

Predation of Alosa Species by Non-native Catfish in Virginia's Tidal Rivers

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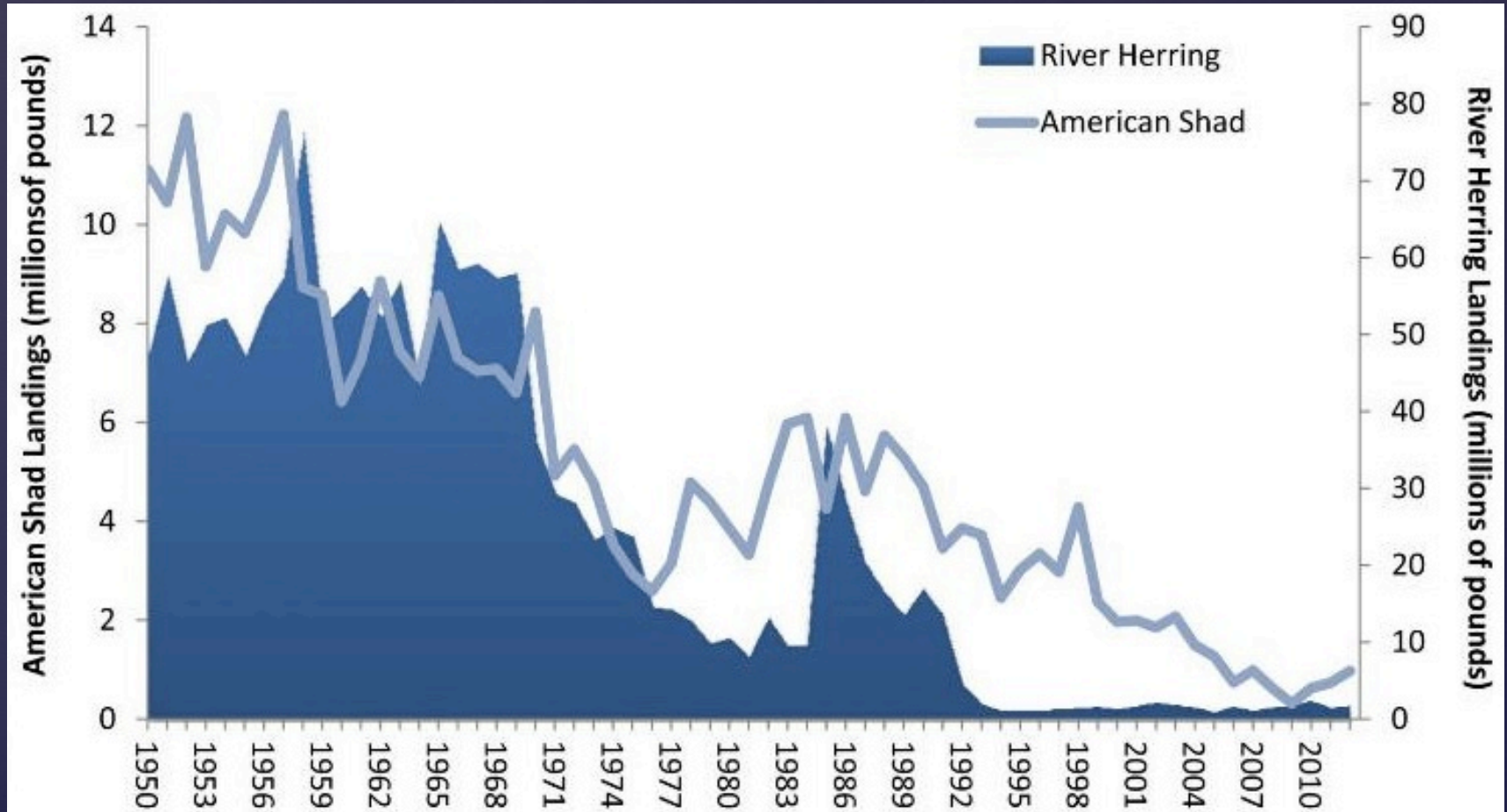
Background

What is the impact of blue and flathead catfish on *Alosa* species?

- During the spring
- Also, as juveniles migrate downriver during the fall
 - *Data has been collected on James, York, and Rappahannock*



Background



Declining American Shad and River Herring fisheries (ASMFC).

Objectives

1.) Quantify predation of Alosa species during the spring

2.) Determine whether or not blue & flathead catfish are selectively feeding on Alosa species

3.) Determine if Alosa predation varies spatially

Very limited information on the diet of fish > 600 mm particularly during the spring

There are no **published** accounts of flathead catfish food habits in Virginia's tidal rivers



