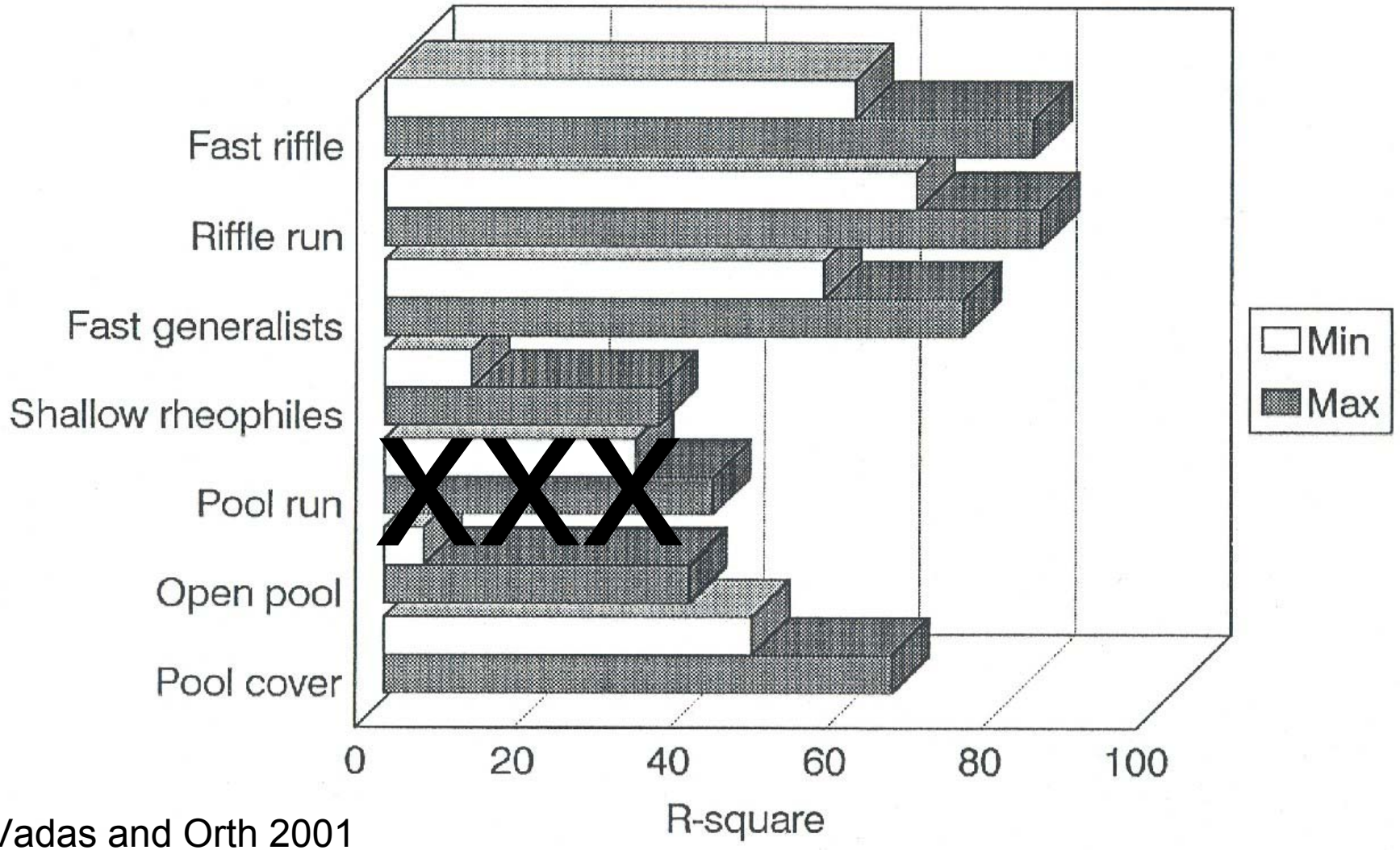


Biodiversity and the Smallmouth Bass



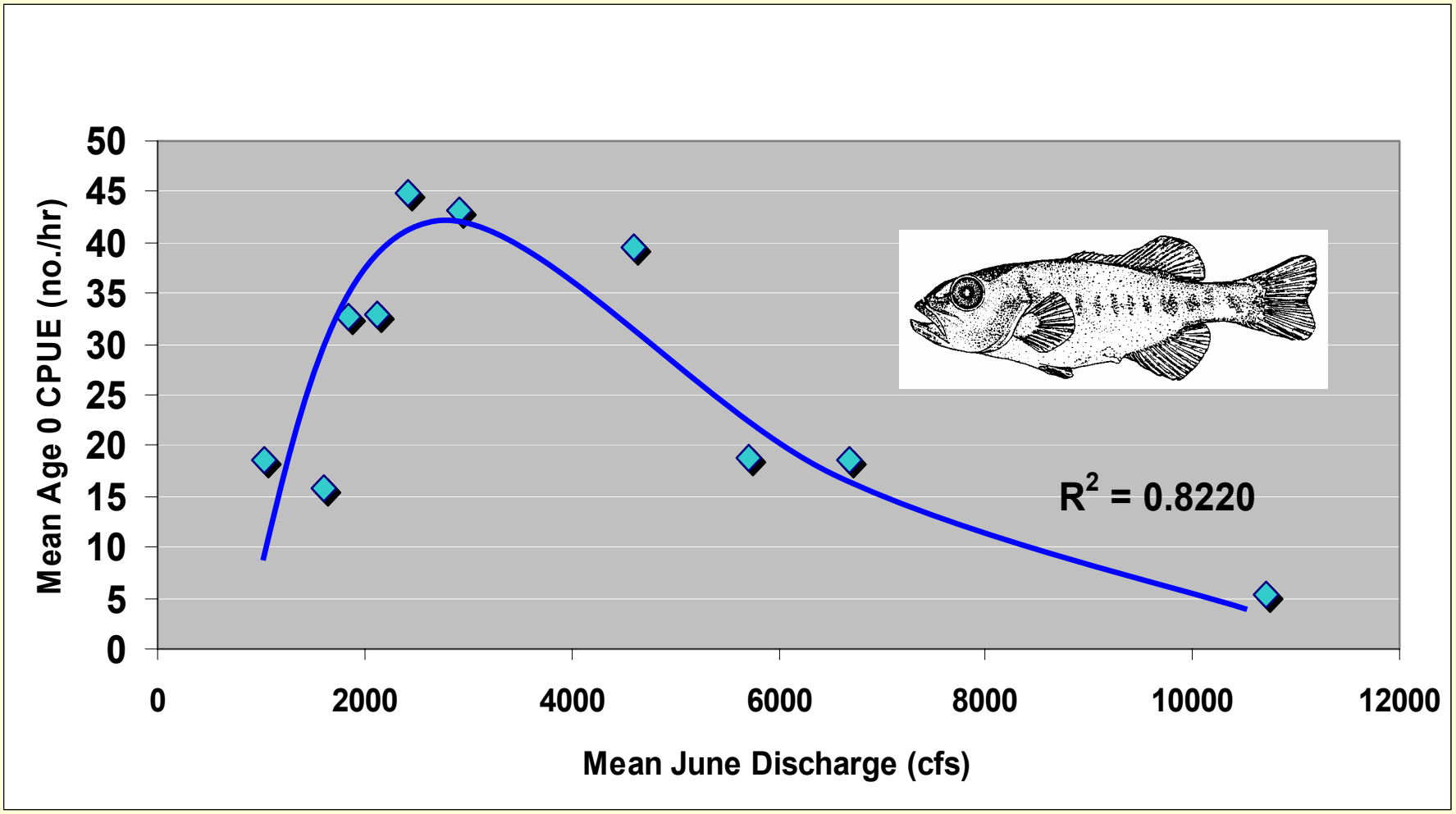
Cross-Validation of

Guild-Level HSI



Vadas and Orth 2001

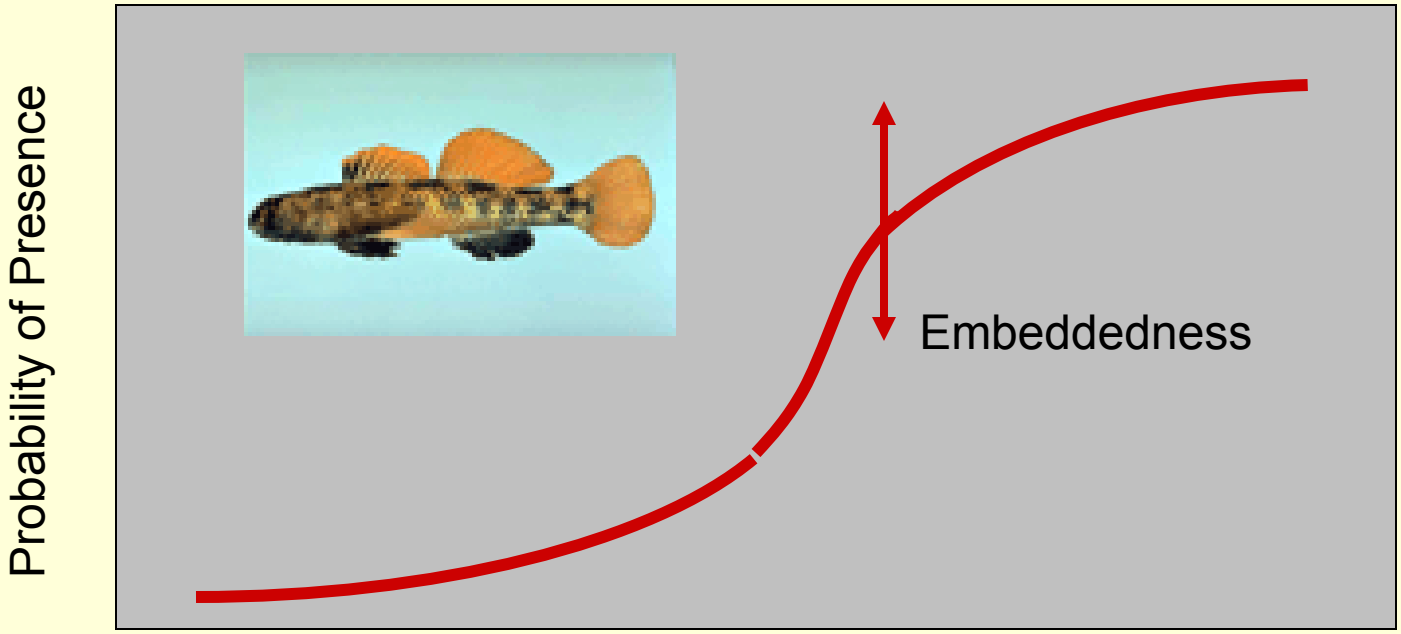
Empirical Relationships are Rare



Smith et al., In Press, North American Journal of Fisheries Management

Freshwater mussels move slowly

Testing Spawning Habitat Relationships for Egg Attachers



Developed by Ryan Smith, tested independently by Anne Hunter


When it's a low flow issue, think
Water Quality

Substantial algal growth and severe low flows

Droughts and Demand Management Rules

- Drought **Watch** stream levels and actions
