Blue Catfish Research: Ecology & Population Biology

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Key Processes that Contribute to Population Growth and Range Expansion
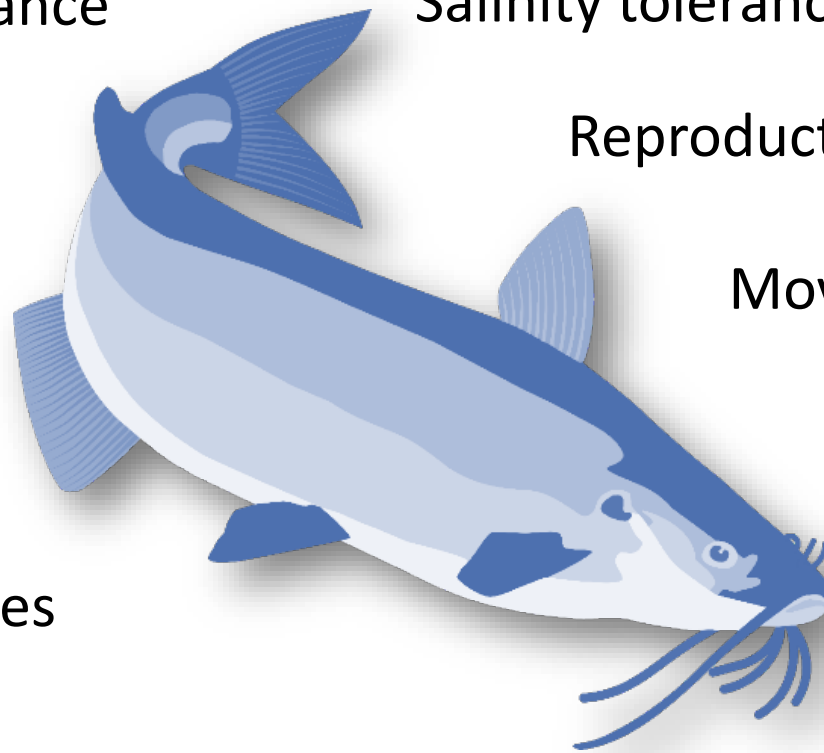
Relative abundance