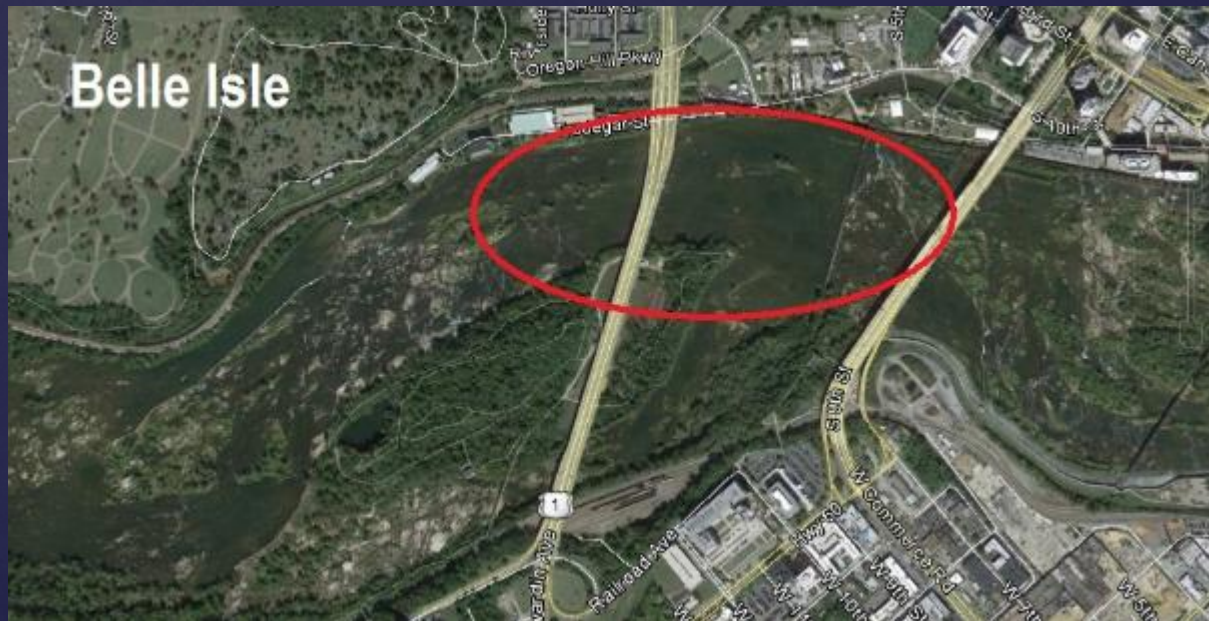
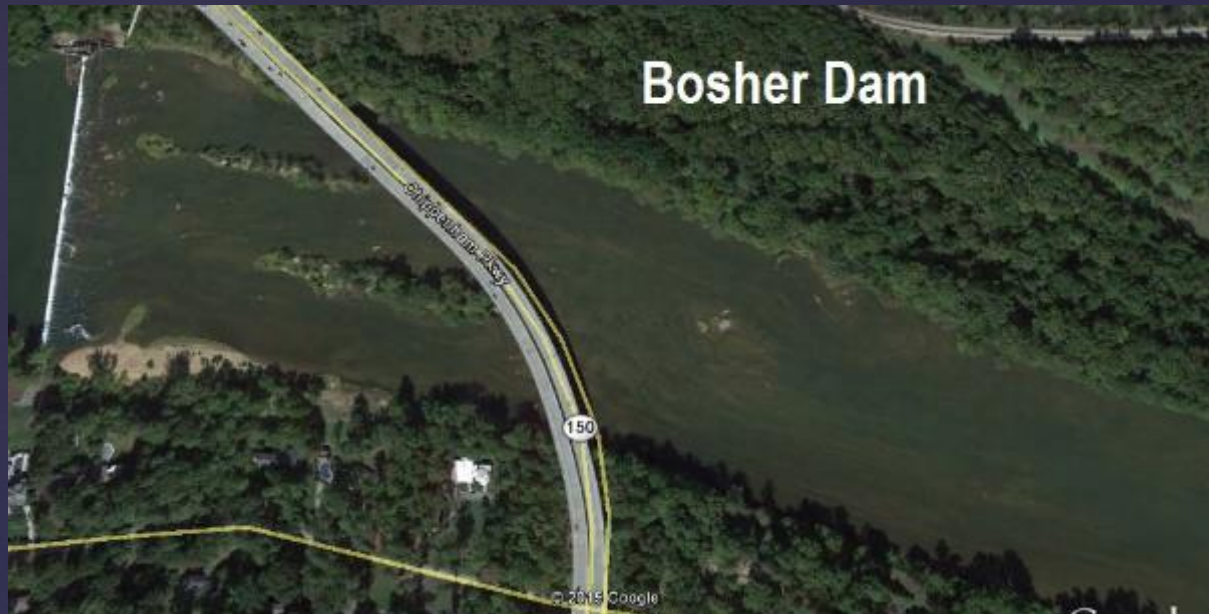
Methods

- 20 km section below fall line on James River
 - *Alosa* species congregate here
- Sampled March – May, as this corresponds with the Anadromous spawning run
- Random sampling design
 - Rivers divided into 0.5 km sections
 - Random site selection
- High-frequency electrofishing for most of the time (LF ineffective in temps < 18 C; Bodine and Shoup 2010)



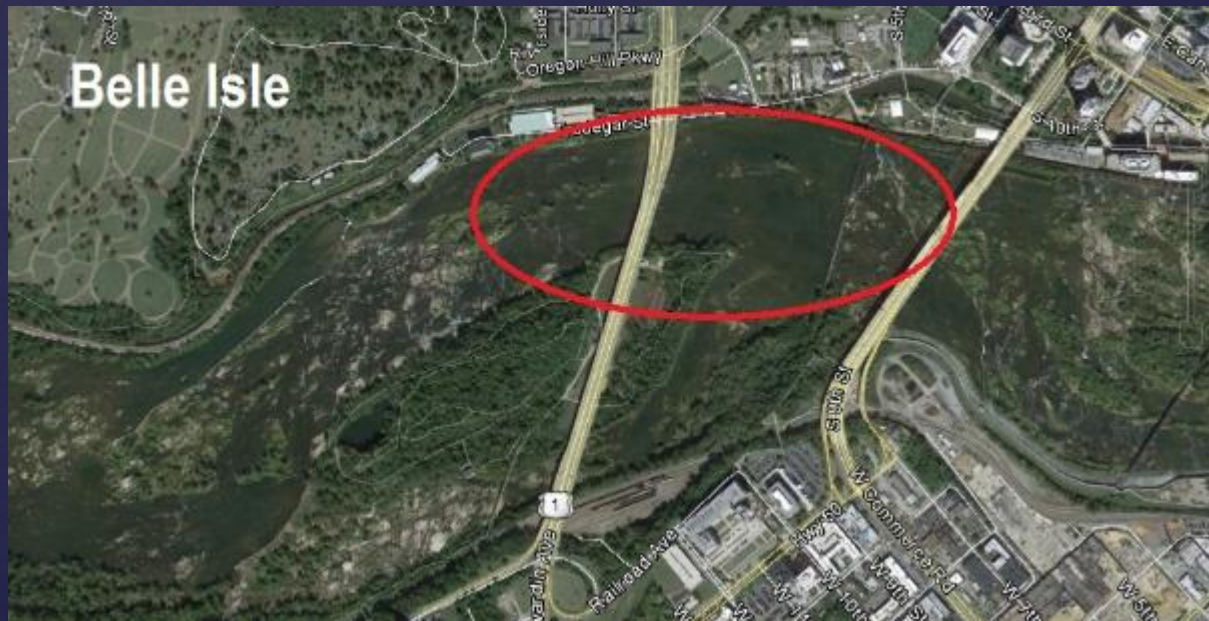
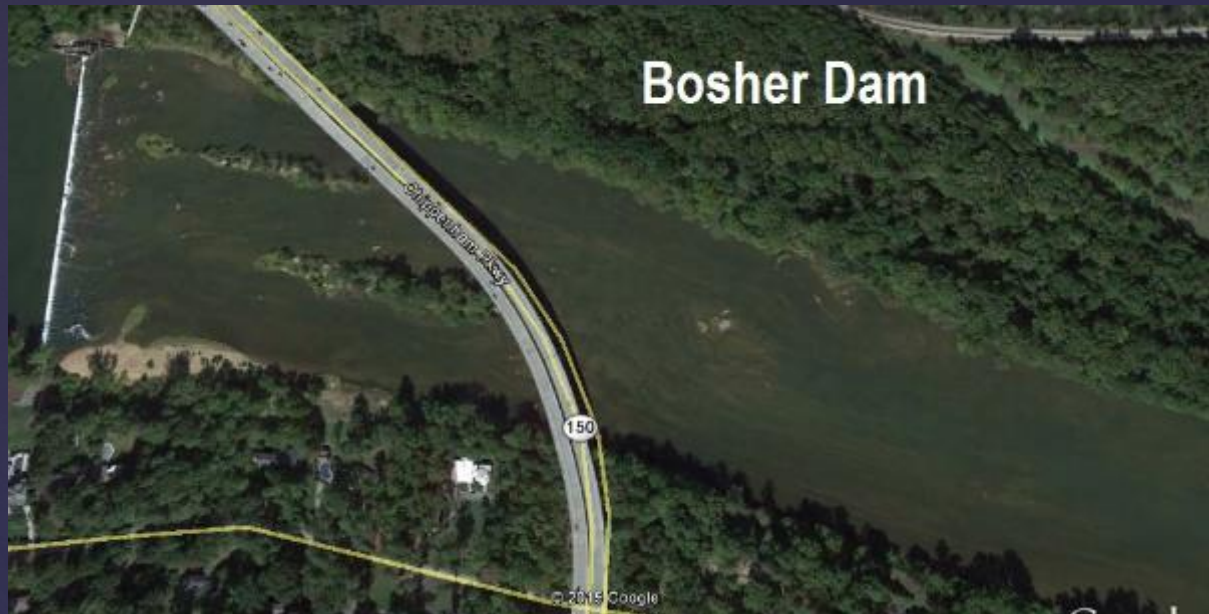
Catfish were also sampled in areas known to hold Alosines in the spring:

- Bosher Dam
- Belle Isle
- Gordon Creek
- Herring Creek
- Ward Creek



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- Coordinates, tide phase, fish length, fish weight, temp recorded for each site/fish
- Diet items extracted using pulsed gastric lavage (Waters et al. 2004)
 - 95% by weight for BCF
 - we tested our extraction efficiency by sacrificing 104 fish

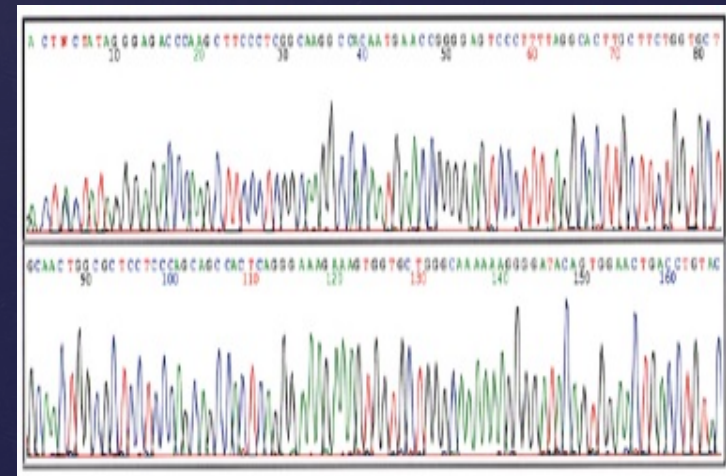
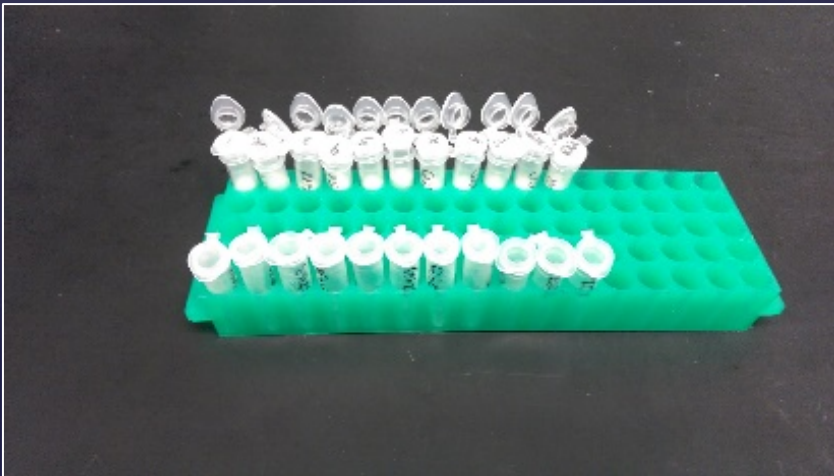
*100% efficiency in 103 out of 104 fish;
efficiency exceeds 99.89% by weight*

Diet items were then bagged, placed on ice, and later frozen.



Extracting diet contents from a large Blue Catfish.

- In the lab, diet items are weighed, counted, and identified to lowest possible taxon
- Partially digested fish remains were identified via DNA barcoding using methods similar to Carreon-Martinez et al. (2011)
- 70 – 80% success identifying samples that still had tissue
- Read more: [Moran et al. 2015](#)



Diet analysis- ontogenetic diet shifts

- Prey items grouped into sensible ecological groupings
- BCF placed into 100 mm length groupings (FCF = 100% piscivorous)
- ANOVA, Tukey's HSD used to determine ontogenetic shifts in %W of major prey categories



Diet analysis – ontogenetic diet shifts

- Proportion by weight data logit transformed; more appropriate than the arcsine transformation (Warton and Hui 2011)
- After transformation, Levene's test indicated homogeneity of variance
- Shapiro-Wilk tests indicated non-normality for some of the diet data; however, ANOVA is robust to normality assumption (Zar 1999)

Relative Importance of Prey Items

- Prey-specific index of relative importance (Brown et al. 2012) was used to determine the relative importance of routinely encountered fish prey
 - *Better than the index of relative importance (IRI), which combines mathematically dependent measures (Brown et al. 2012)*
- Calculated as:

$$\%PSIRI_i = \frac{\%FO_i \times (\%PN_i + \%PW_i)}{2}$$

Where %FO is the percent frequency of occurrence, %PN is the prey-specific percent by number, and %PW is the prey-specific percent by weight

Blue and Flathead Catfish Feeding Selectivity

- Proportion of prey in the environment to Proportion in diet
- *Are non-native catfish actively selecting for Alosa species or are they just feeding on them relative to their abundance in the environment?*
- Relative abundance of teleost prey
 - 60 random sites within 20 km sampling reach
 - Three 120 s passes
 - 30 sites sampled in April; compared to diets from same area in April
 - 30 sites sampled in May; compared to diets from same area in May

Blue and Flathead Catfish Feeding Selectivity

We elected to use Chesson's index (1978) as it has been recommended in most situations (Chipps and Garvey 2007).

