Freshwater Fish Assemblages of the Delaware Drainage

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Outline

- Short discussion of assessment and sampling, with emphasis on abundance and biomass estimation
- Application to DRWI fish
  - Assemblage structure
  - Patterns of fish biomass
- Before I run out of time, acknowledgement to many members of project team for field and data entry, project management, etc.

Modes of Assessment

	Input	Output	Examples with fish
	Prior models	link to phys-chem	
Pattern (Ordination)	None	post hoc; influence of natural and anthropogenic factors	2 main gradients: stream size and land cover (proxy for anth. Stress)
Indices of biotic integrity	Species groups (trophic, spawning, tolerance, etc.)	Impaired, unimpaired rankings; sometimes stressor specific	Regulatory listing (e.g., NJ)
Indicator or target species (1 or more)	Species characteristics	ad hoc; trend analyses	Trends in harvested fish; trout abundance

Basic Biotic Measures

- Relative abundance
  - Doesn't require complete sample or measurement of area or effort
  - Sensitive to differences in species detection
- Catch per unit effort
  - Index of abundance presumably correlated to total abundance
  - Variety of effort indices
  - Sensitive to differences in species detection
- Abundance and biomass

Each type allows progressively richer analyses

Choice Based on Goals and Balance of Variance Components

(More samples or area)/$

	Relative Abundance	CPUE	Abundance, biomass
Ordination			
IBI			
Indicator, target species			
Spatial & temporal trends			
Ecosystem studies			

Less Bias

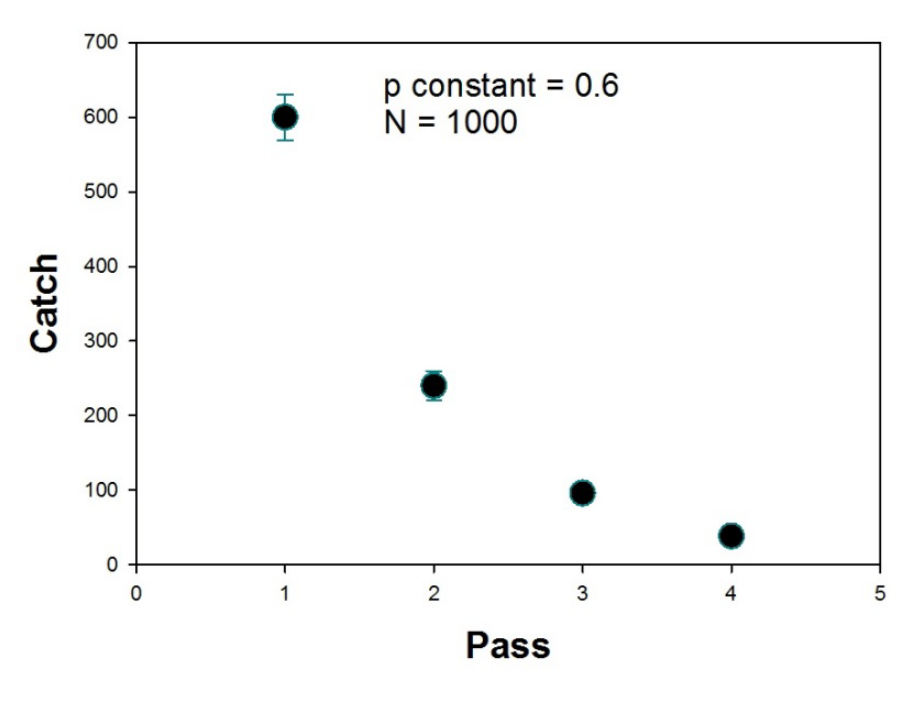
Abundance and Biomass Estimates

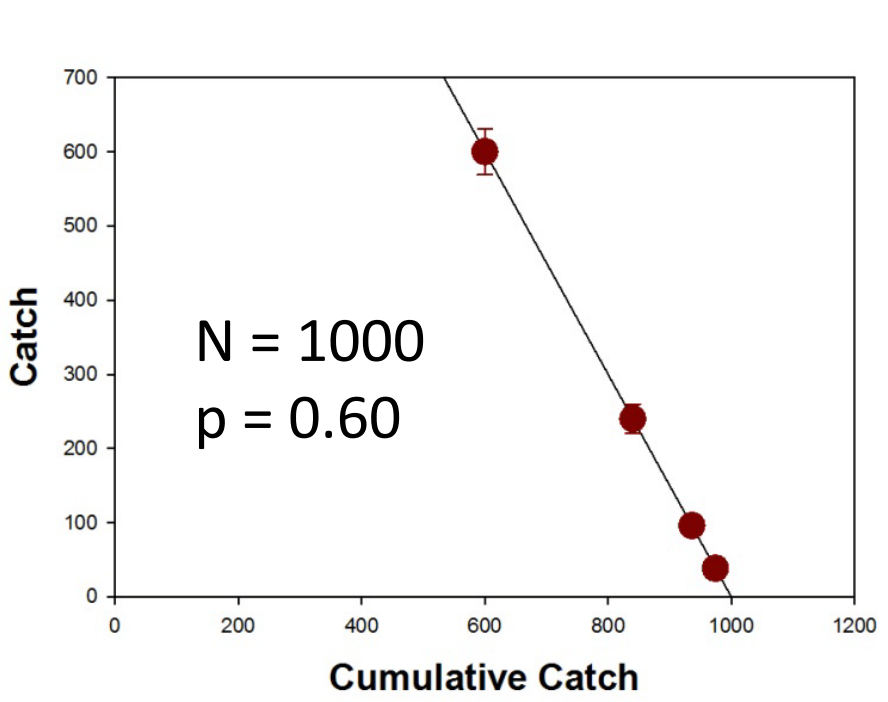
- For sessile or small organisms, can get (nearly) complete samples; need to extrapolate
- For faster organisms, usually need model to estimate detectability
  - Can incorporate differences in site and species-specific detection rates
  - Catch and release
  - **Depletion: used here**
  - Distance-detection models
  - These add model error component

Delaware River Watershed Initiative: Most Elements Capable of Estimating Abundance or CPUE

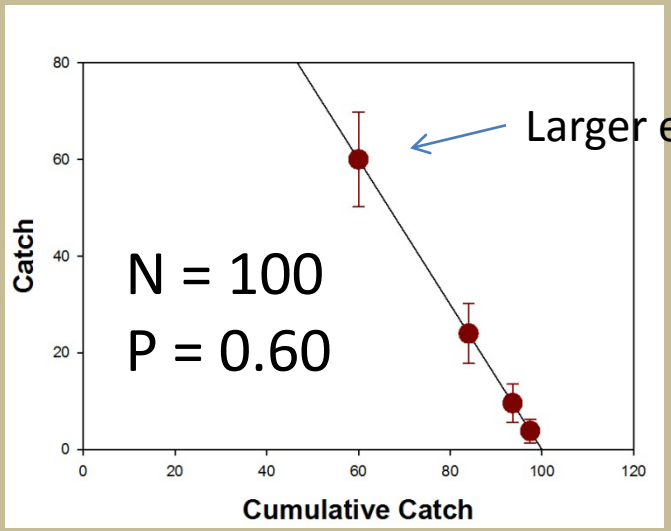
- Fish sampling uses depletion method
- Block reach and do multiple (2-3) passes

Example of Depletion with Fake Data





- Less precision
  - Smaller population
  - Lower detectability



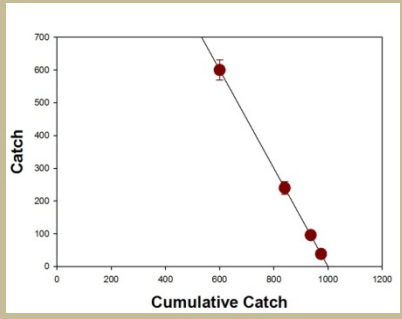
What About Biomass?