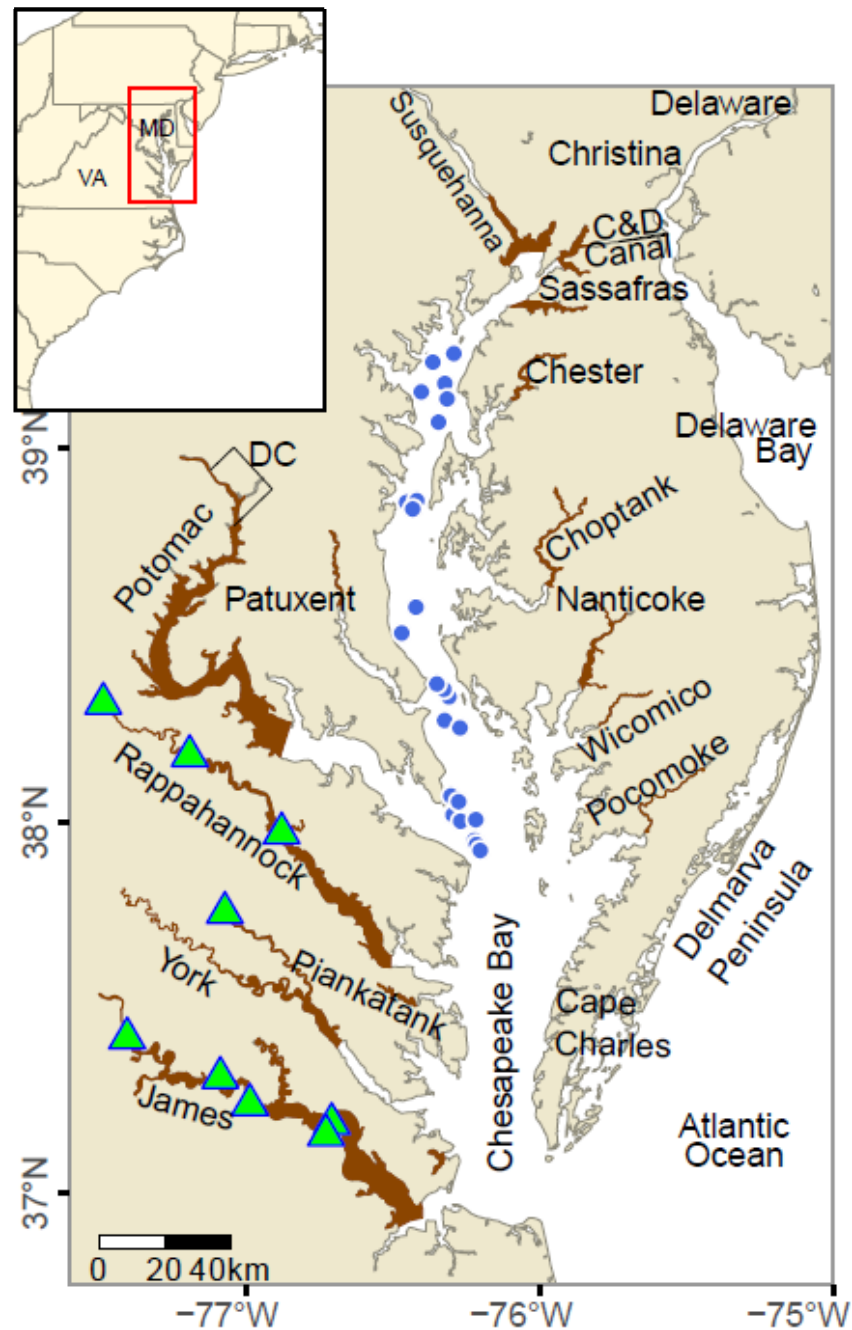Salinity tolerance

Population size

Reproductive traits

Movement ecology

Growth rates

Contaminants
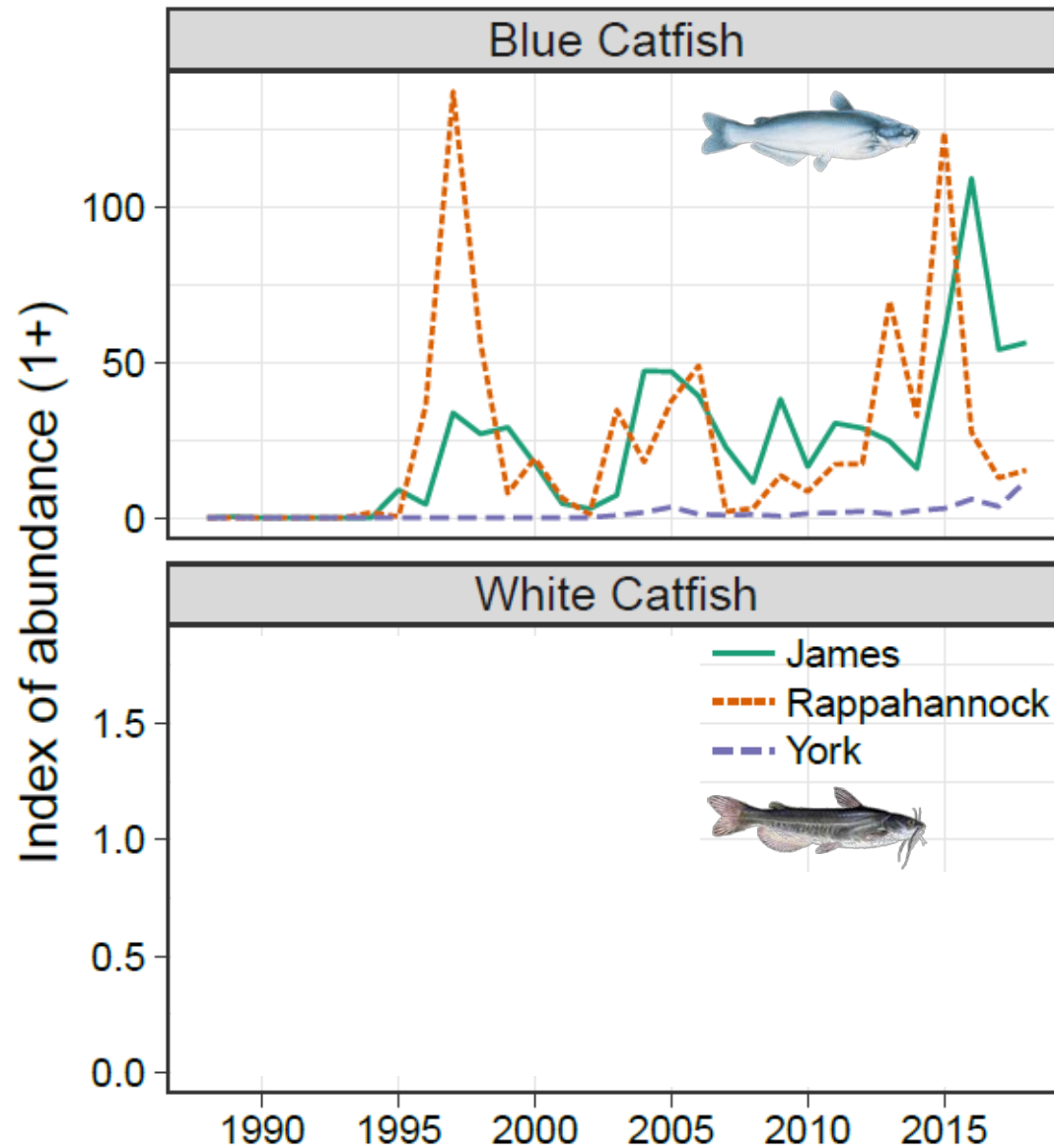
Metabolic rates

Current Distribution & Occurrence

Adapted from Nepal & Fabrizio (2019)

Relative Abundance in VA Tidal Tributaries

Tuckey & Fabrizio 2019

Population Size in the James River

- $\hat{N} = 1{,}639{,}830$ fish

  [926,307 - 2,914,208]

  $240 - 460$ mm FL

Tagged	Inspected	Recap	Recov
34,252	52,722	247	279
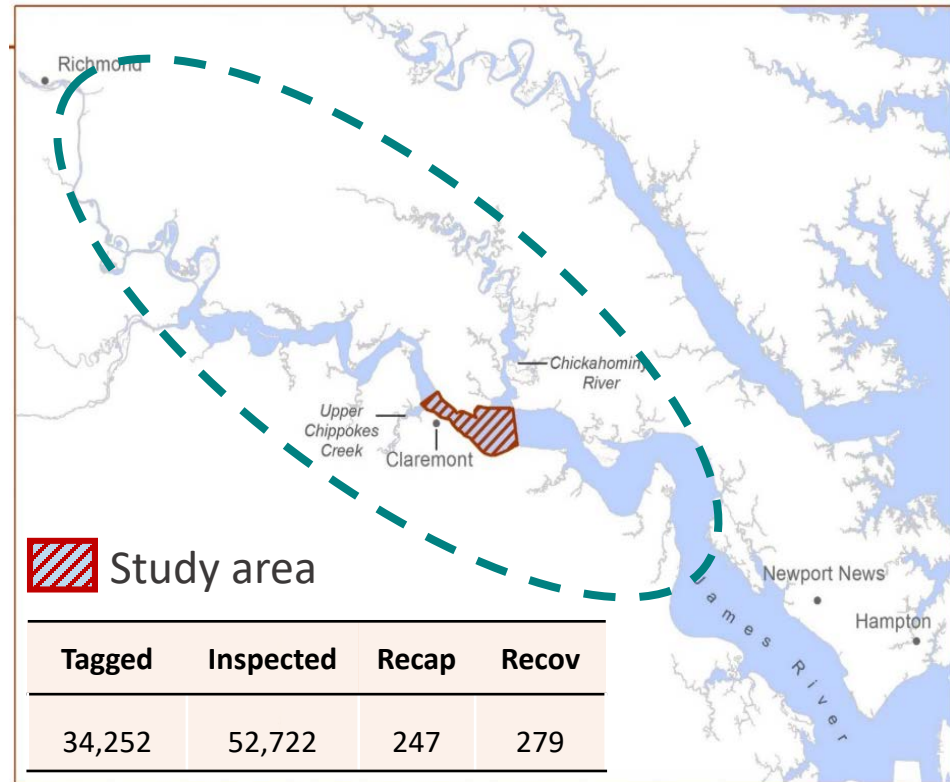
- What does this represent?
  - 12-km section of the James River ➔ 544 fish/ha
  - River between Richmond and Burwell Bay ➔ 19.8 M fish