Calculated as:

$$\alpha_i = \frac{r_i / p_i}{\sum_{j=1}^m (r_j / p_j)},$$

Where r_i is the percent of a prey taxon in the diet, p_i is the percent available in the system, and r_j and p_j are these values for all fish prey

Index ranges from 0 – 1; with random feeding occurring at $1/m$

Spatial Analysis

We modeled the binary occurrence (1=presence, 0=absence) of *Alosa* species in the diet of blue catfish by spatial location:

- Freshwater Tidal, Freshwater Non-tidal, Herring Creek, Ward Creek, Gordon Creek

Generalized Linear Model with a logit link function and a binomial distribution (JMP 11.0; SAS Institute)



What are they eating?



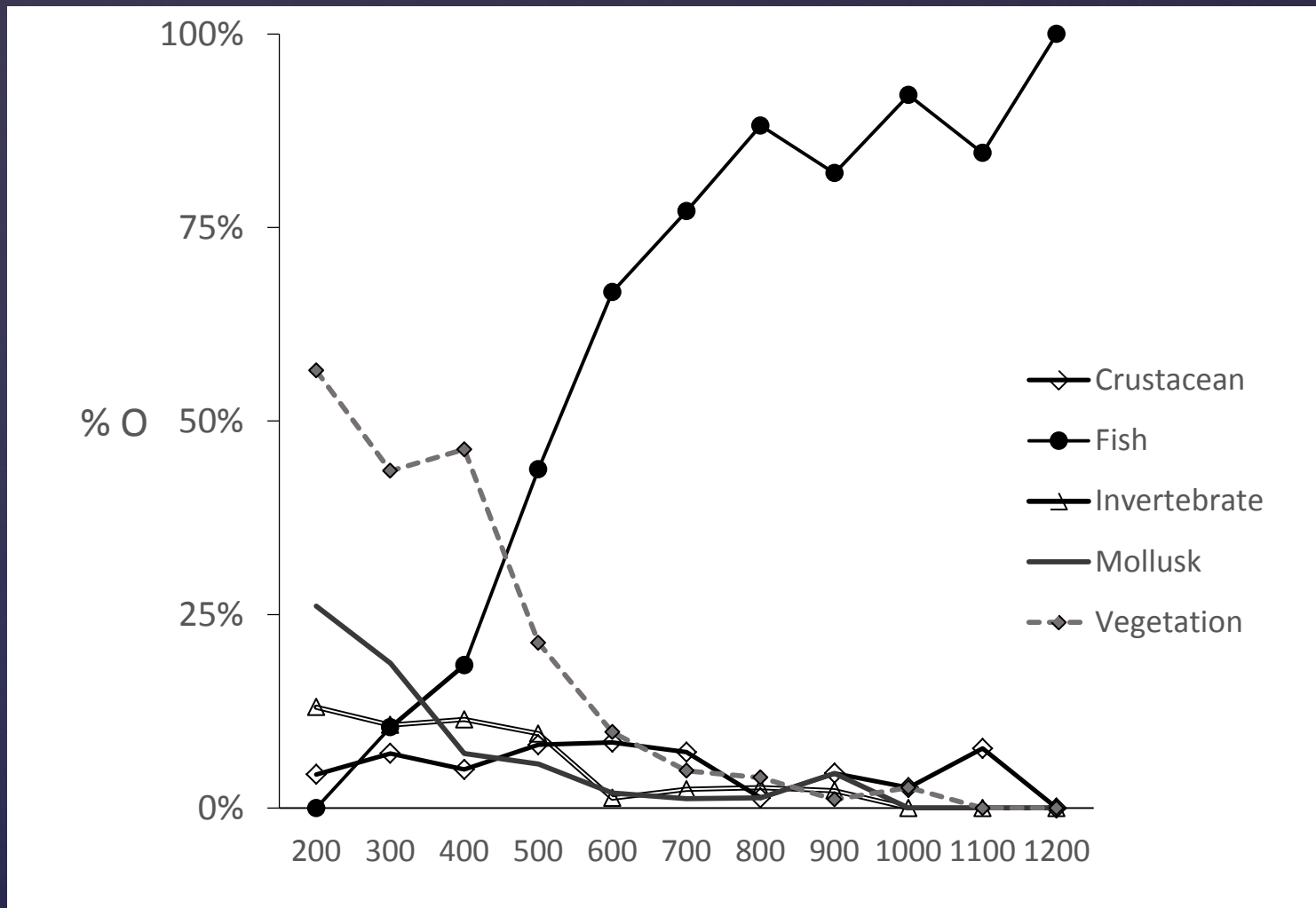
Diet contents were extracted from:

- 2,164 blue catfish during March, April, May
- 331 flathead catfish

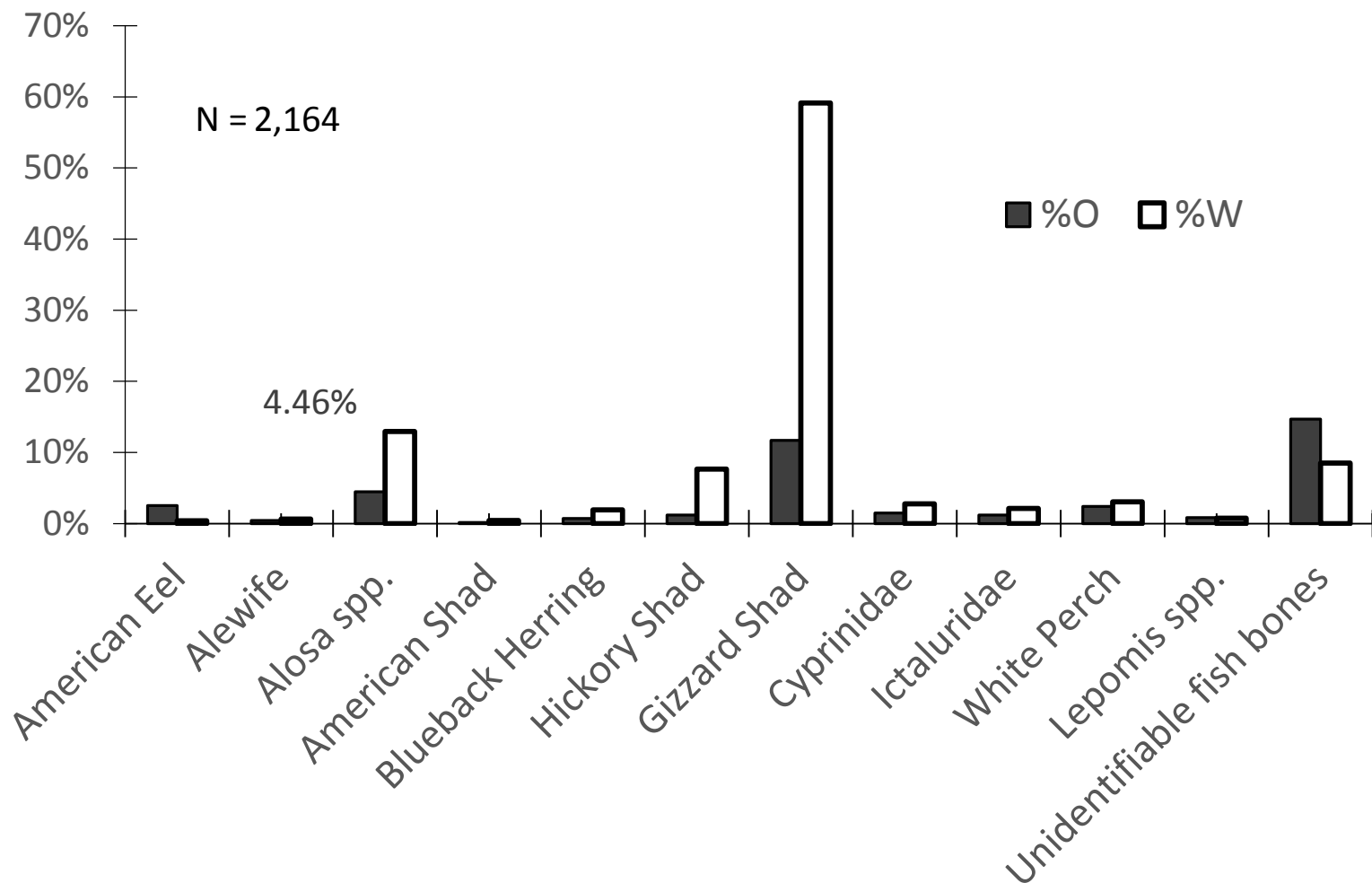
This included hundreds of large fish (526 catfish > 800 mm TL)