- Establish Drought Warning stream levels and restrictions

- Emergency Drought levels
  - Unrestricted water use is not permitted
  - Mandatory restrictions

More behavioral science than biological or physical science.

Connectivity

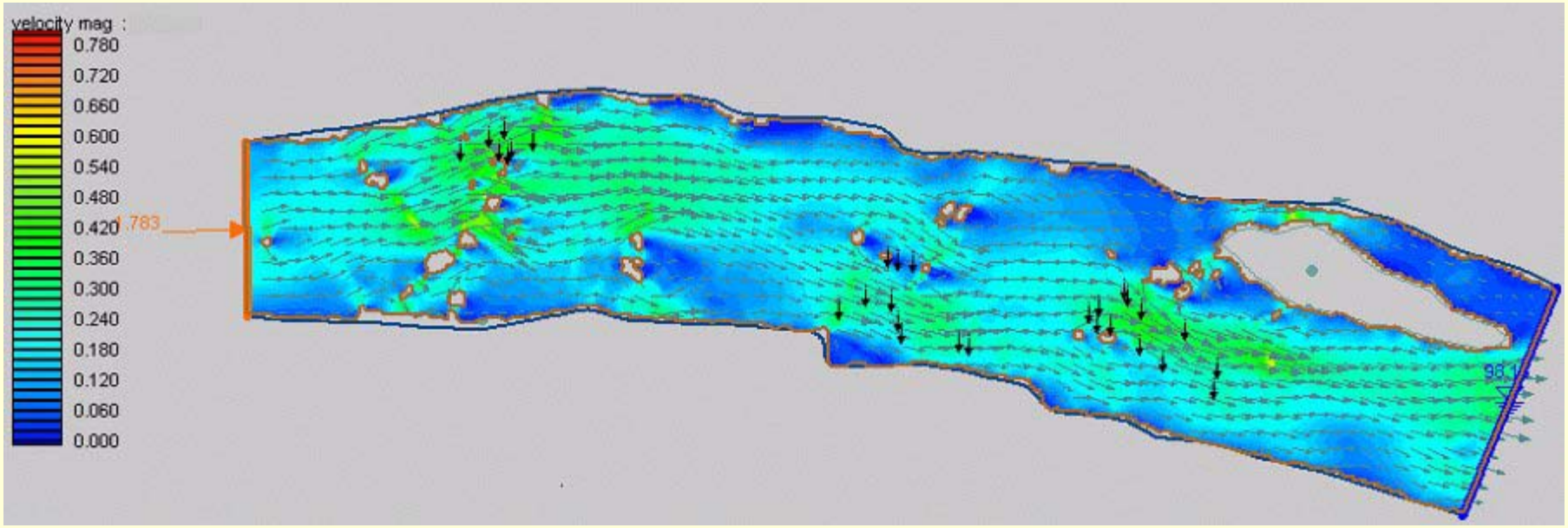
State of Confusion by

Carbon Copy ©

“My state of confusion isn't helped by the illusion.
Your keeping me in the dark.
My vision would be clearer if you came a little nearer.
And light my world with your spark. “

I have nothing to say, talk to Ziewitz, Brownell, Nadeau, Poff, Bovee, Gutreuter, Roy, Wallace, Peterson, Auble, Haack, Shofroth, et al.