Fabrizio et al. 2018

Salinity Tolerance of Blue Catfish

- Fish survive exposure to salinities up to 15.7 ppt for 72-hrs

- Larger fish tolerate elevated salinities better than small fish

72-hr salinity tolerance experiment

15.7 ppt

Nepal & Fabrizio 2019
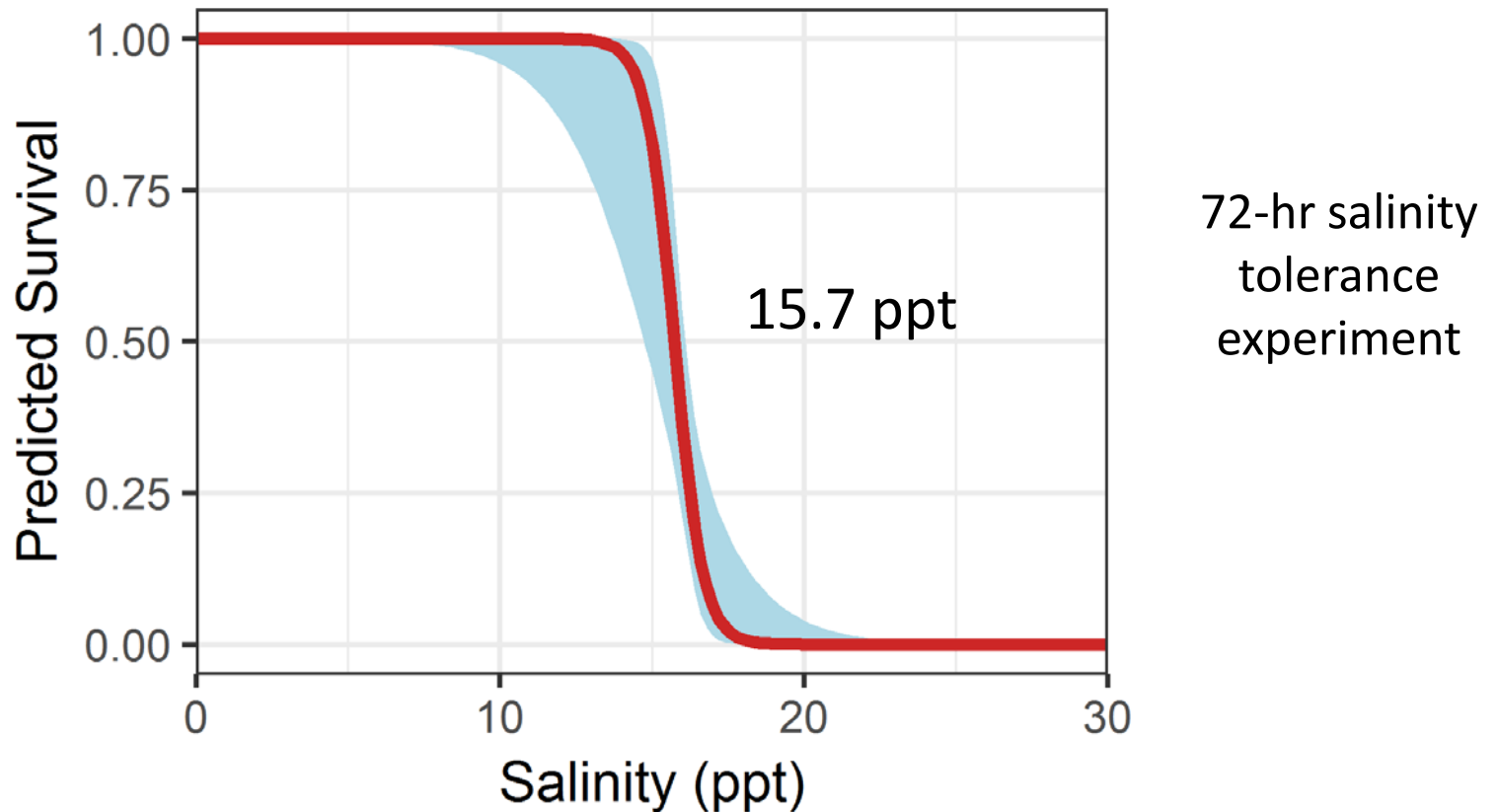
Size-Related Habitat Use

James River

Fork length (mm)
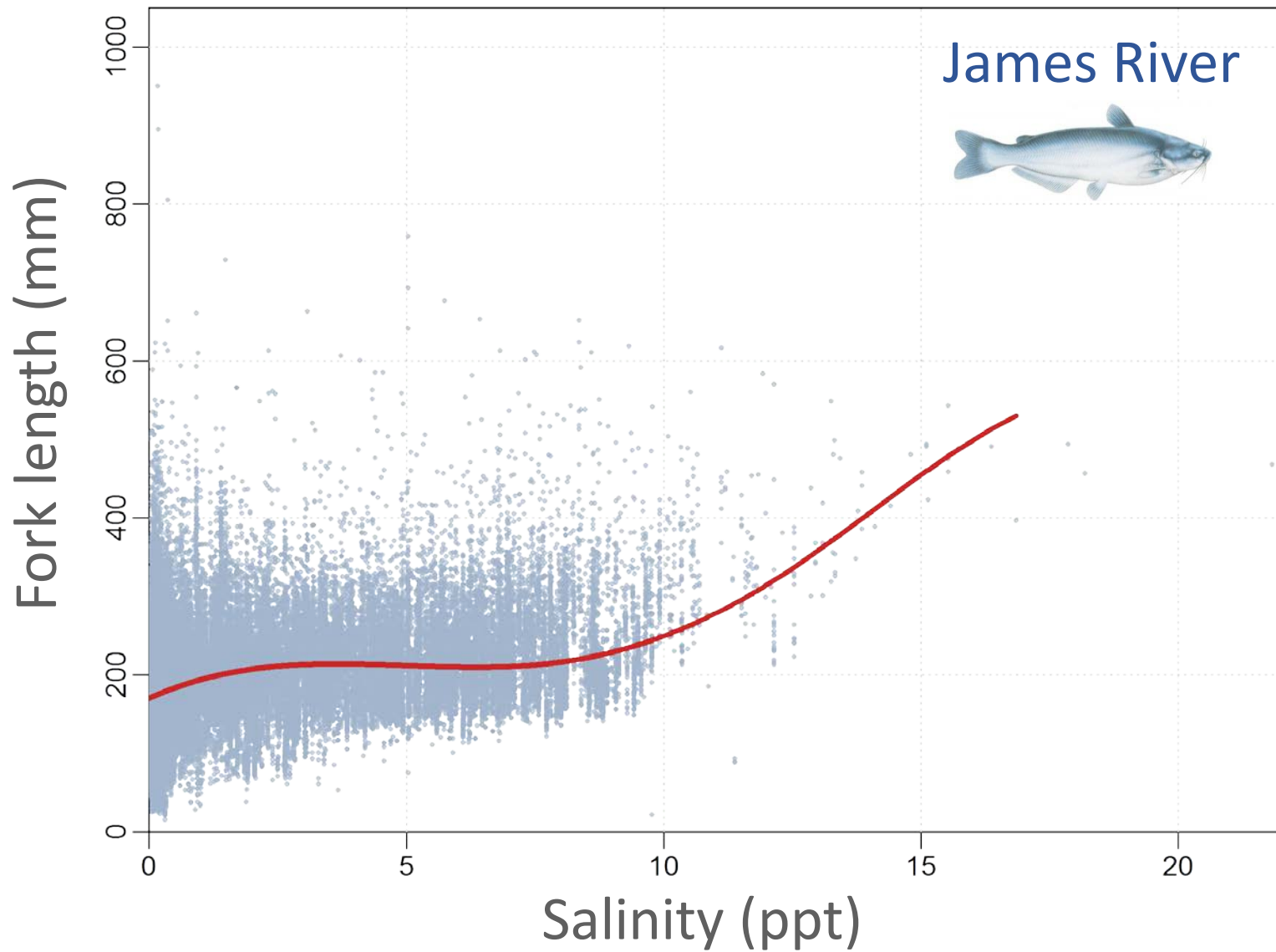
Salinity (ppt)