- Measure every fish
- Have developed length-weight regressions

  $W = cL^b$ or as linear regression

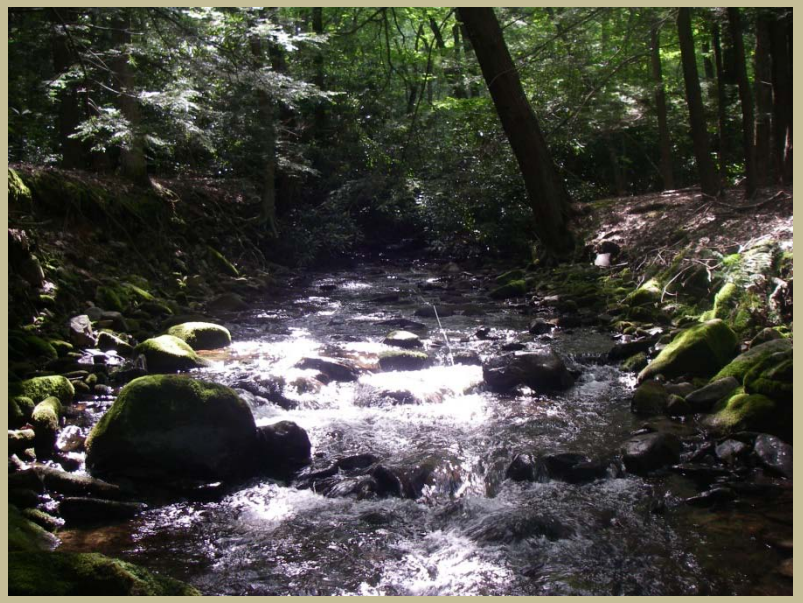
  $\ln W = a + b \ln L$

  Where $a = \ln c$
- Estimate weight of each fish
- Sum over species, etc.
- Investigate use of biomass depletion

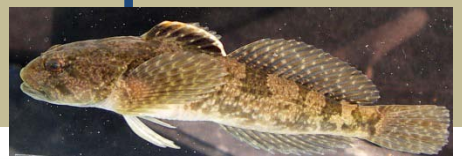


Application to DRWI

- 2013 data
- Generally moderate to large streams; some smaller streams (mostly in upper basin)
- Same sites as other biotic samples



Ordination of 2013 DRWI samples



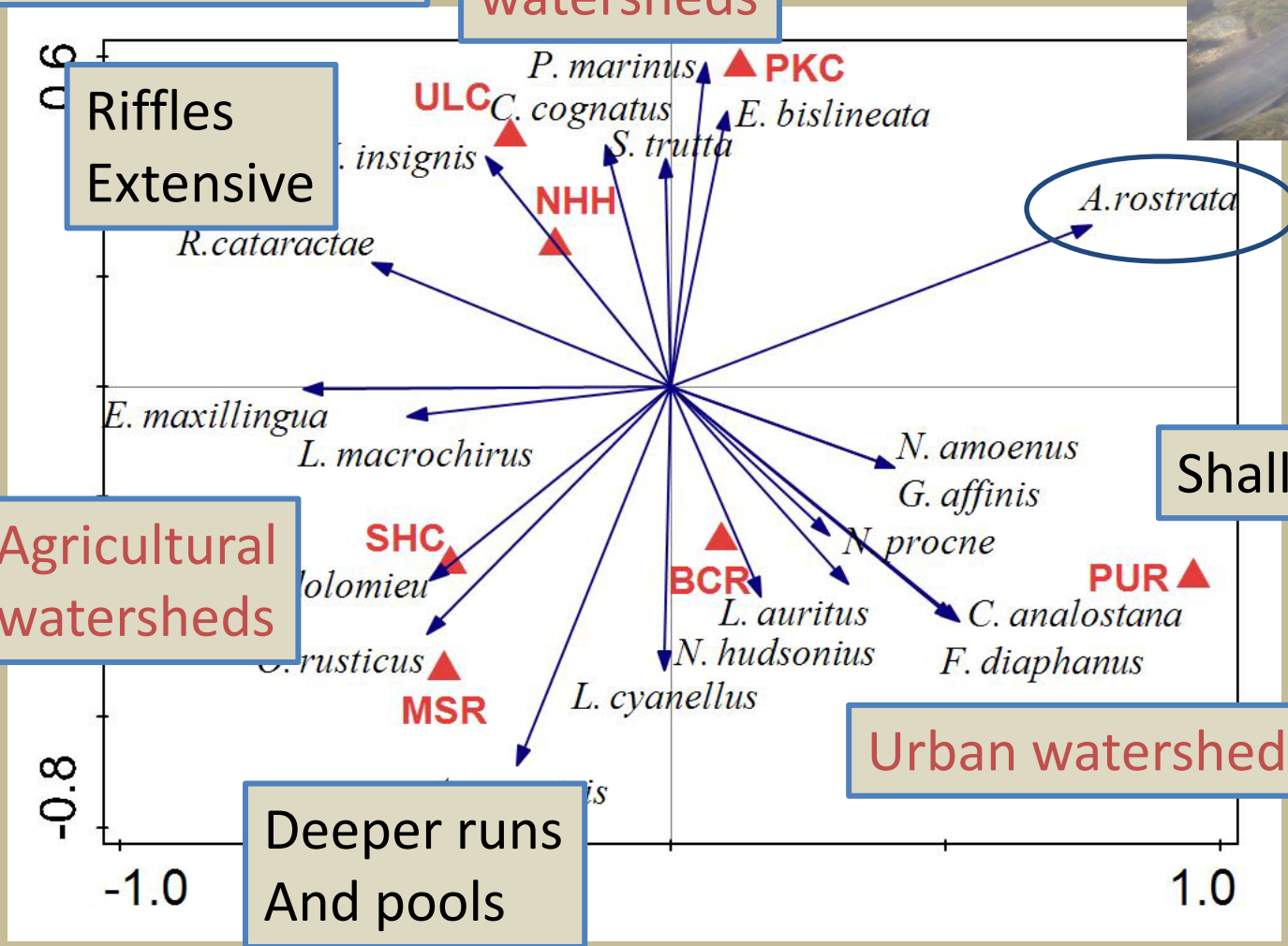
From Species and Cluster Characteristics