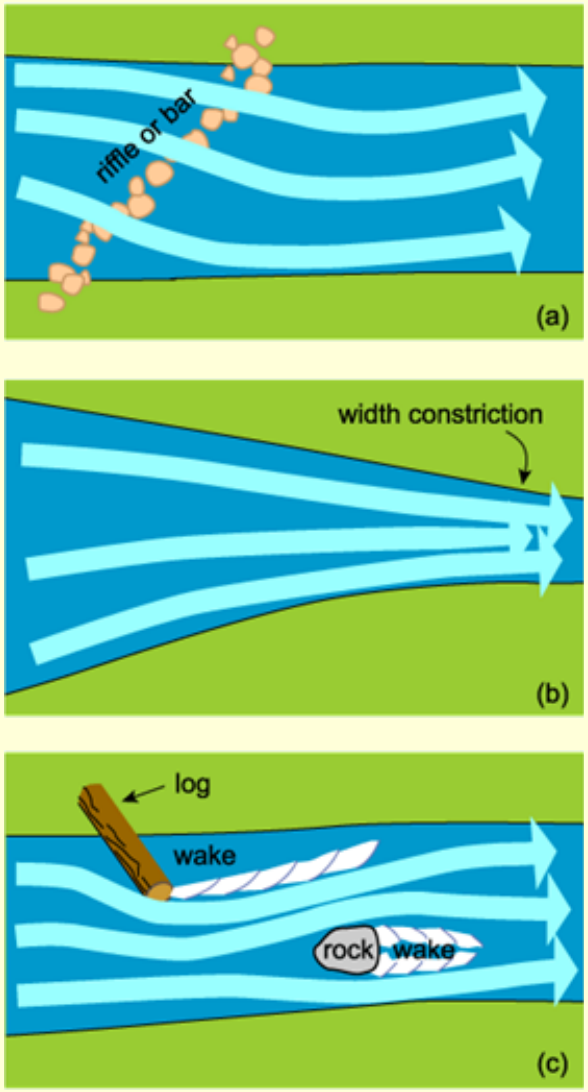
Scale


velocity mag :
0.780
0.720
0.660
0.600
0.540
0.480
0.420
0.360
0.300
0.240
0.180
0.120
0.060
0.000
.783