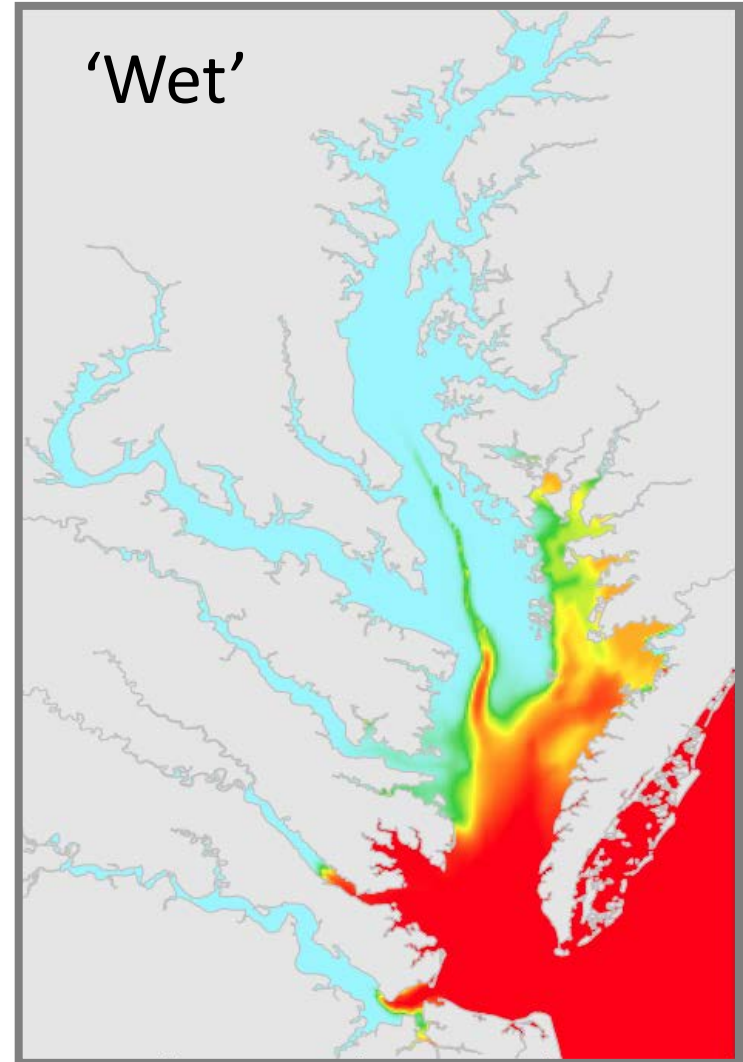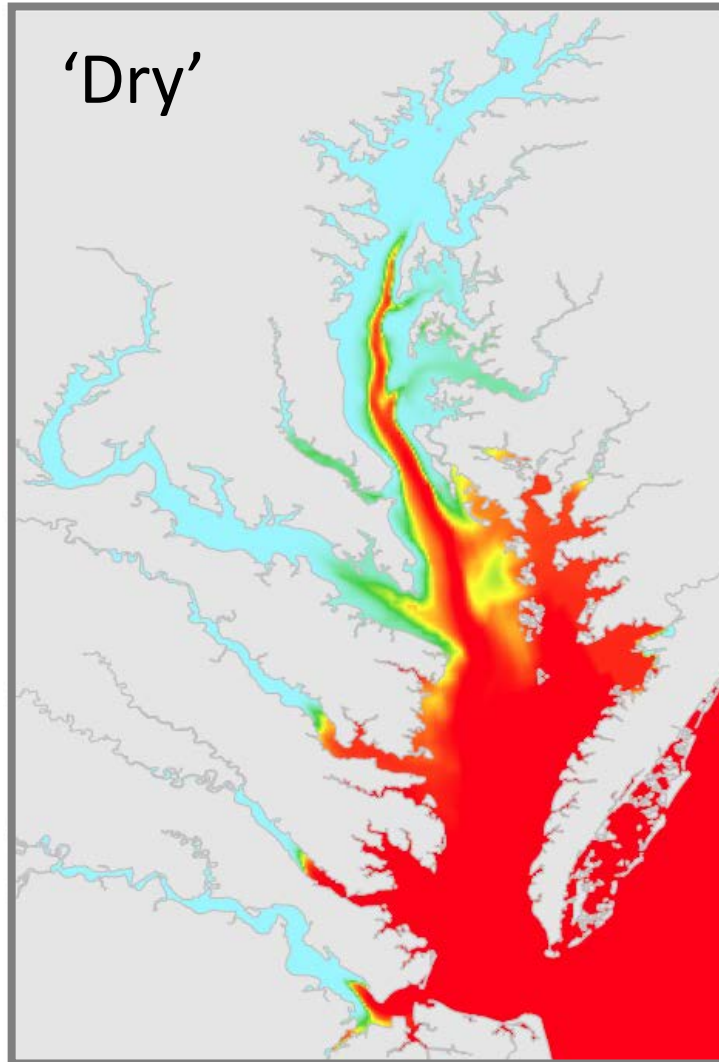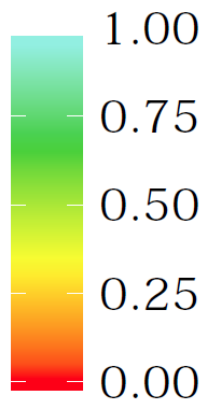# Potential Habitat: Probability of Survival
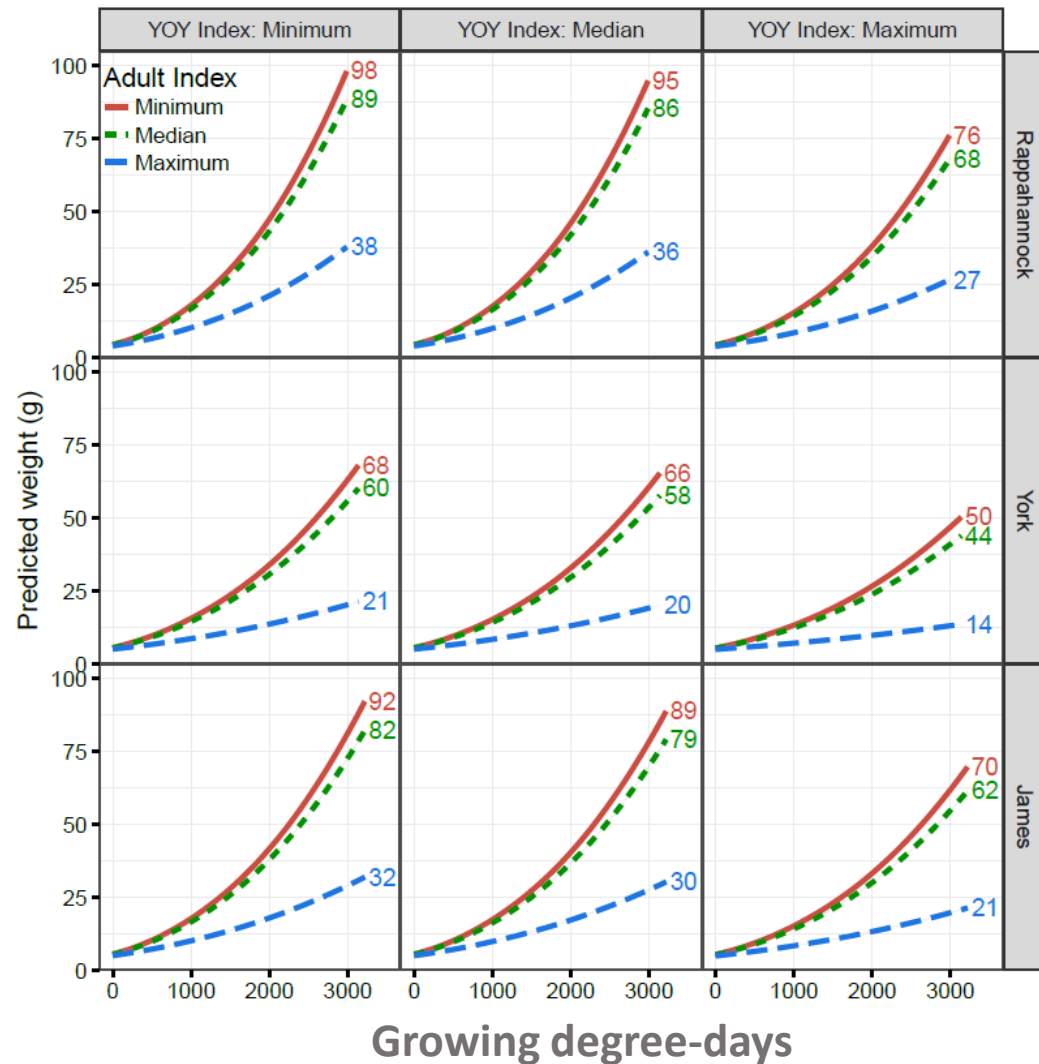