Cool or cold water

Forested watersheds

Higher Water quality

Riffles Extensive



Shallow runs

Agricultural watersheds

Urban watersheds

Lower Water quality

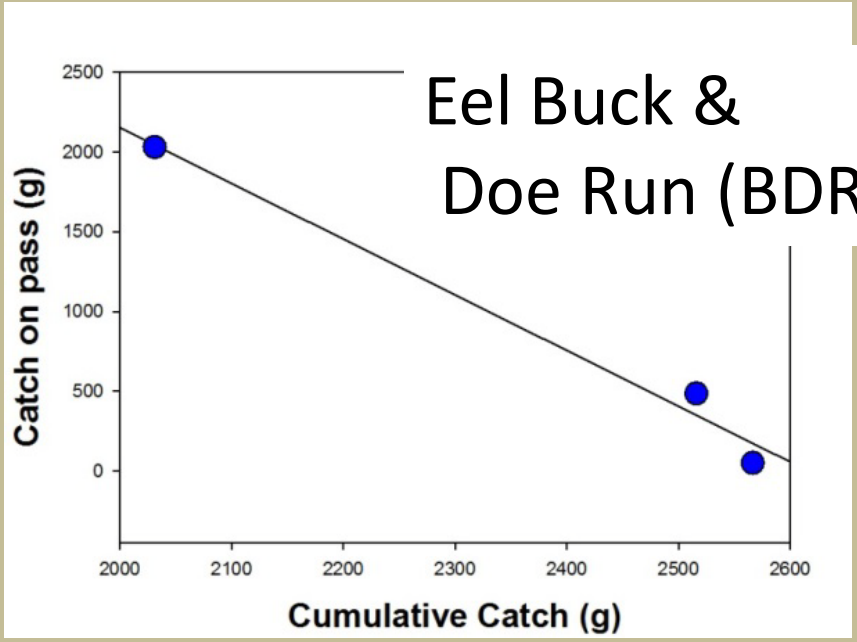
Deeper runs And pools

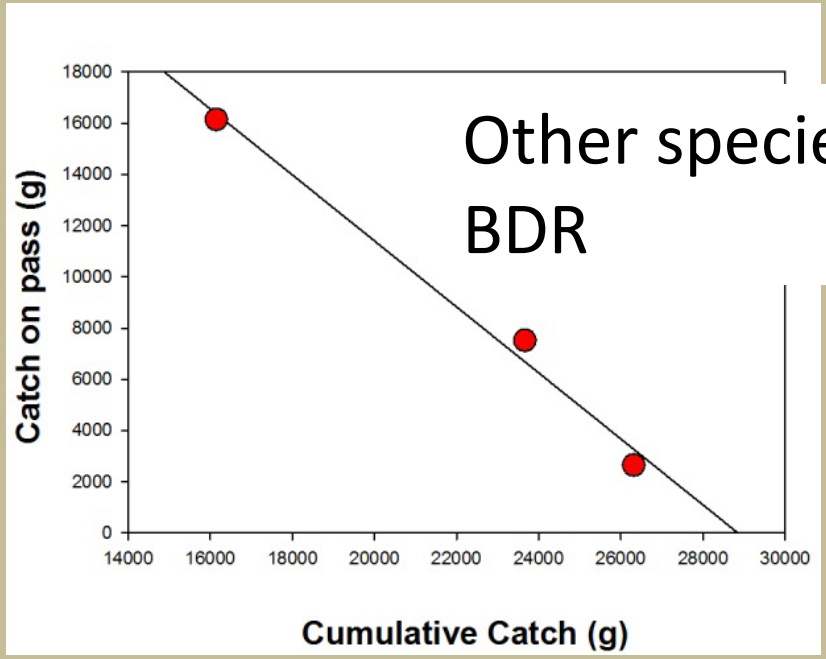
American Eel

- Not well correlated with other species
- Occurrence controlled by passage blocks, e.g.
  - Schuylkill River (partial)
  - Musconetcong
  - Paulinskill
  - Lehigh

American Eel Biomass

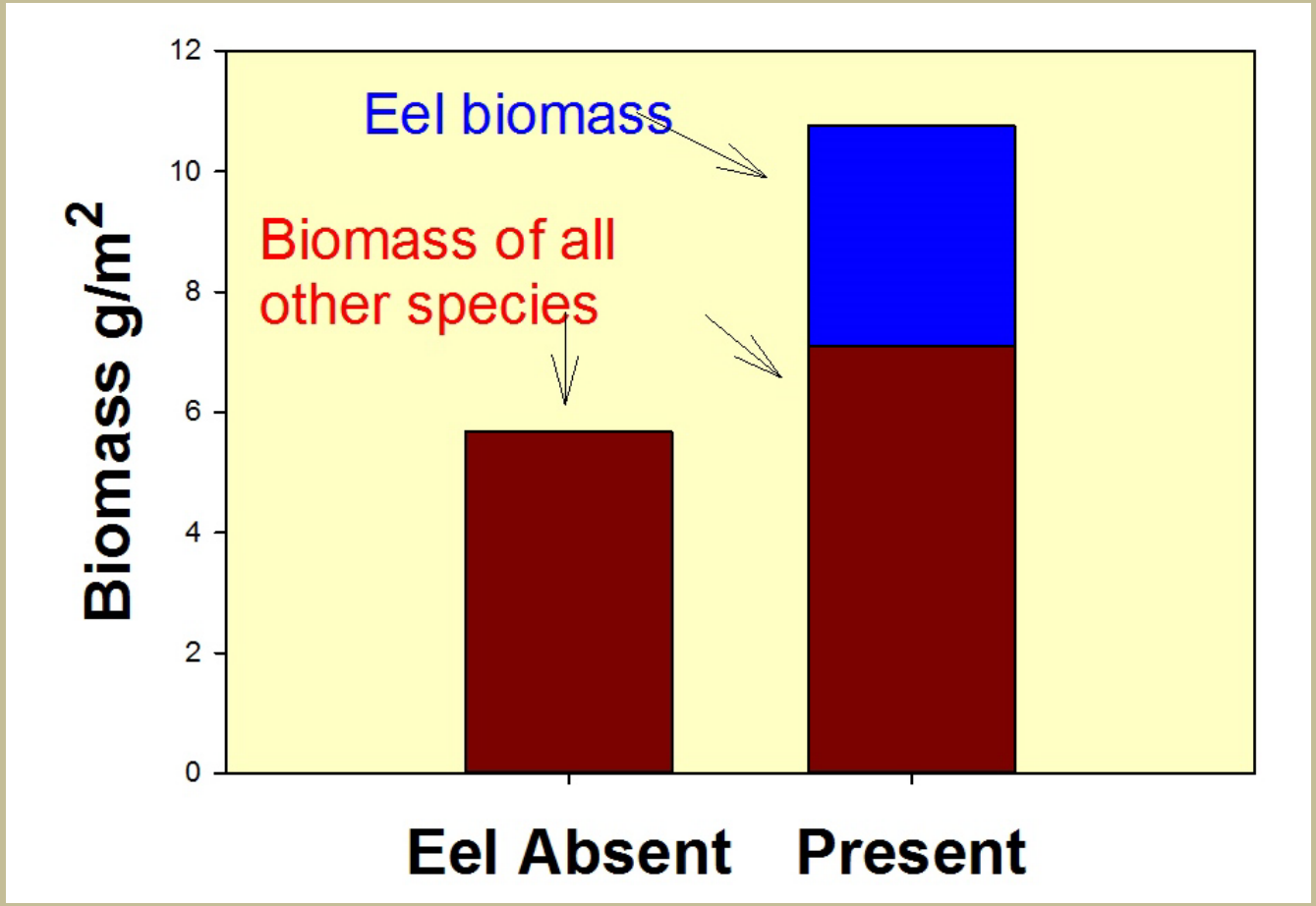
- Biomass depletion usually worked very well for eel; similar or somewhat less for other species
- Where present, eels comprise large part of total biomass: median of 33% of total (range 2 – 78%)