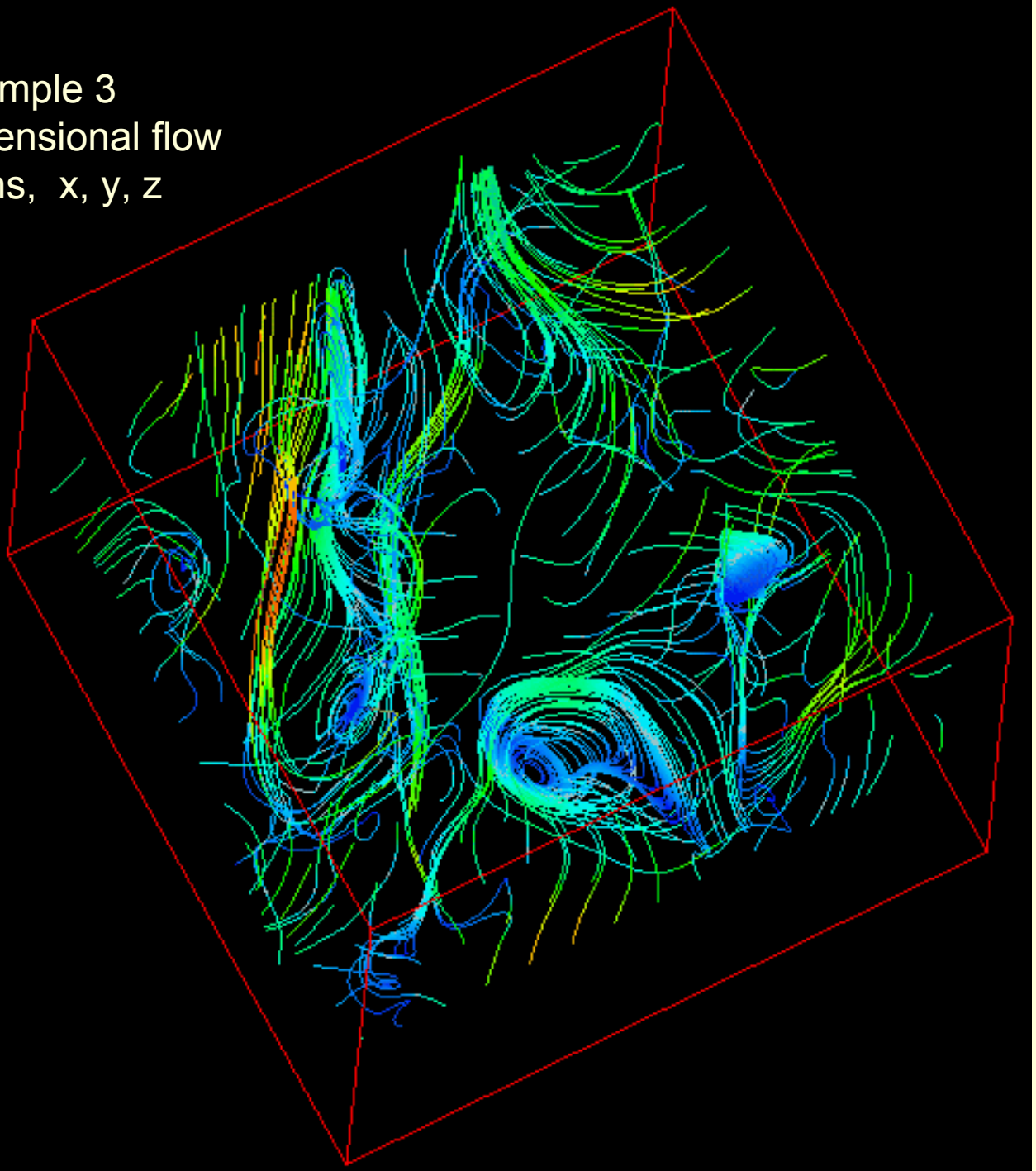

Jason Neuswanger
www.troutnut.com

Dimensionality is Important

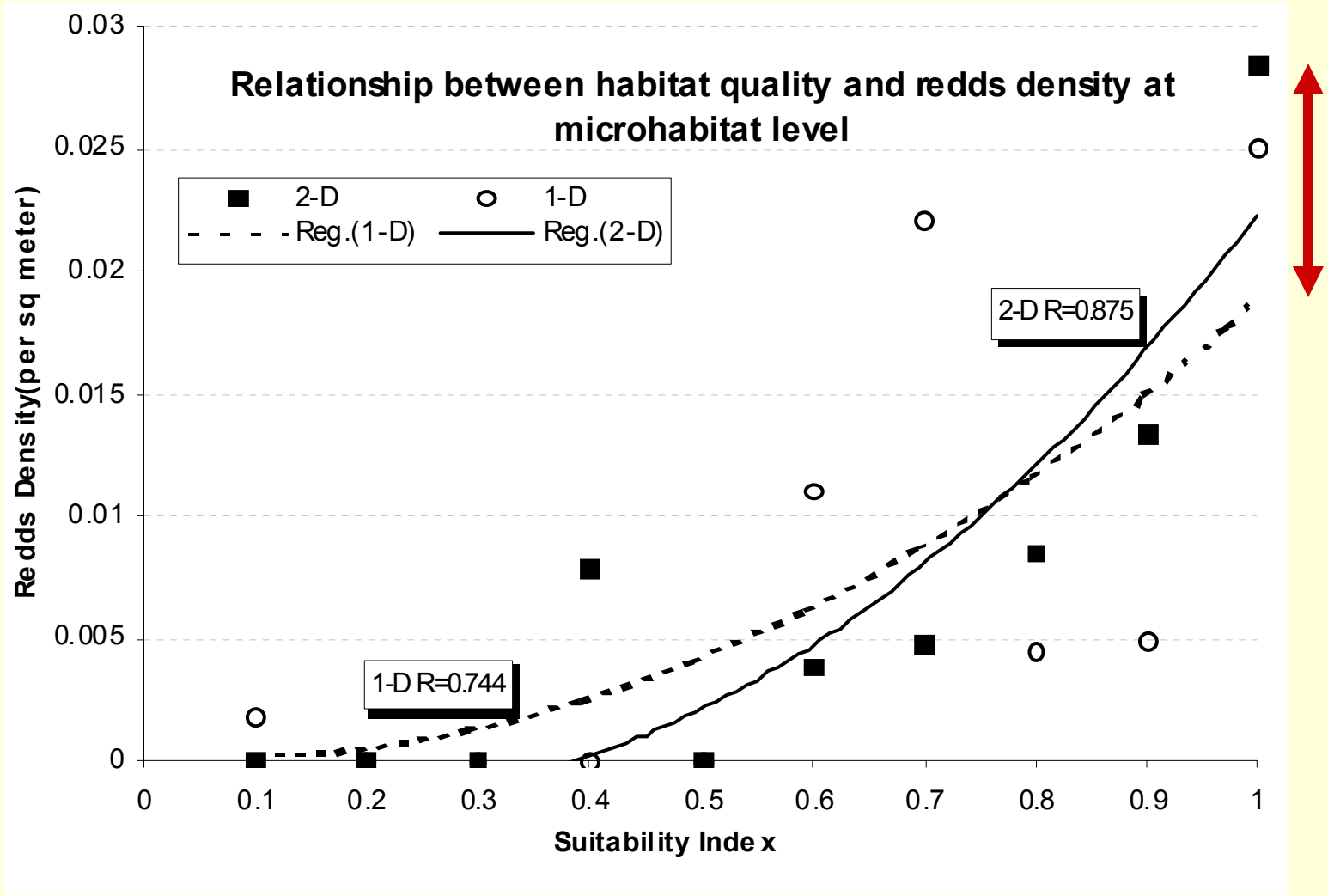
Example of some 2 dimensional flow paths, x, y



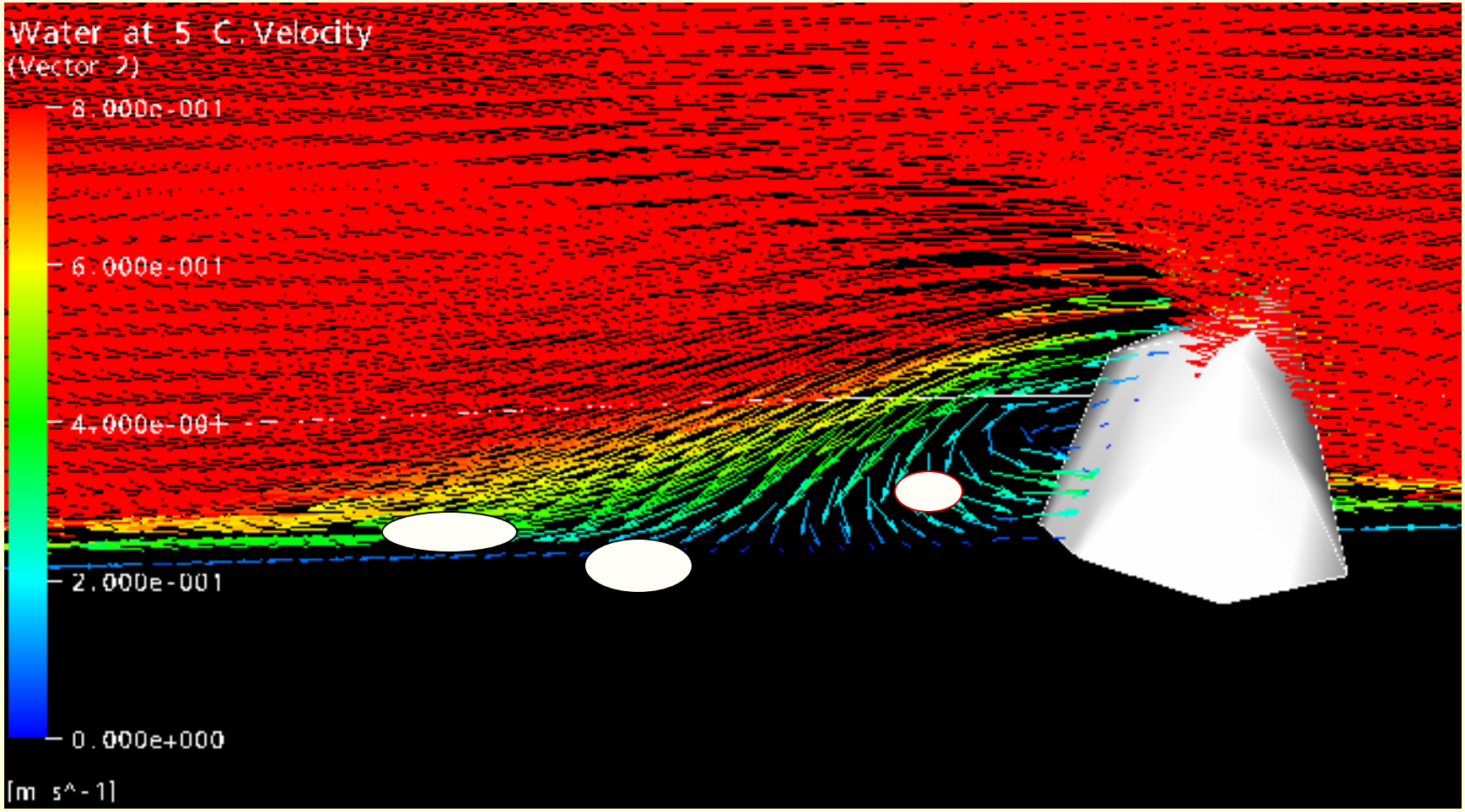
Example 3
dimensional flow
paths, x, y, z



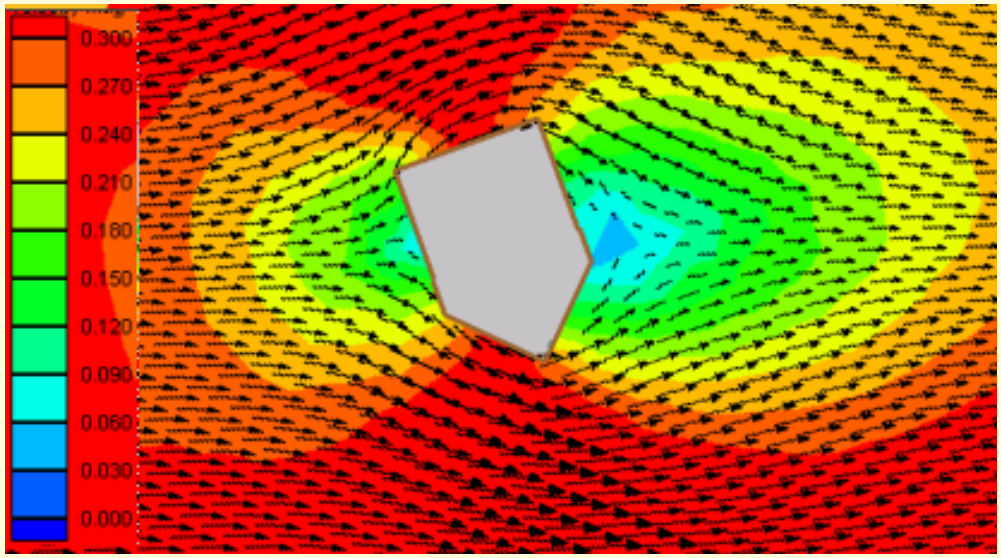
2 D model shows improved correlation with redd density