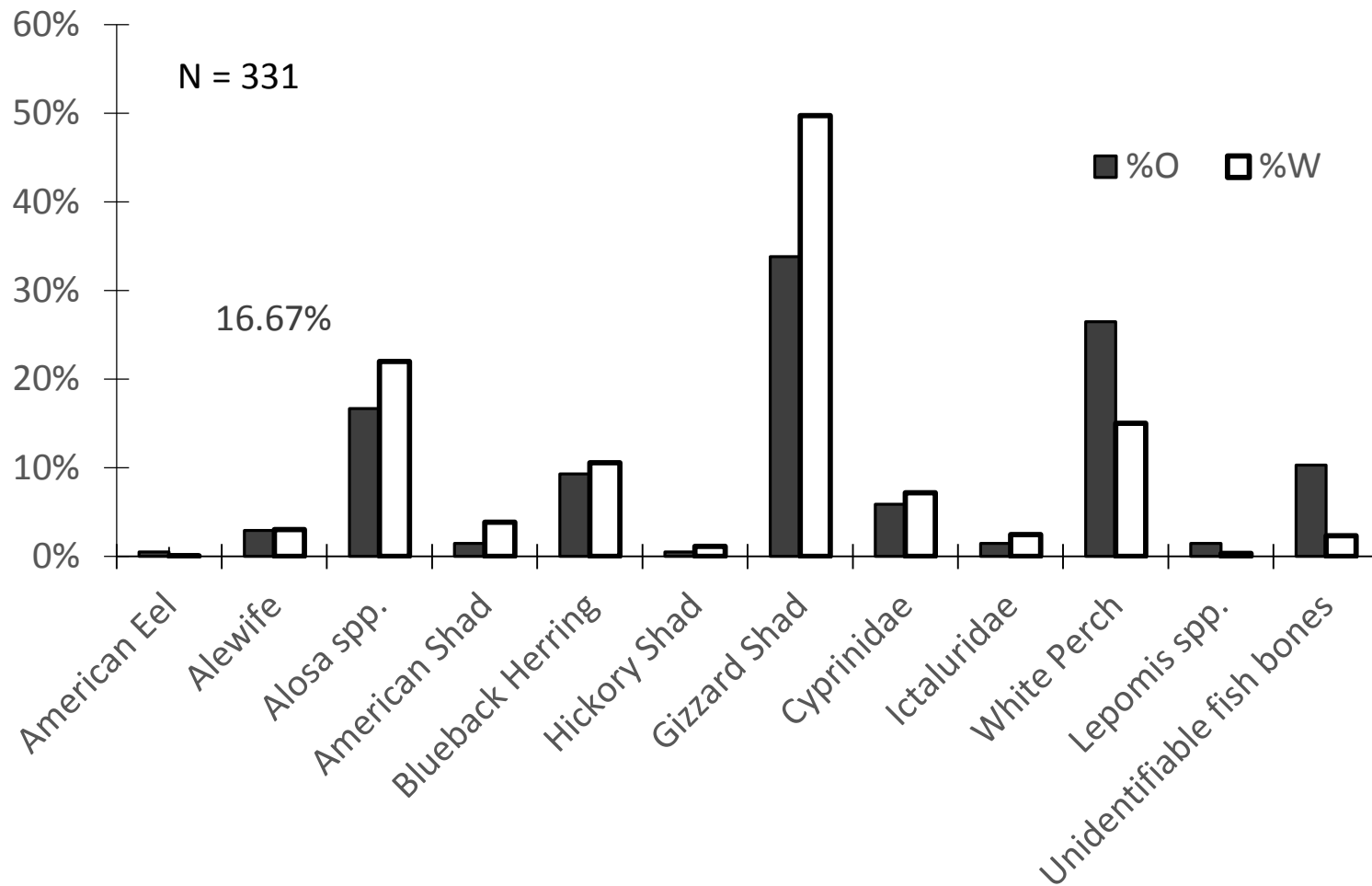
Ontogenetic shifts blue catfish



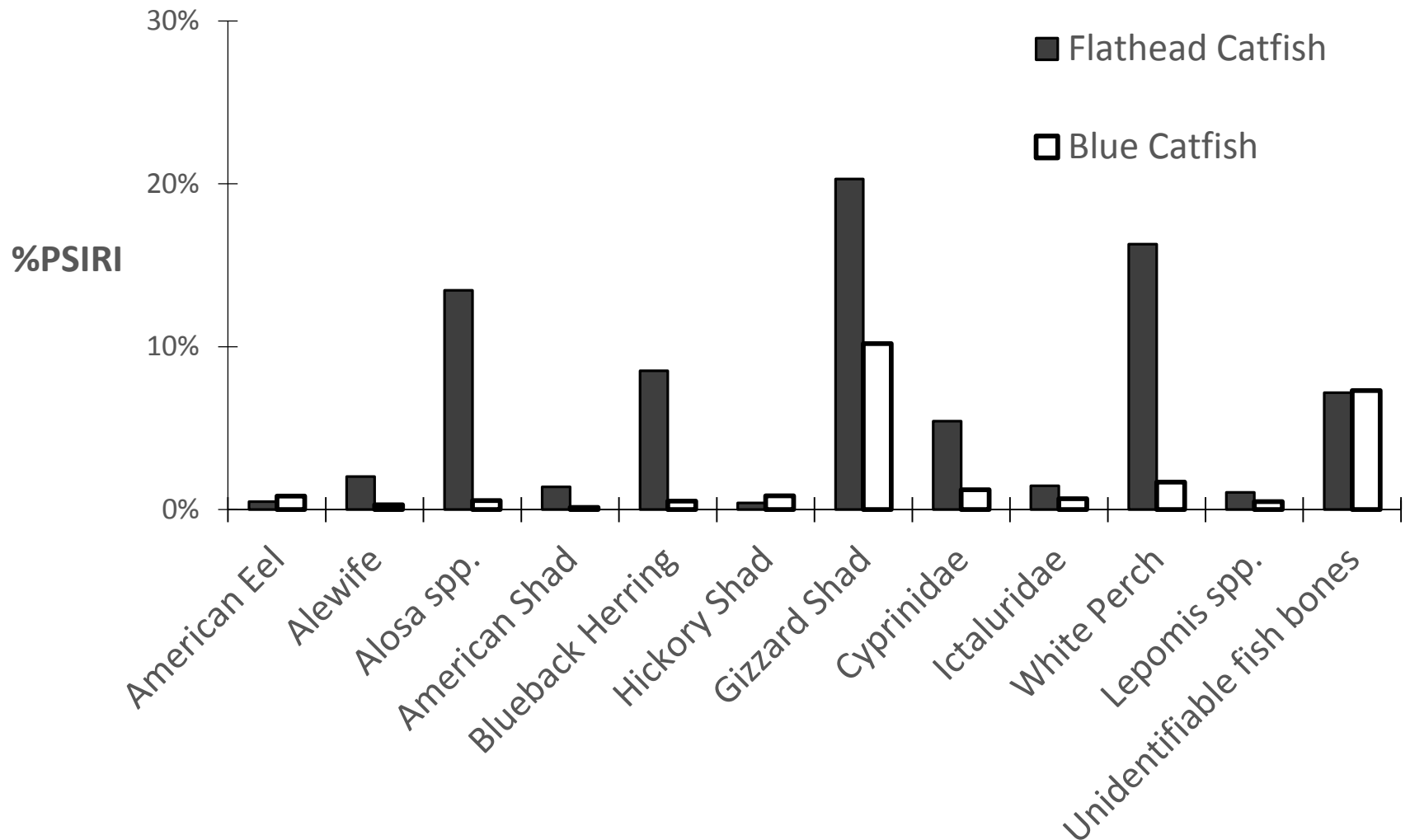
ANOVAs revealed significant ($P < 0.05$) ontogenetic diet shifts for most prey categories. *Post hoc* Tukey HSD tests indicate that the majority of these shifts occur at 500 and 600 mm TL. The shift to piscivory occurs at 500 mm TL ($P < 0.01$)



Percent weight and percent occurrence for fish prey consumed by blue catfish in the James River, VA, during March, April, and May. "Alosa spp." includes all Alosa species grouped together into a single category.