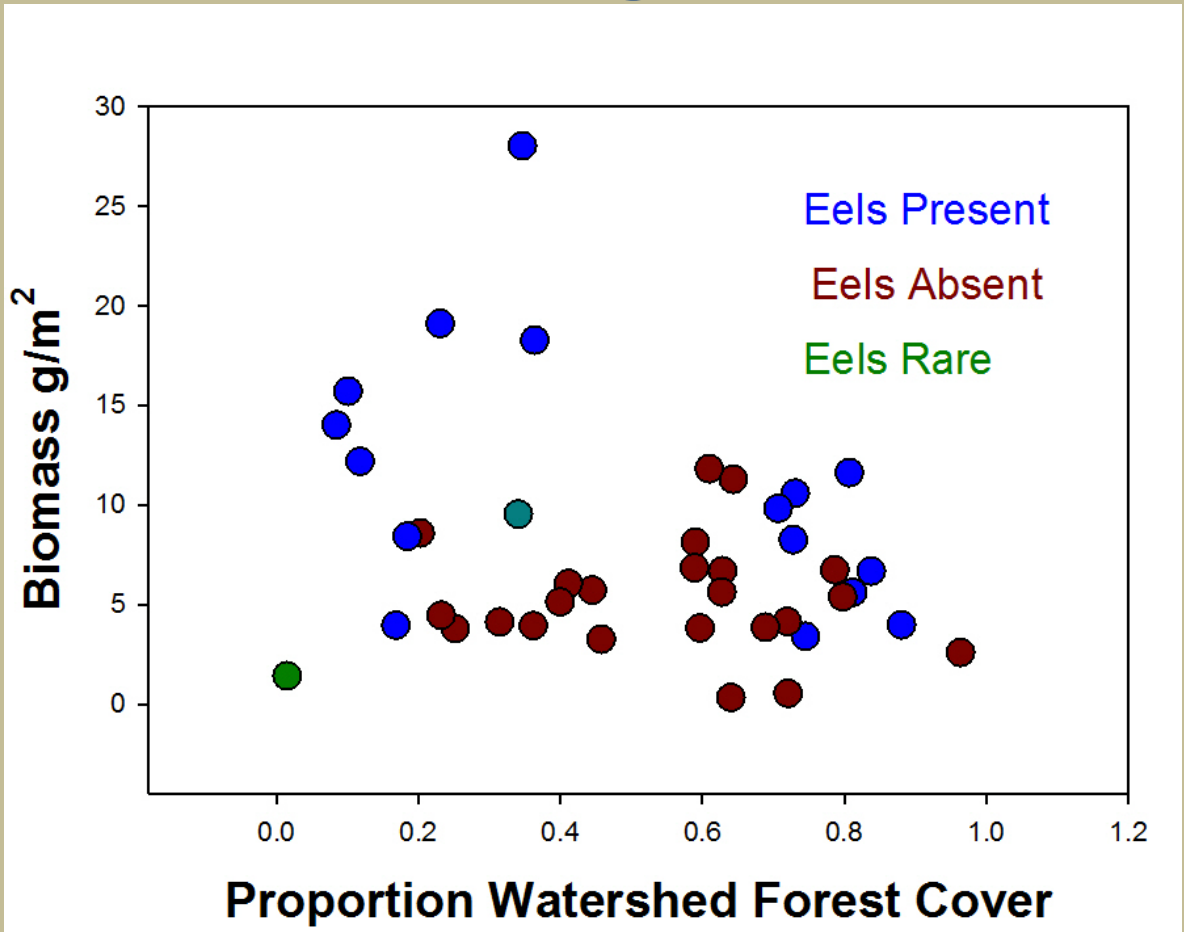


Biomass of eels and other species

- Biomass of other species similar in streams with and without eels
- Biomass of other species doesn't increase when eel absent
- Lots of variability