72-hr salinity tolerance experiment

'Dry'

'Wet'

Prob(Survival)

1.00
0.75
0.50
0.25
0.00

Nepal & Fabrizio 2019

Juvenile Growth Rates: 1996-2017

- Positive effect of GDD
  - Biomass during warm years was 63% greater than during cool years

- Negative effect of age-0 and age-1$^+$ abundance
  - Fourfold difference

Reduced densities diminish negative impacts of BC on native species, but this will be offset by increased growth rates
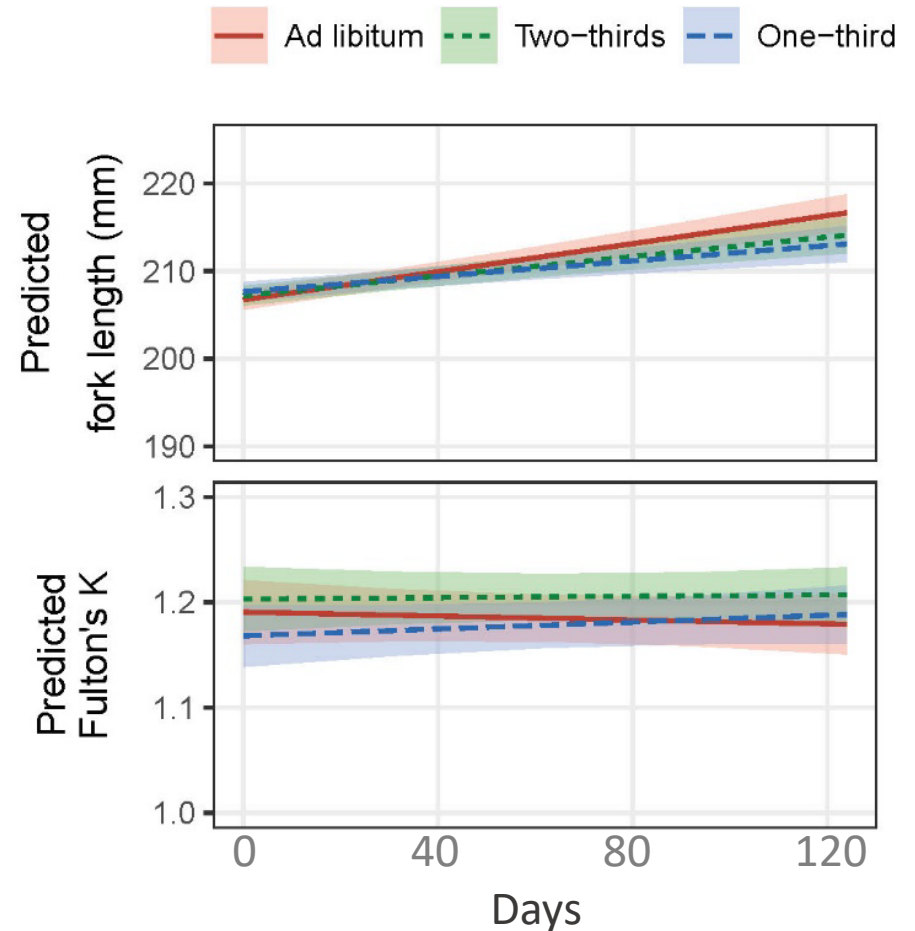
Nepal & Fabrizio 2020