Vortices and Wakes are 3 Dimensional

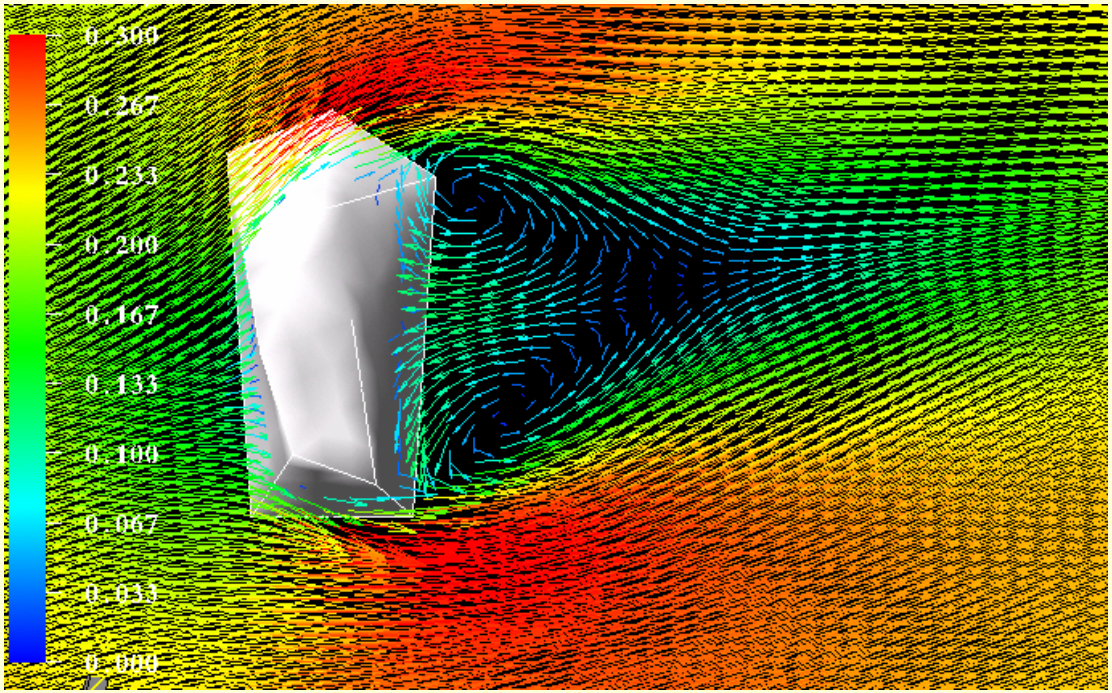


2-D models cannot capture vortices at base flow



Flow direction

2-D depth-averaged velocity predicts a wake but not vortex

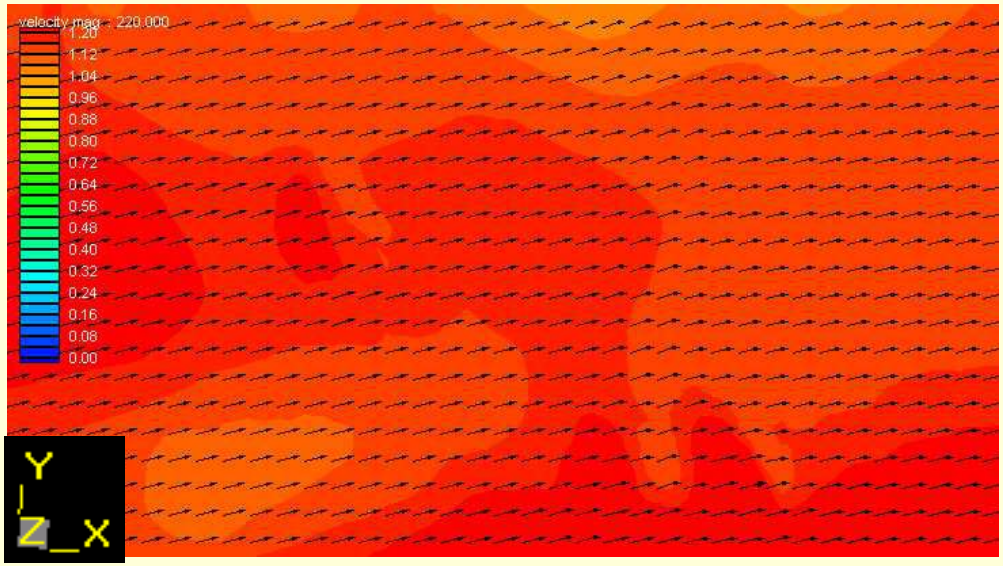


Flow direction

3-D velocity at 15 cm height above the channel bottom shows two vortices shed from the boulder

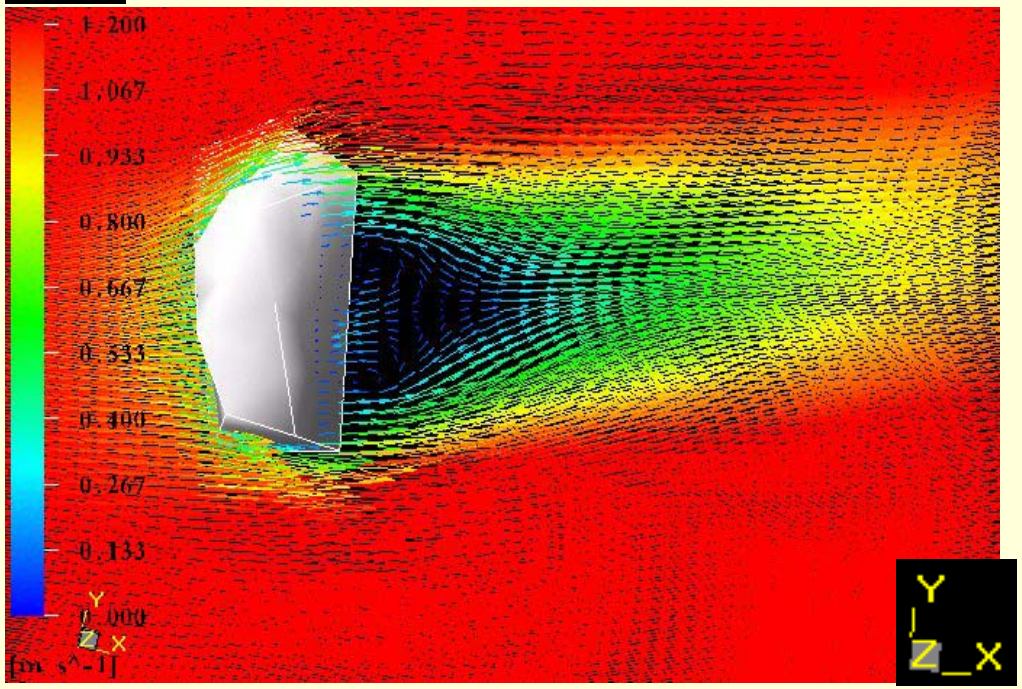
2-D Model cannot capture wake or vortices at peak flow