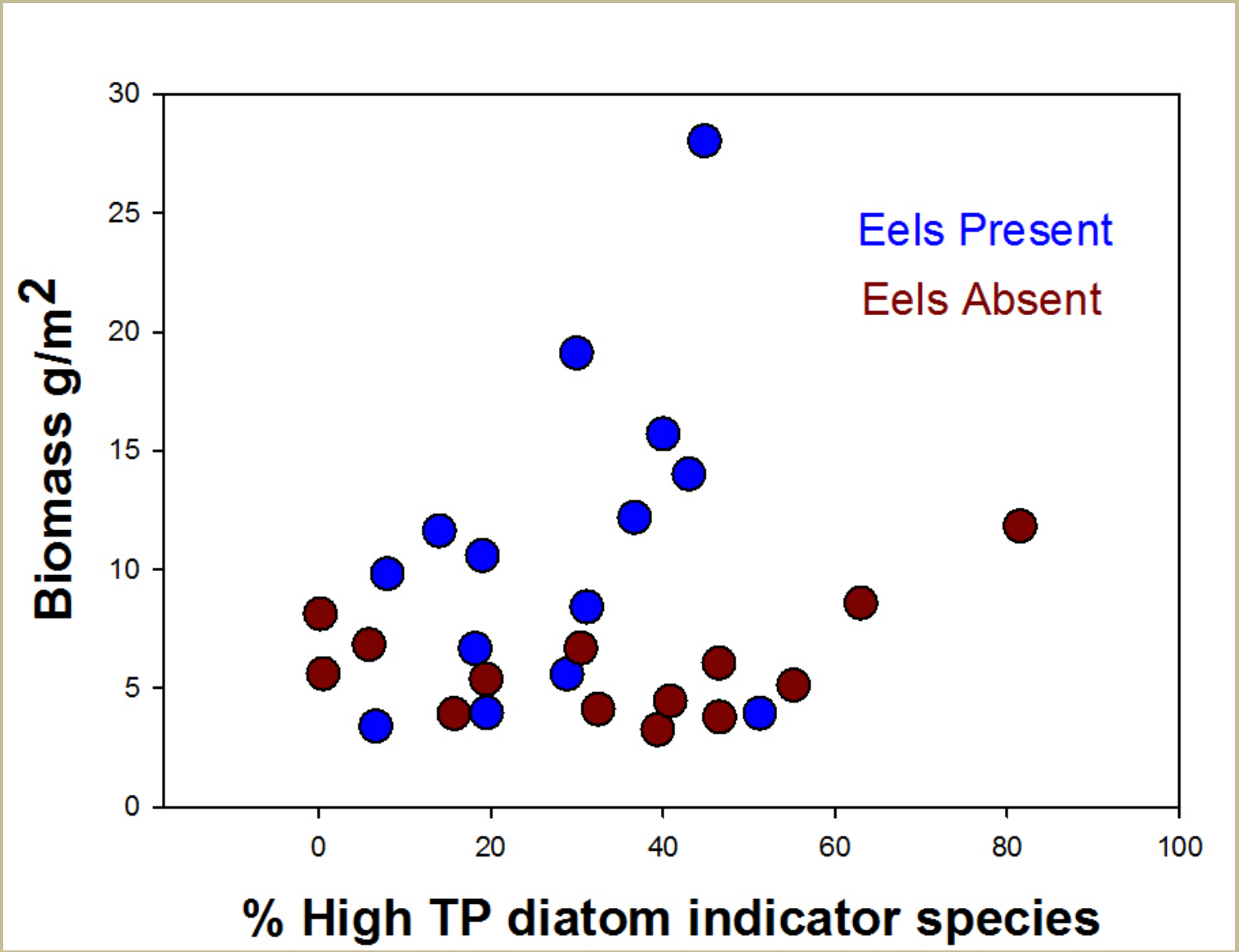


Forest Cover surrogate for Nutrient



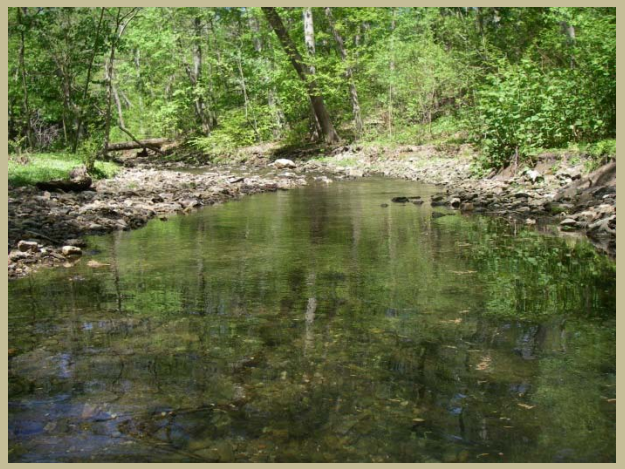
- In small, highly forested watersheds, total abundance similar with and without eels (eels low biomass in these)
- In ag or urban watersheds, increased biomass largely driven by eel abundance

Patterns differ across nutrient gradient



Possible explanations

- Eel fills niche other species can't fill?
- Eel as predator: Many predator-prey model indicate that increase of productivity of lower trophic level translates to higher predator standing crop
- Increase in other taxa (crayfish)?



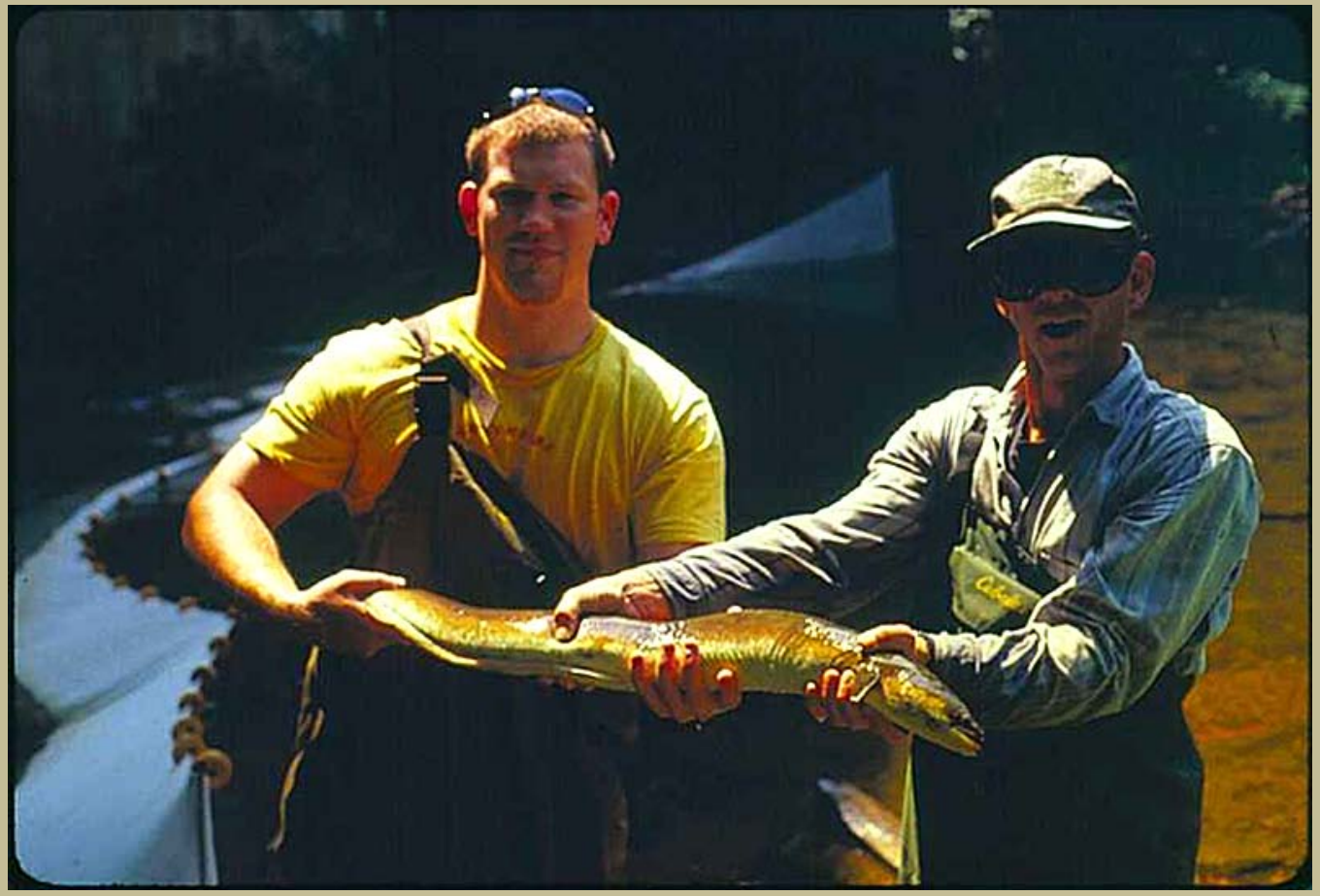
Early Conclusions

- Fish assemblages of DRWI show gradients related to stream size, habitat and disturbance
- American eel shows somewhat different pattern
  - Rare or absent above large dams, falls
  - Absent from some upper drainage sites without obvious blocks
  - Eels have higher biomass in agricultural and urban streams and in larger streams
- Where found, eel comprise important part of biomass: median of 33% of total biomass