Metabolic Rates

- Relatively low metabolic demand, similar to other benthic fishes

Nepal, Fabrizio, & Brill, *in prep*
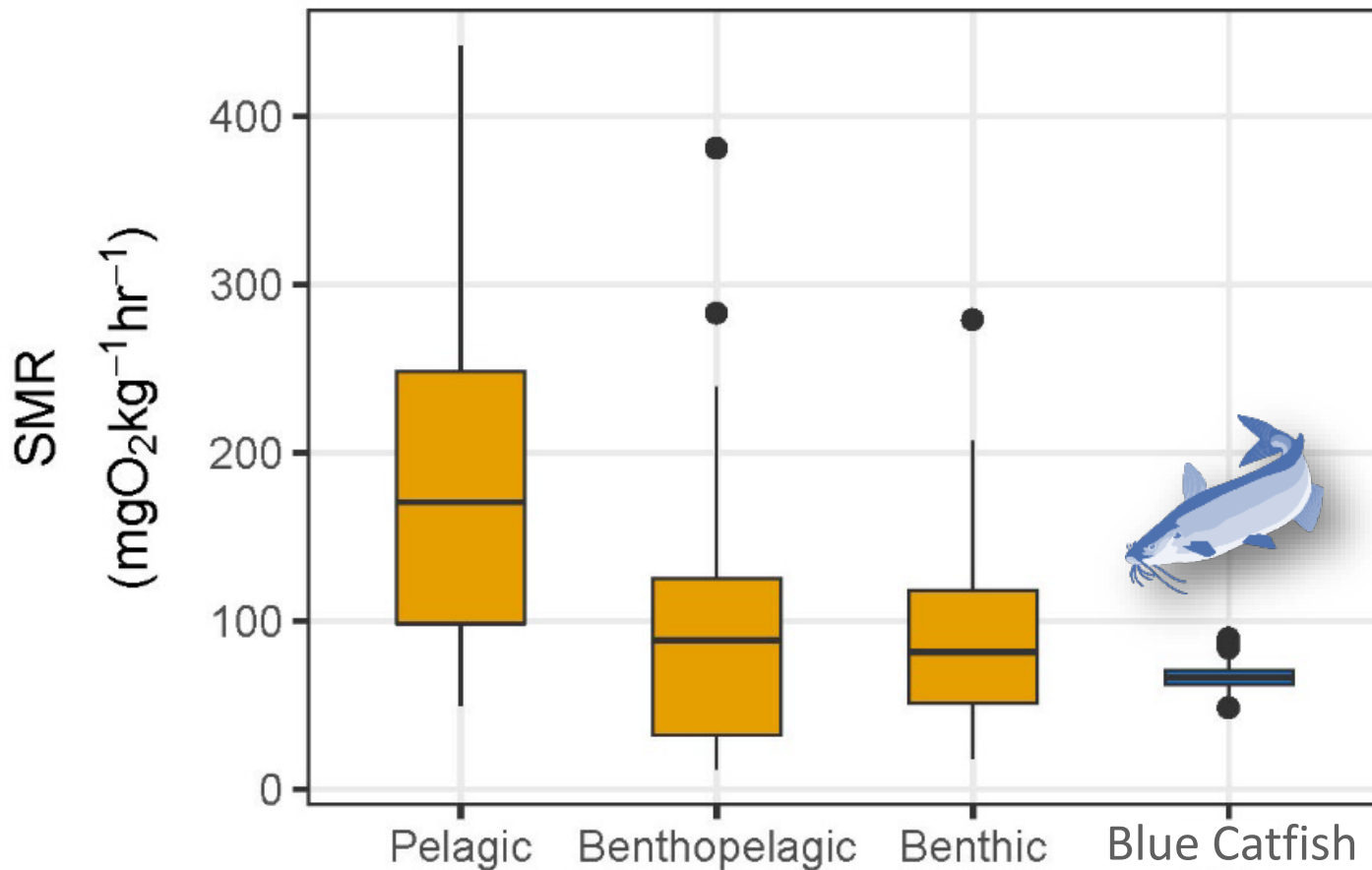
Responses to Ration Size: Growth & Condition

- Juvenile fish held 124 days
  - *ad libitum*, 2/3 *ad lib*, and 1/3 *ad lib* ration size

- Mean growth rates were lower at 1/3 ration

- No changes observed in body condition across ration levels

Blue catfish appear to have mechanisms that enable them to survive low rates of caloric intake

Nepal, Fabrizio, & Brill, *in prep*

FL: 188 - 241 mm
Ad libitum = 3% of fish biomass/day

R. Fisher, VIMS Marine Advisory Service

Monthly GSI for blue catfish:
James & York rivers, 2015-2017
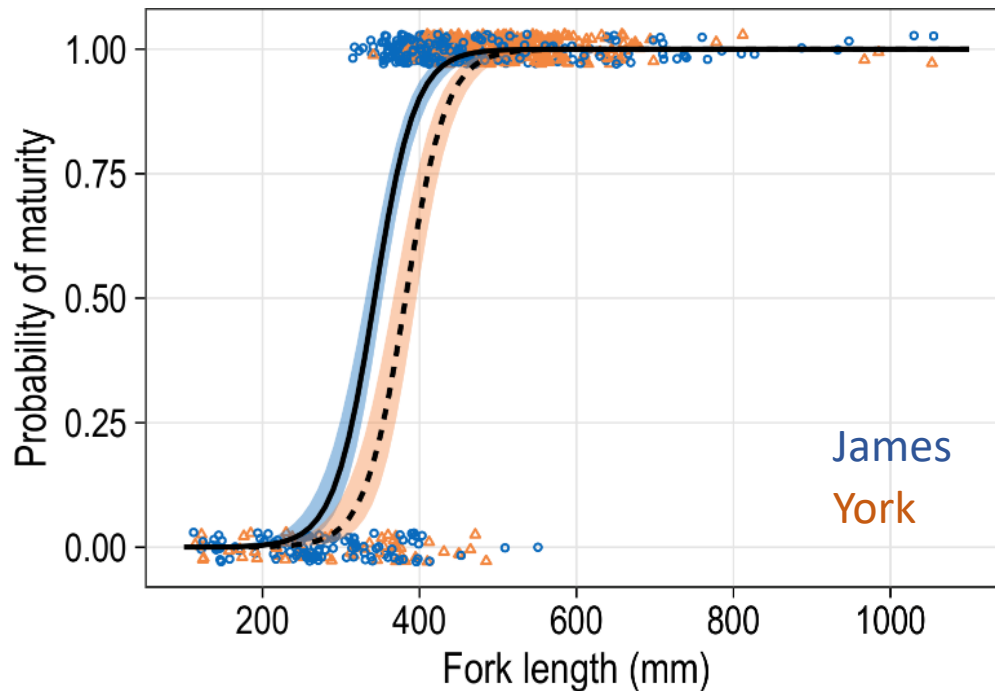
- Spawning period:
  May – July