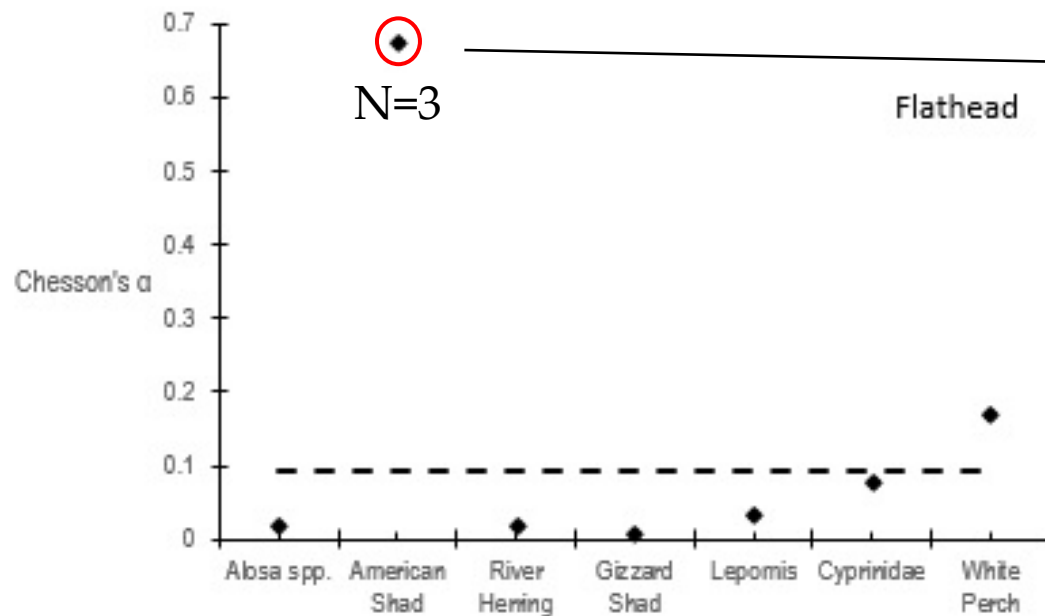
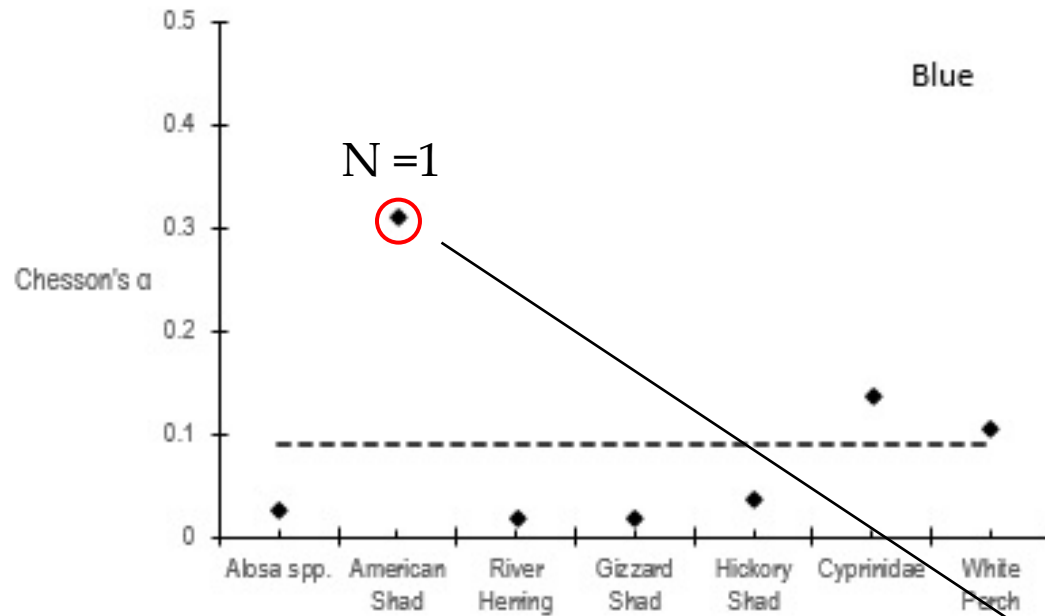


Percent weight and percent occurrence for fish prey regularly consumed by flathead catfish in the James River, VA, during March, April, and May. "Alosa spp." includes all Alosa species combined into a single category.



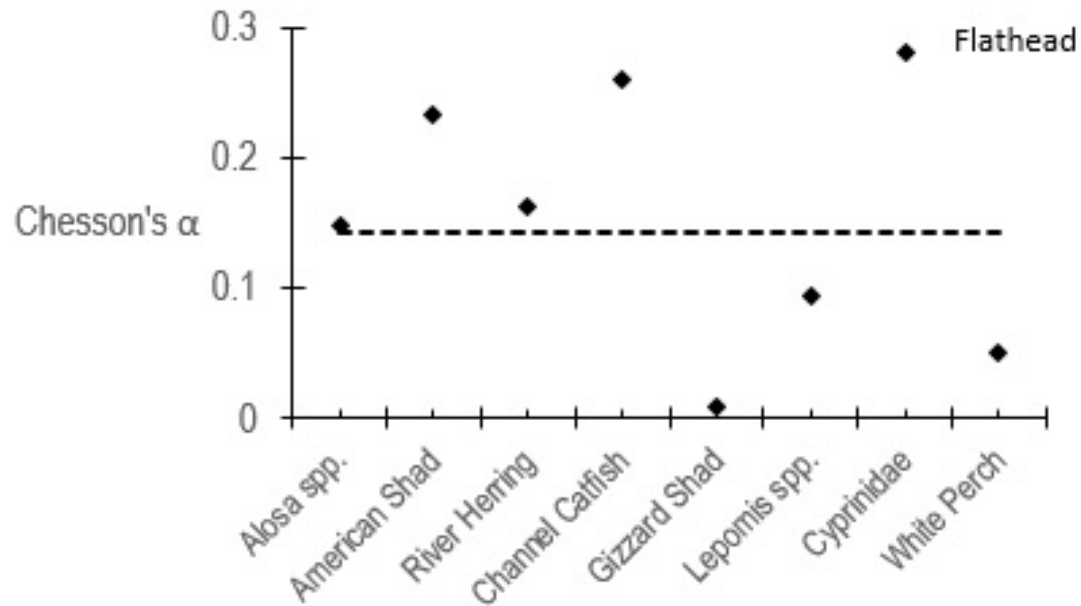
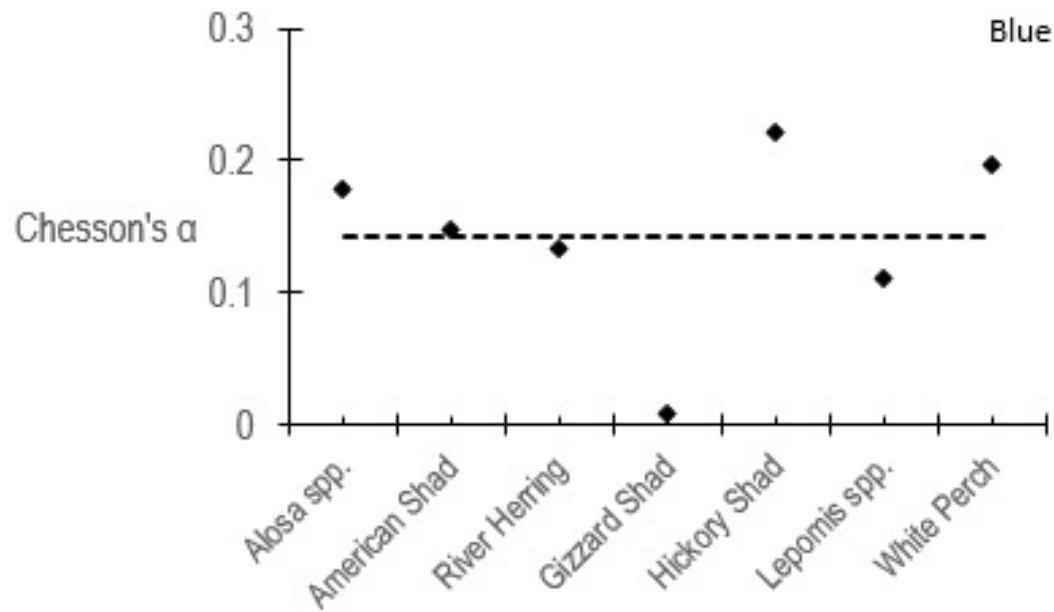
Percent Prey-Specific Index of Relative Importance (%PSIRI) for fish prey consumed by blue and flathead catfish in the James River during March, April, and May.