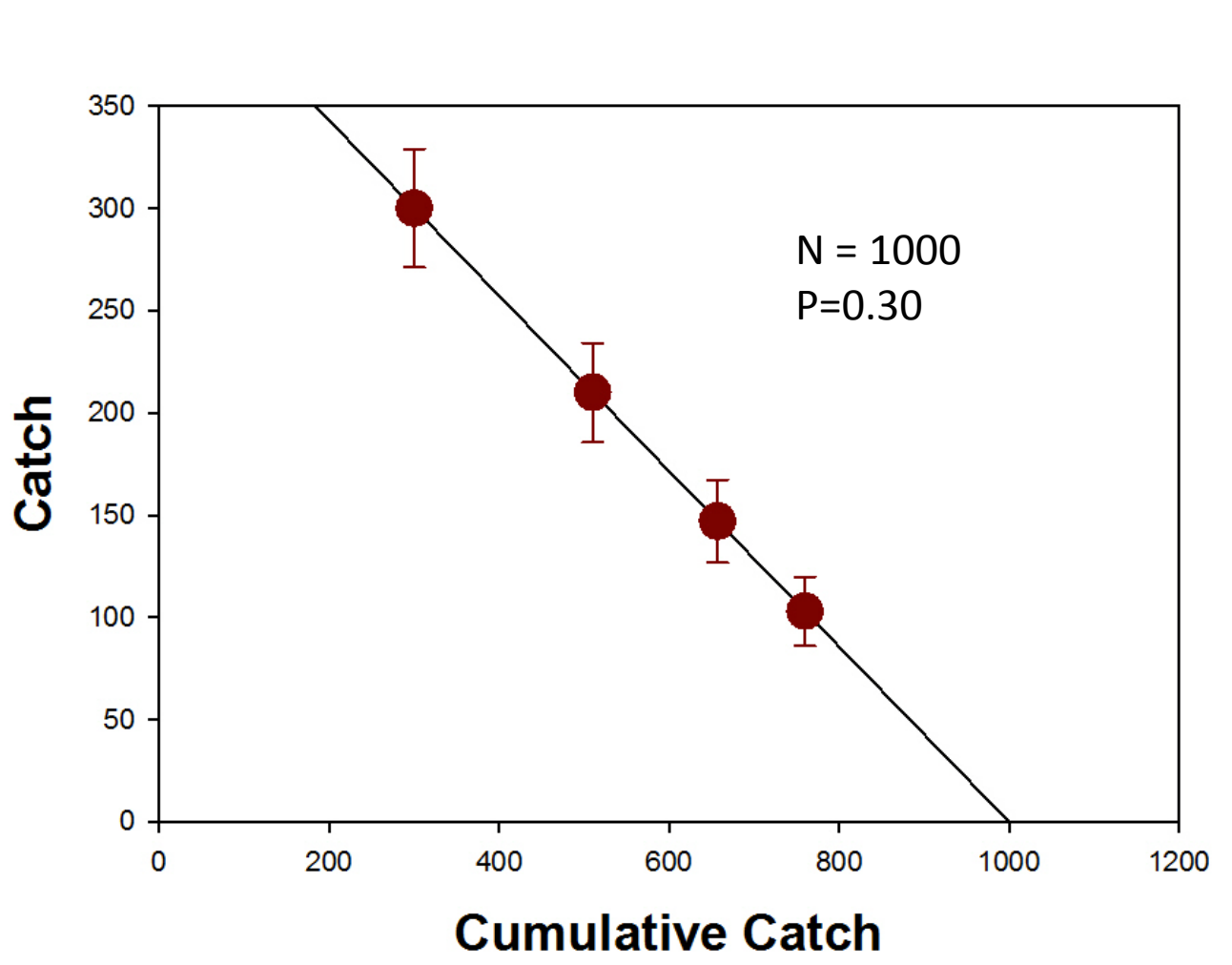
Response of other Species to presence and absence of eels

- In smaller, higher quality streams (less nutrient, forested watersheds), eels less abundant and total biomass similar in streams with and without eels
- In more disturbed streams, biomass of other species is similar in streams with and without eels
  - Other species don't increase biomass when eels absent
  - Could interpret that much of additional biomass supported by higher nutrient inputs goes to eels

Questions?

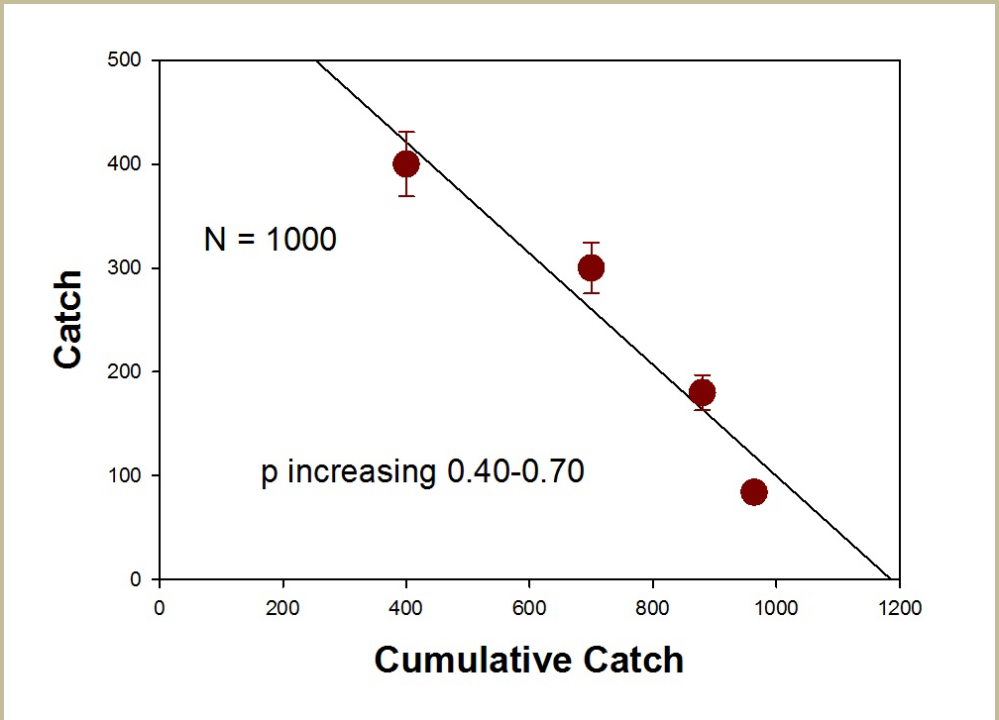


Works with Lower Effectiveness



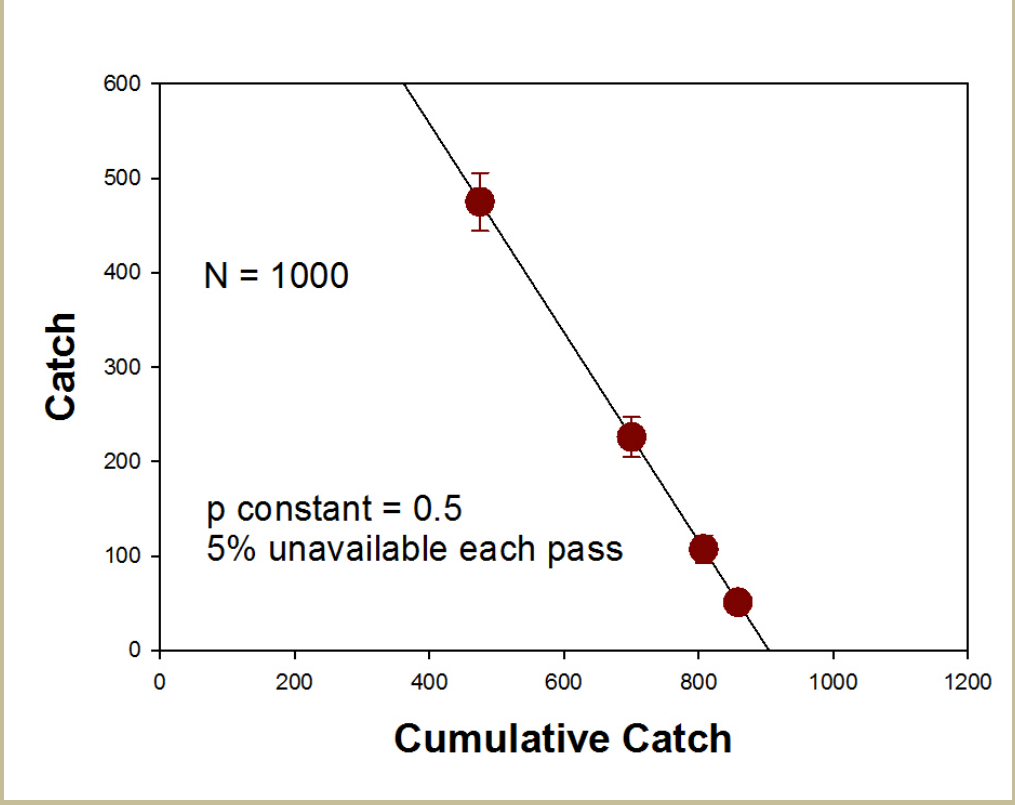
What if Assumptions Violated?