Flow direction



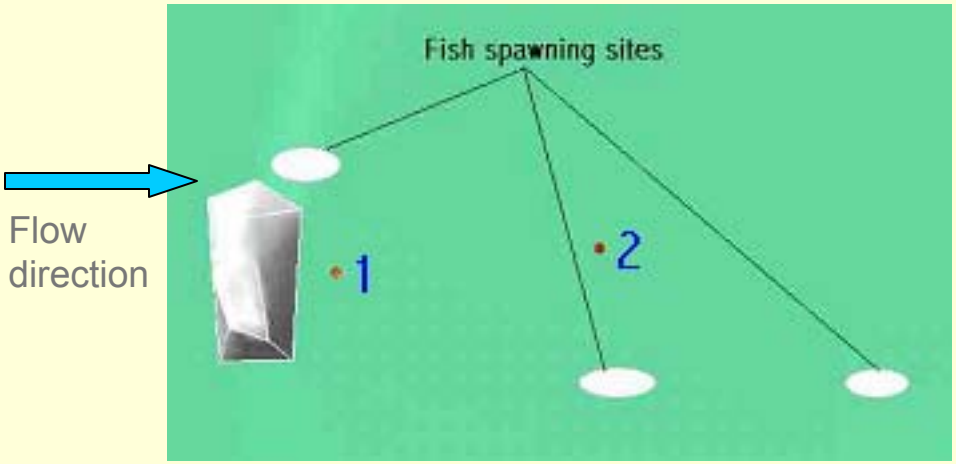
2-D depth-averaged velocity only predicts uniform flow

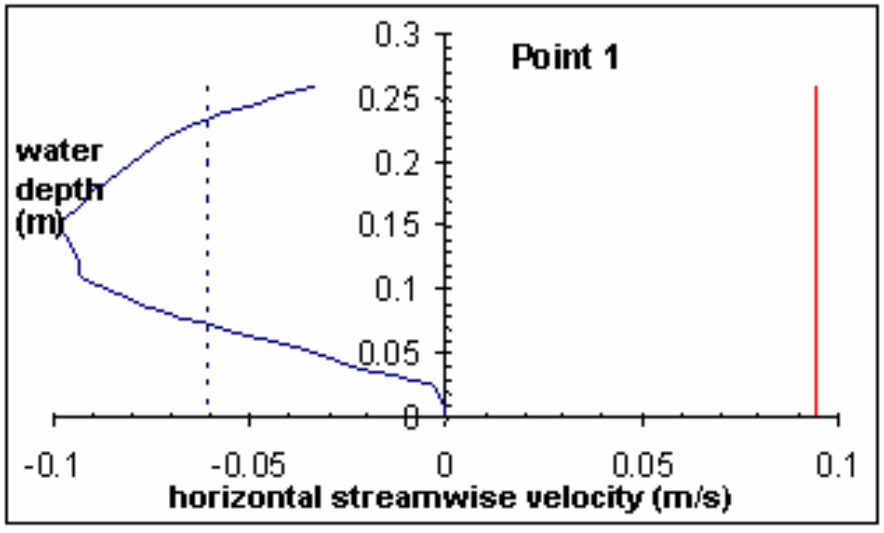
Flow direction



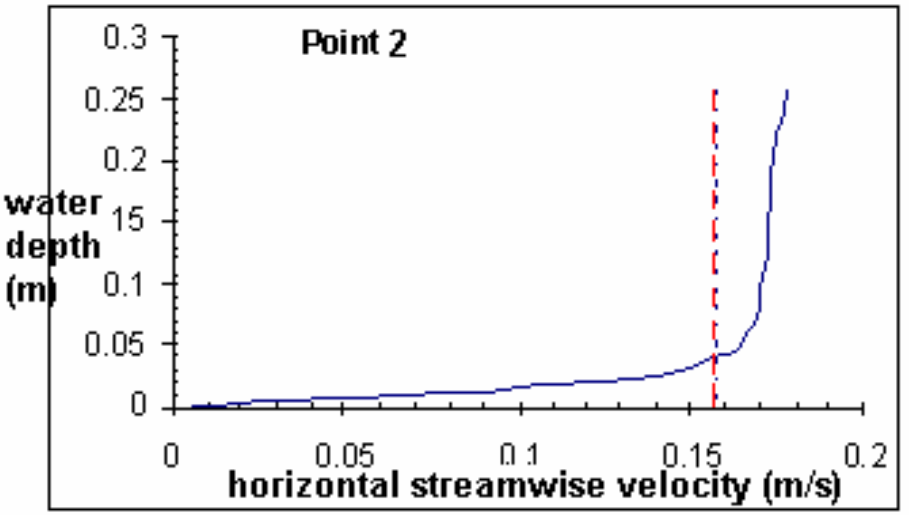
3-D velocity at 15 cm height above the channel bottom shows velocity heterogeneity

Velocity distributions are important





Velocity prediction difference exists for backward flow, the difference decreases for uniform flow



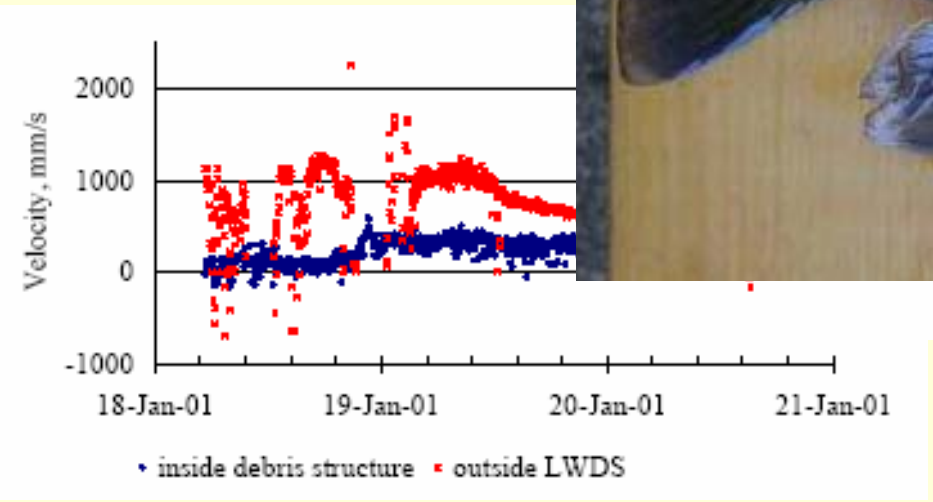
velocity profile (3-D model)

depth-averaged velocity (3-D model)

depth-averaged velocity (2-D model)

Yi Shen, unpubl data, Smith River, VA

Nonsteady flow and importance of velocity shelters



Source: Shields, USACE Waterways Expt Station

Where do we go now?

Who will follow?

Who will get lost along the way?