- Larger fish spawn earlier than smaller fish

- $\overline{GSI}_{James} > \overline{GSI}_{York}$

  (size-adjusted comparison)
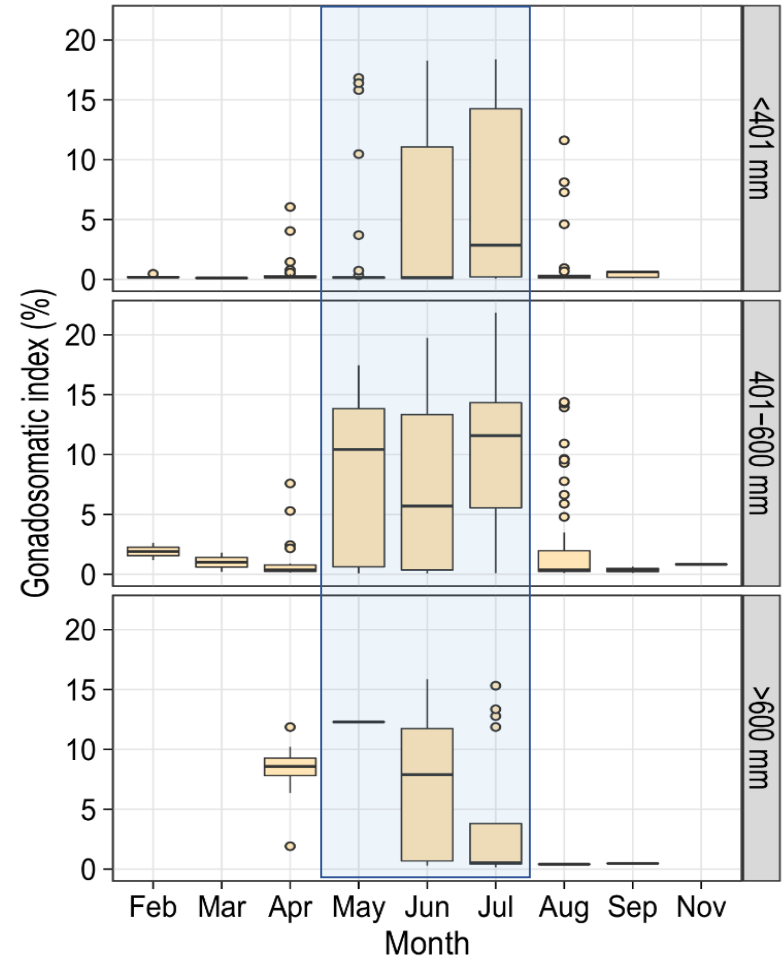
Blue catfish produce large eggs (~3 mm) & provide parental care, thus ensuring high survival of young

Nepal & Fabrizio, *in review*

Blue Catfish from the James River mature at a smaller size, but older age than those in the York