April Selectivity

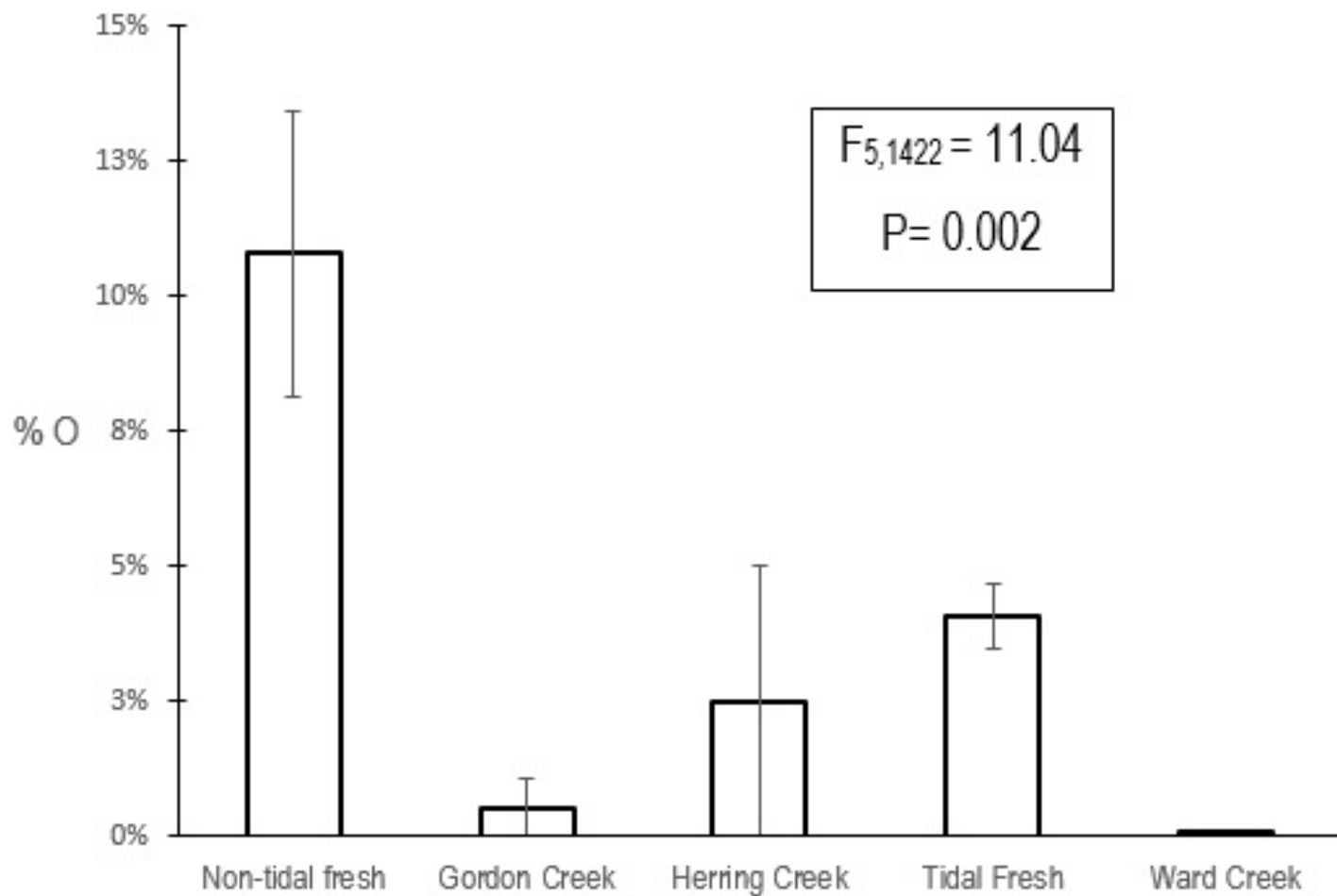


May be
artificially
inflated (no
American
Shad
detected
during
sampling)

May Selectivity



**Better
information**
(all Alosa
species
detected)



Mostly Boshier Dam!!

Selectivity

April:

BCF & FCF select Am. Shad

- blue catfish $\alpha = 0.3$
- flathead catfish $\alpha = 0.7$
- BCF that ate Am. Shad = 1
- FCF = 3

BCF & FCF select white perch



Selectivity

May:

Blue catfish selectively fed on hickory shad and white perch

Flathead catfish selectively fed on American shad, river herring, channel catfish, and cyprinids



Blue Catfish

Blue catfish = broad, omnivorous diet

Ontogenetic shift to piscivory at 500 mm TL

Gizzard shad by far the most important fish prey

Hickory shad most commonly consumed Alosa (**All other Alosa had <1% Occurrence**)



Flathead Catfish

Flathead catfish = exclusively piscivorous

Gizzard shad & white perch also very important

Alosa species consumed more often by flatheads

particularly blueback herring
(Occurrence = 9.31%)



Summary

Flathead catfish have a much higher *per capita* impact on species of concern (river herring, American shad)

Flathead Alosa occurrence = 16.67%

Blue catfish Alosa occurrence = 4.46% (Mostly hickory)

Flatheads less common, but larger average size

Are catfish responsible for the declines?

Unlikely- declines began in 1970s

Could they impede the recovery of these species?

-15% occurrence in flathead catfish diet, 20% by weight

****Population sizes and consumption estimates necessary to model population-level impacts on Alosines*

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