More Study is Needed

- How to describe and analyze the diverse flow patterns and phenomena in natural rivers?
- How to understand controls on rates of nutrient spiralling and organic matter retention
- Develop a conceptual framework for environmental flow paths and connectivity
- Comparison of multiple risks in short, medium, and long-term frameworks.

Incrementalism, or the **Science of Muddling Through**, holds that:

Narrow range of alternatives and consequences can examined seriously.

- The policy provides a **limited, short-term amelioration** of the problem posed
- *Overhaul* introduces formidable risk
- We prefer a **risk-aversion strategy** which prevents unanticipated and possible irreversible outcome.

Incrementalism Continued

- Not goal *maximizing*, but administrative ***satisficing***, slight improvement as compared with past performance.
- Incrementalism and inaction **consume fewer resources** than a more systemic solution, especially an unproven one.
- Budget concerns dampen enthusiasm for tackling problems on a grand scale.

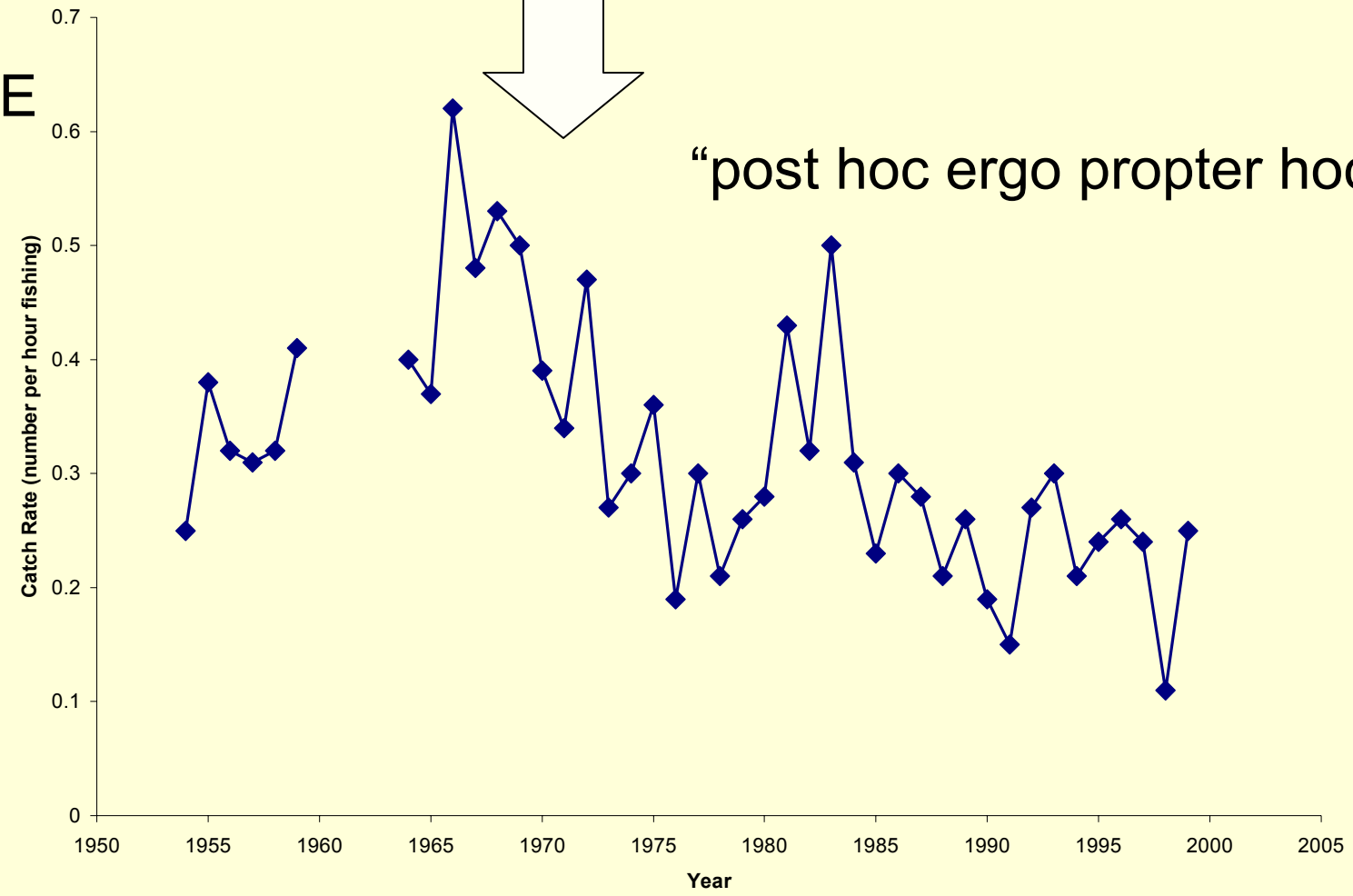
Lindblom, C. 1959. Public Administration Review 19: 79-88. and
Lindblom, C. 1979. Public Administration Review 39 517-526

Expectation

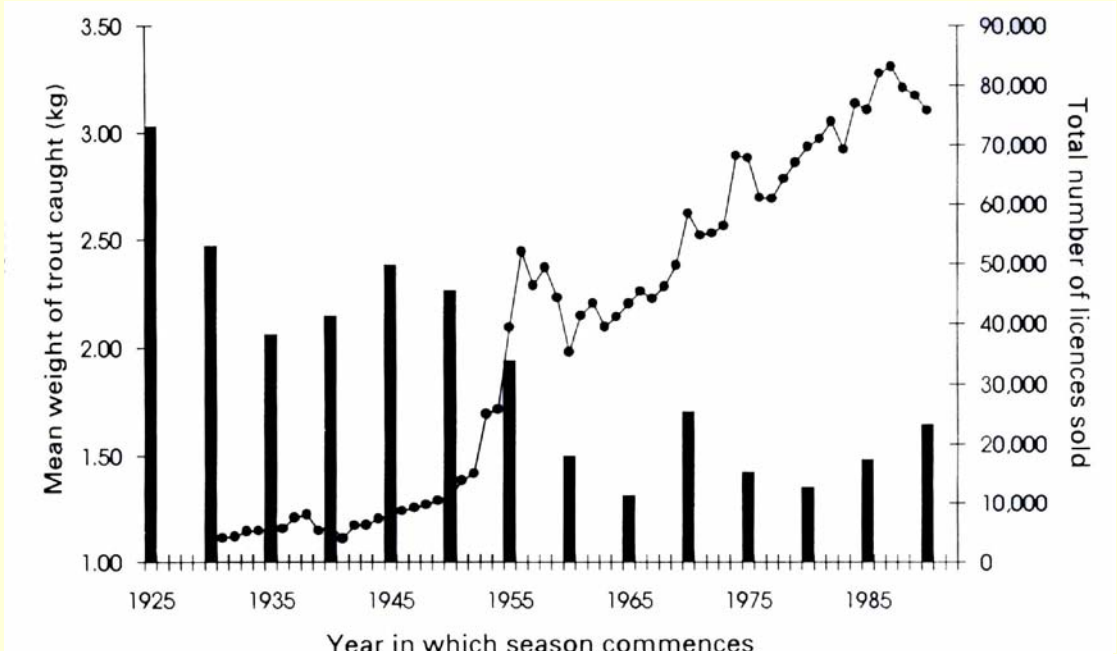
- Adaptive management will not be adopted
- Scientists have not demonstrated the potential benefits to be realized by society
- Expect incremental improvements until we see a revolution in the science of instream flow
- Expect multiple competing hypotheses
- Let’s see some science, for a change