- If probability of capture increases with each pass
  - Line overestimates
  - Effect evident, can be corrected

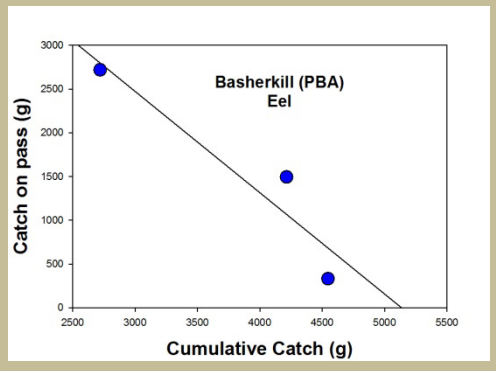


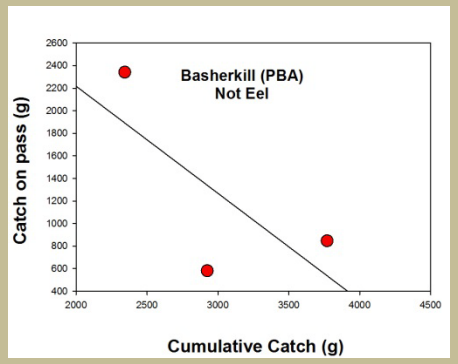
But

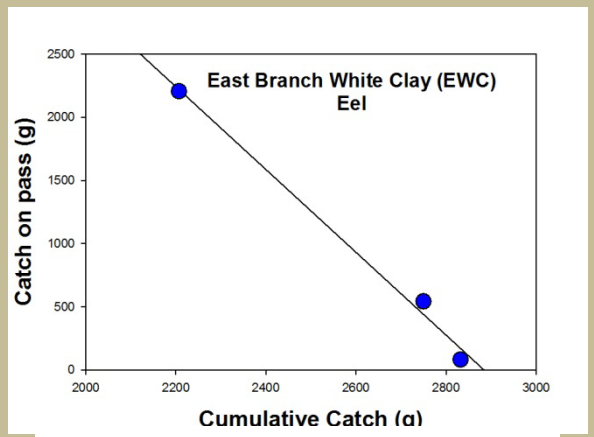
- What if some fraction can't be caught?
  - Underestimate population
  - Not as obvious