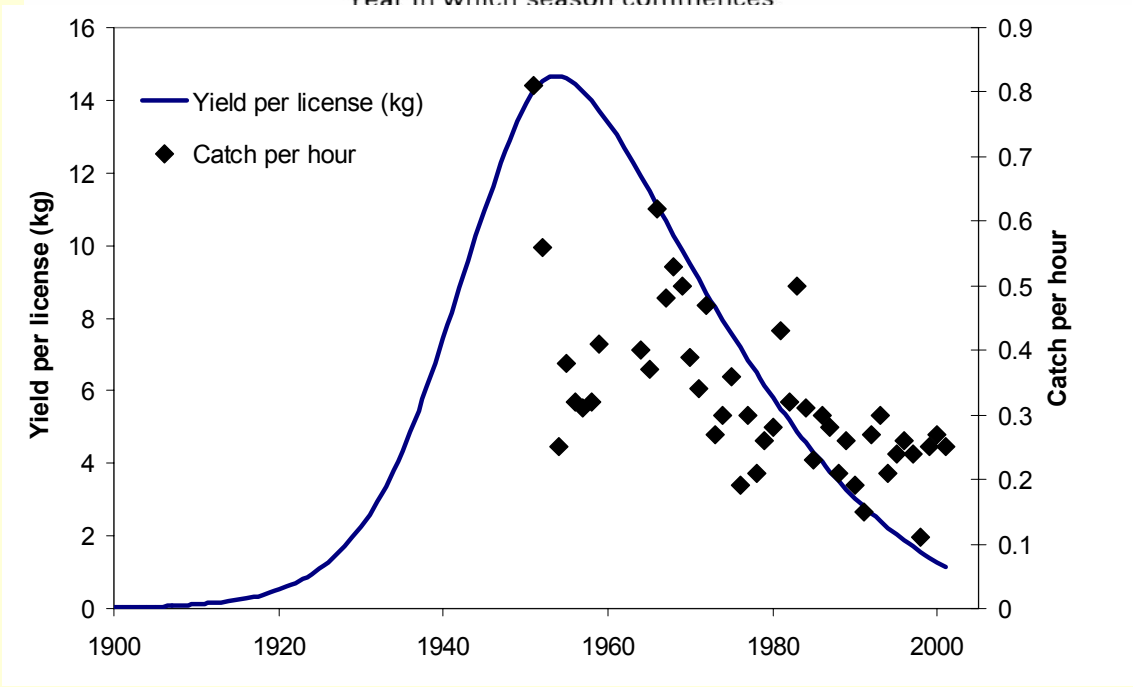
New intake and new flow

CPUE



“post hoc ergo propter hoc

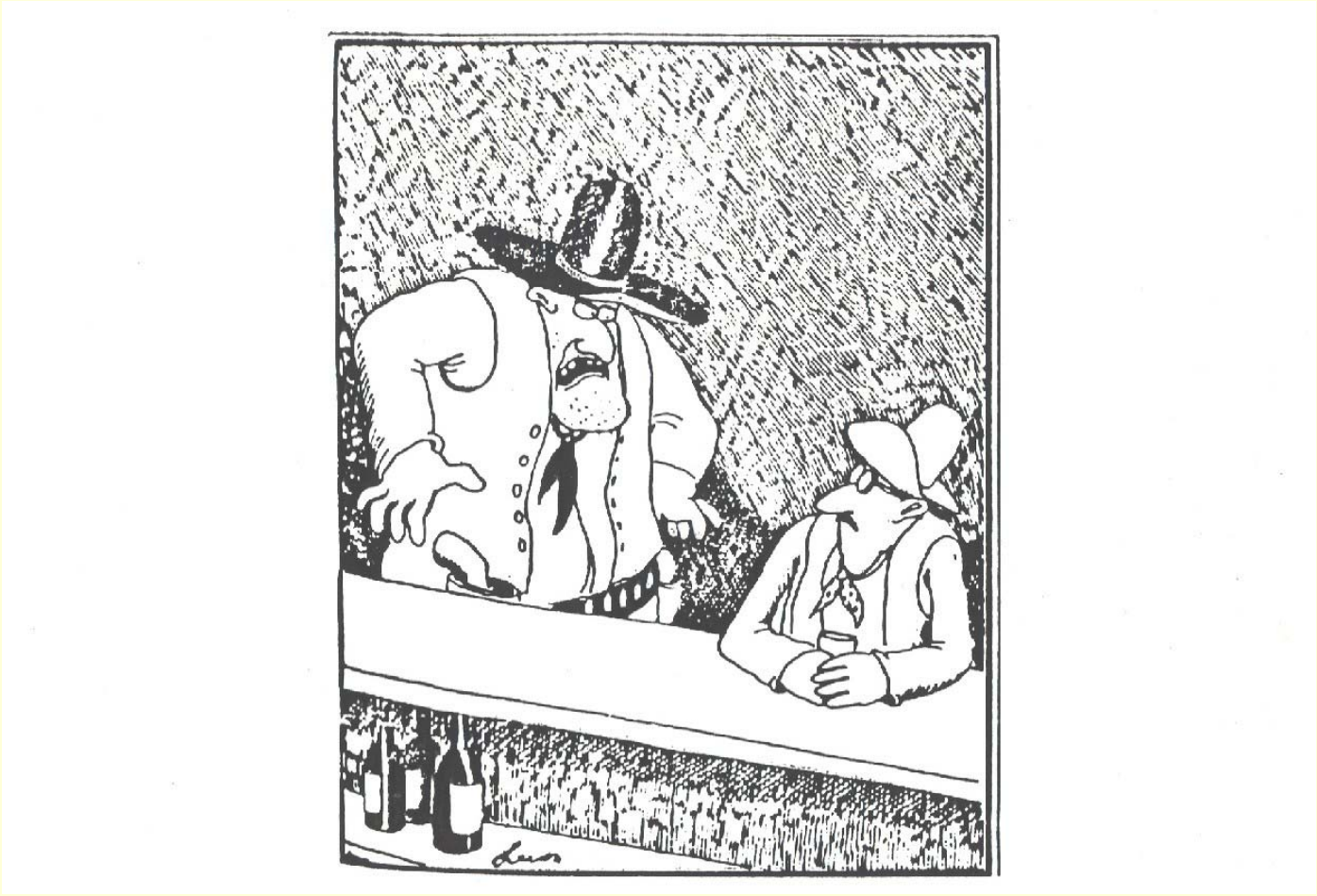

Mean weight of trout caught (kg)
3.50
3.00
2.50
2.00
1.50
1.00
Total number of licences sold
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1925
1935
1945
1955
1965
1975
1985
Year in which season commences


Yield per license (kg)
Catch per hour
Yield per license (kg)
Catch per hour
16
14
12
10
8
6
4
2
0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1900
1920
1940
1960
1980
2000

Final Thoughts

- **Accept uncertainty and admit ignorance**
- **Test provisional hypotheses**
- **Accept of nonscientists around the table**
- **Adopt a precautionary principle because of limits of science**
- **Experience the process without divorcing the scientific issues from the emotional, legal, historical, and political issues**

In Our Dreams…



I asked you a question, buddy. Where are the elements of natural flow in your dam operations?