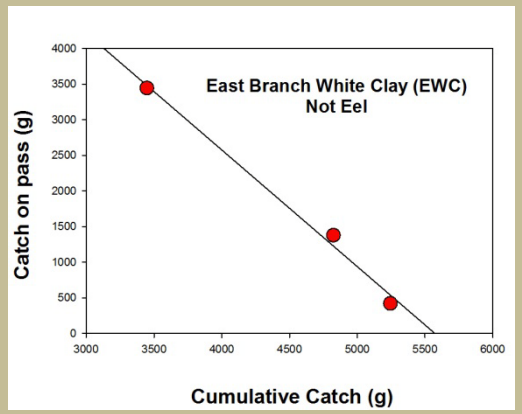


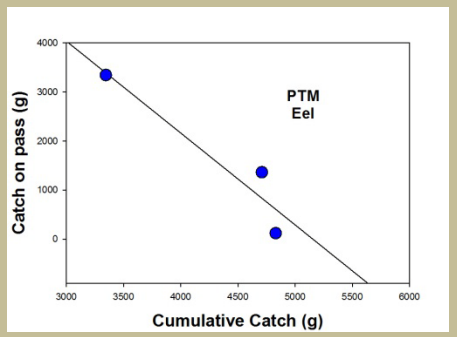
Examples of DRWI biomass depletion

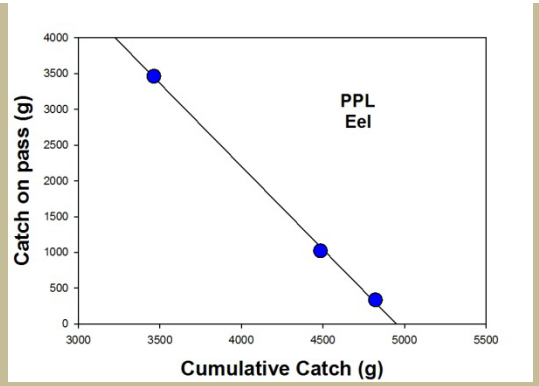


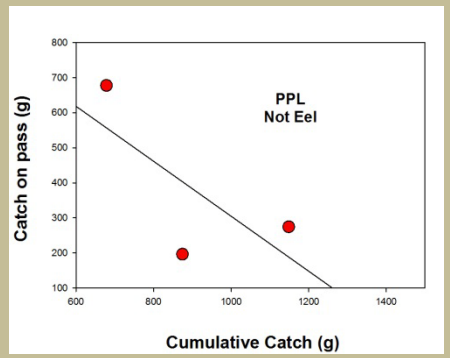


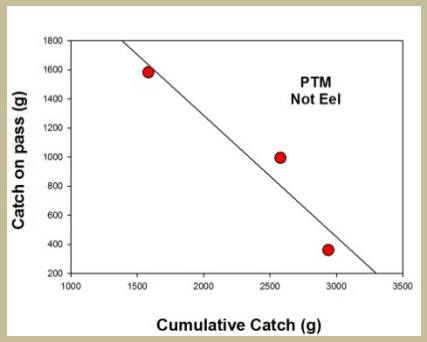


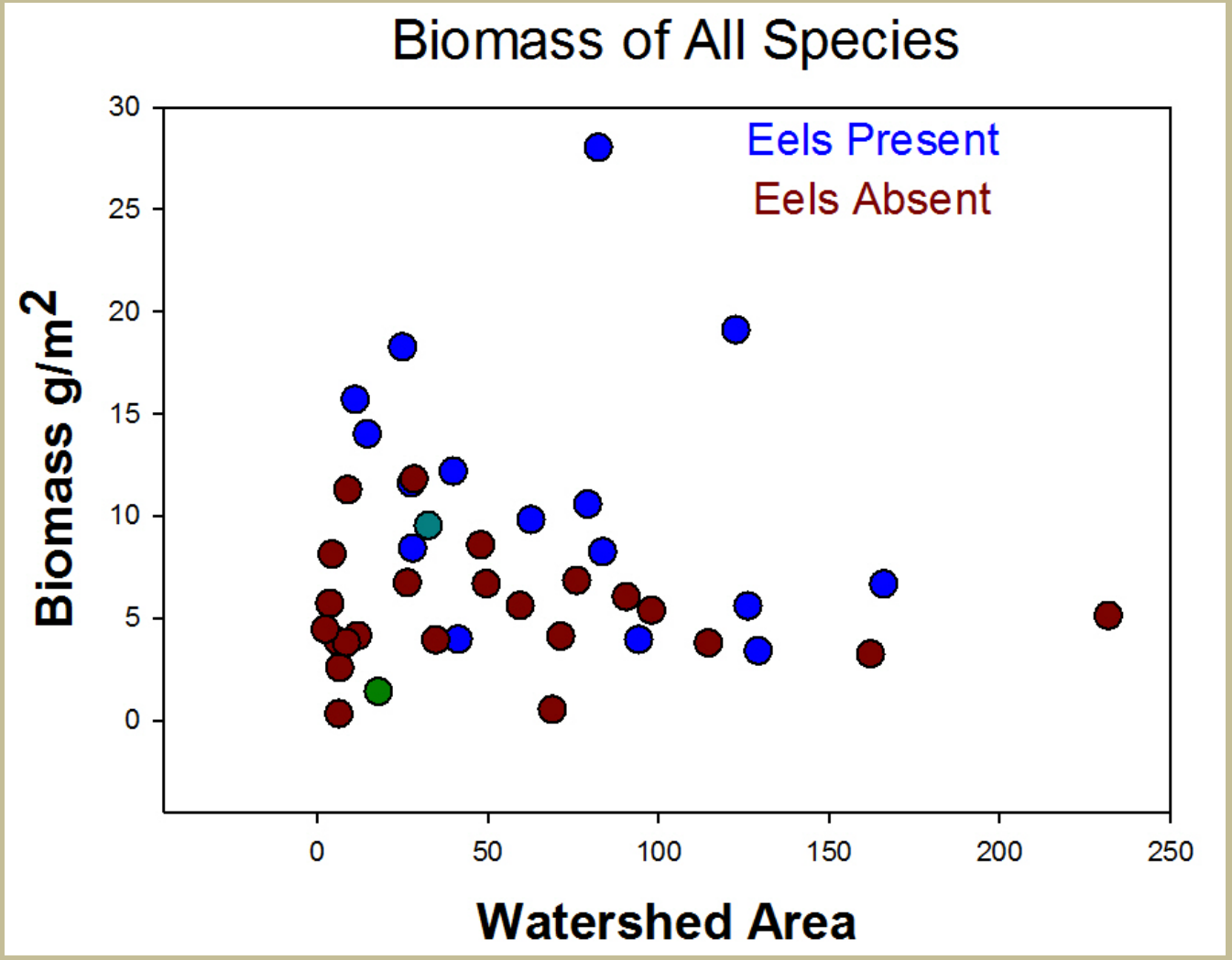


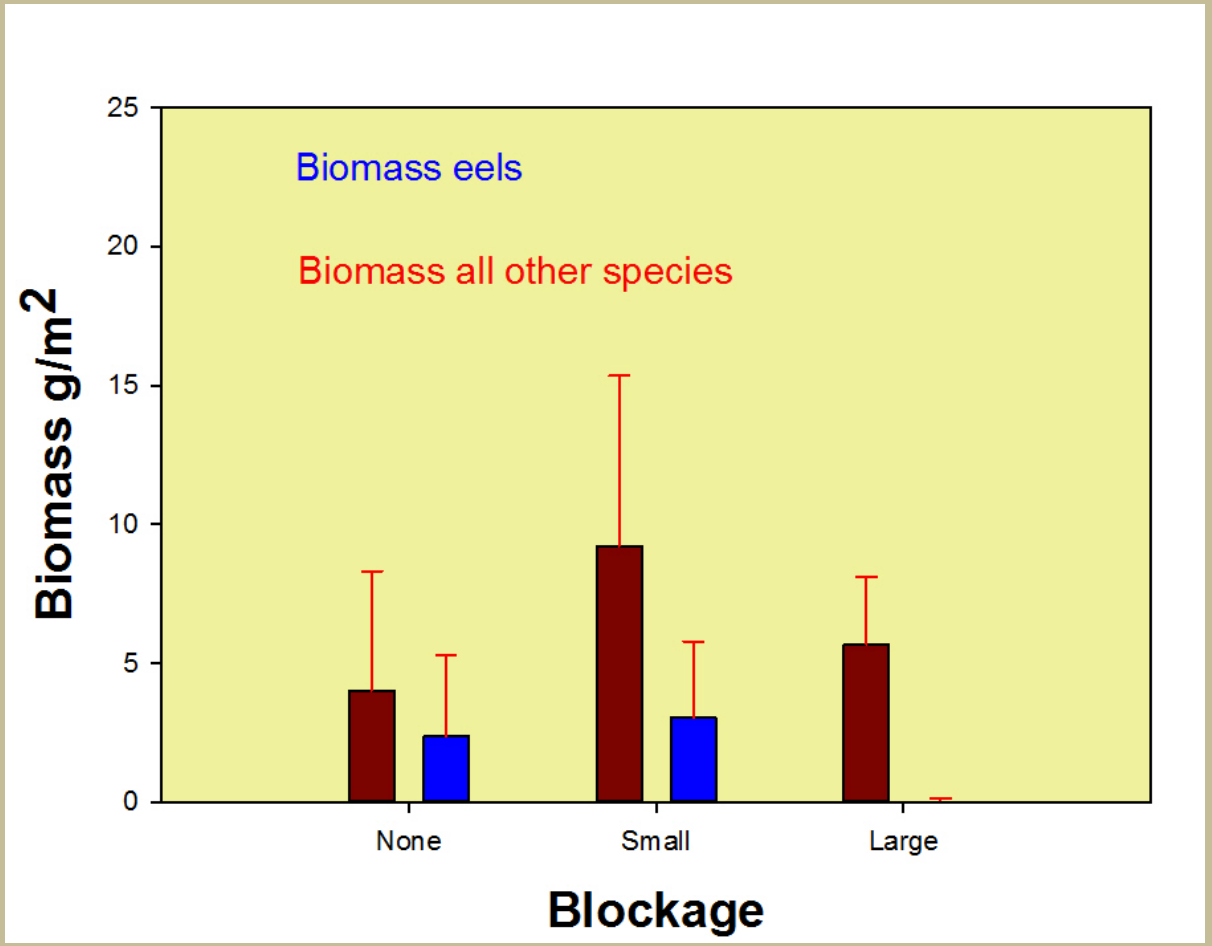









Biomass of All Species
Eels Present
Eels Absent
Biomass g/m2
30
25
20
15
10
5
0
0
50
100
150
200
250
Watershed Area


Biomass eels
Biomass all other species
Biomass g/m2
25
20
15
10
5
0
None
Small
Large
Blockage