Size & Age at Maturity

	Mean FL (mm)	Mean Age (yrs)
James (n=493)	343	7.7
York (n=438)	382	7.0

Reduced densities will diminish negative impacts of BC on native species, but this will be offset by higher reproductive output
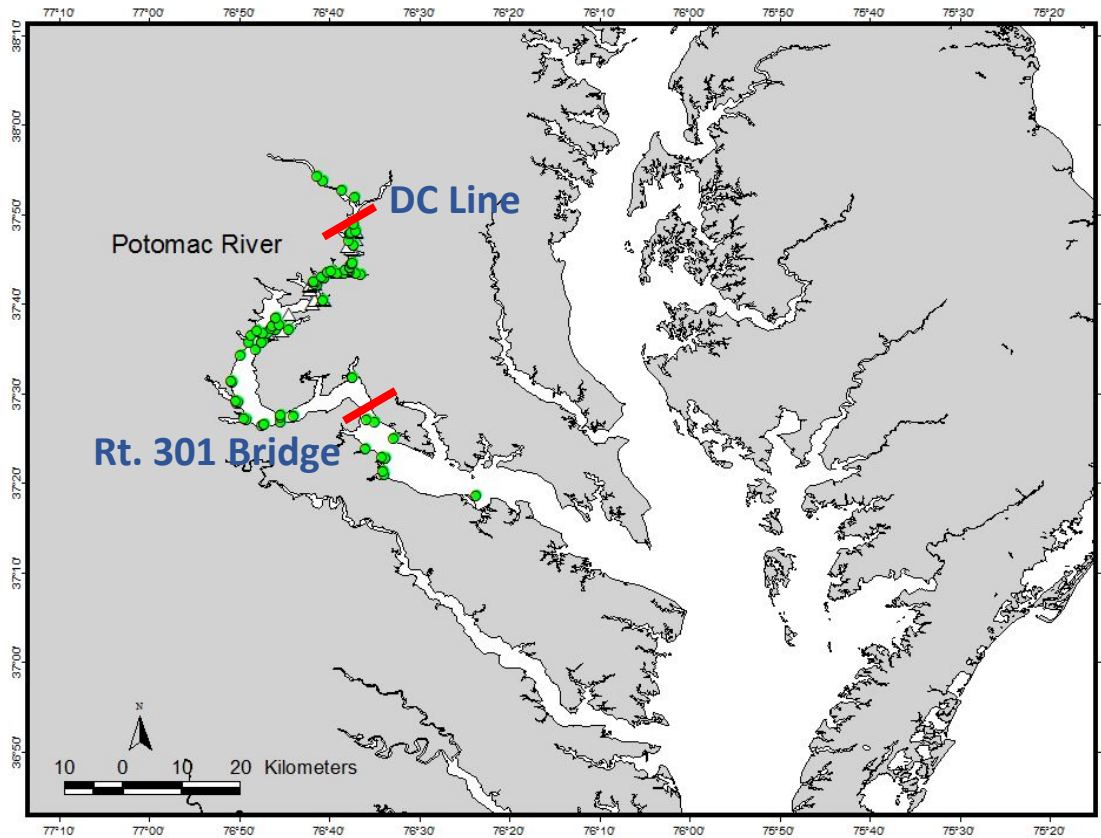
Contaminants (PCBs in Blue Catfish)
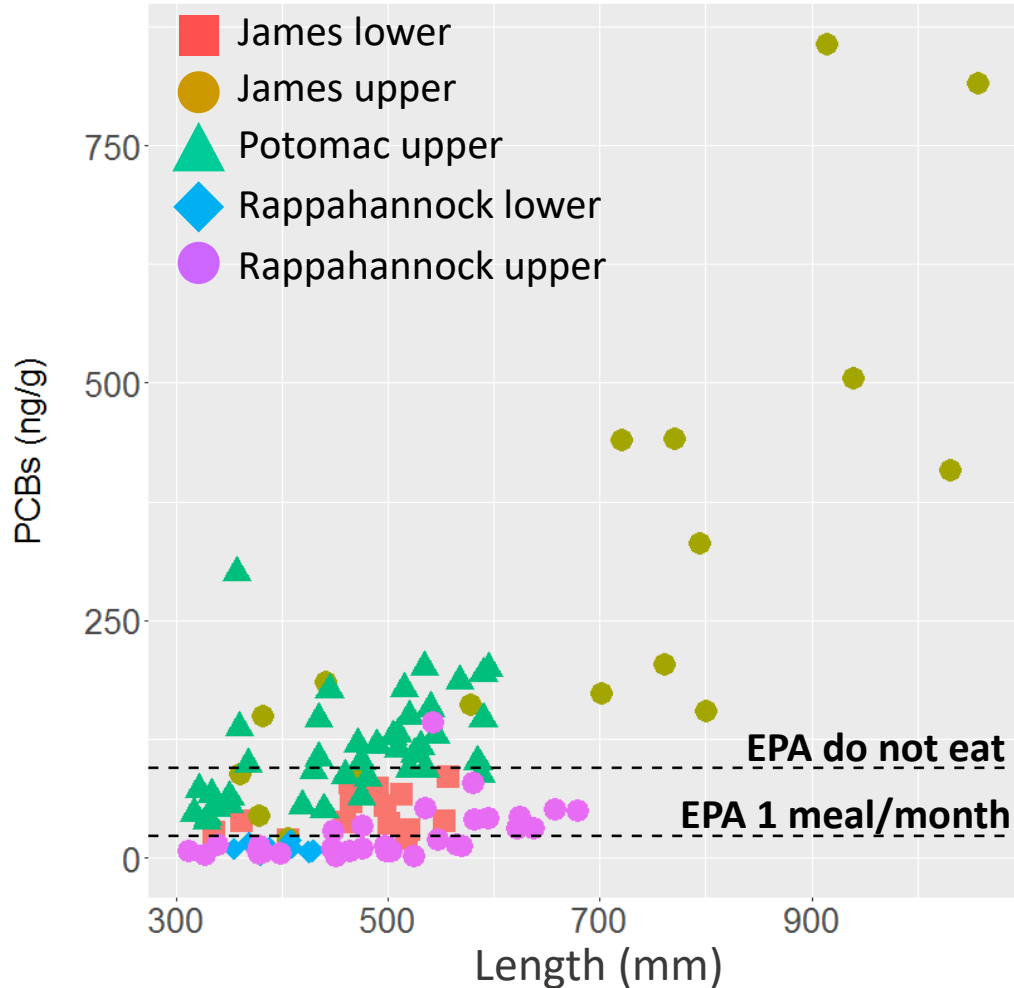
- Differences in [PCB] in fish from upper & lower portions of rivers

- Many fish in the Potomac & upper James exceed the do-not-eat limit

Length is a poor indicator of PCB content

Luellen et al. 2018

Consumption advisories are based on fish length & are often location-specific


- Mean min distance moved was 24.1 km

- 63% of recaptured fish moved downriver

- Much of the tidal Potomac River was used (→12.8 ppt)

- 12.5% of returns came from outside of the advisory area

Blue catfish behavior increases human exposure to fish with elevated levels of contaminants outside of advisory area

Tuckey et al. 2017

Research Gaps

- Detection probabilities associated with fishery-independent surveys

- Connectivity between large tributaries and rivers that feed into tributaries

- Identification of effective early-detection & surveillance methods

- Effect of salinity on reproduction
  (egg production, viability, hatchability, larval survival, behavior)

- Stock-recruitment relationship

- Population models
  (matrix model, stock assessment, or similar)
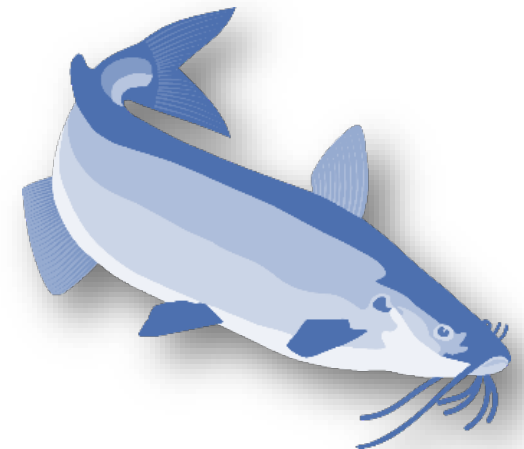
Thank You
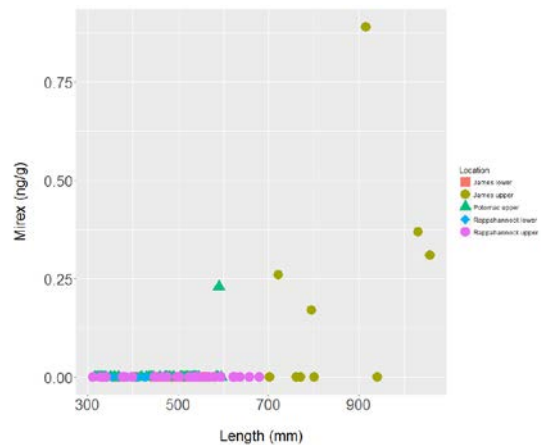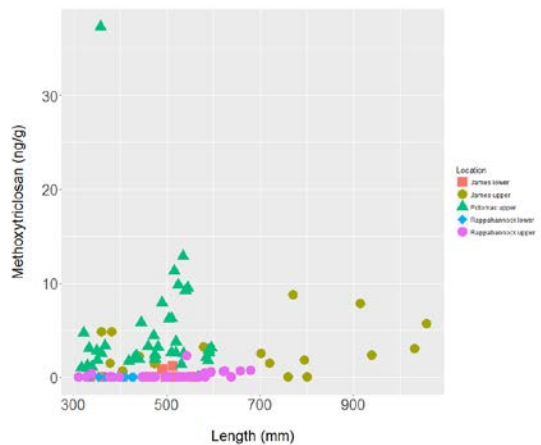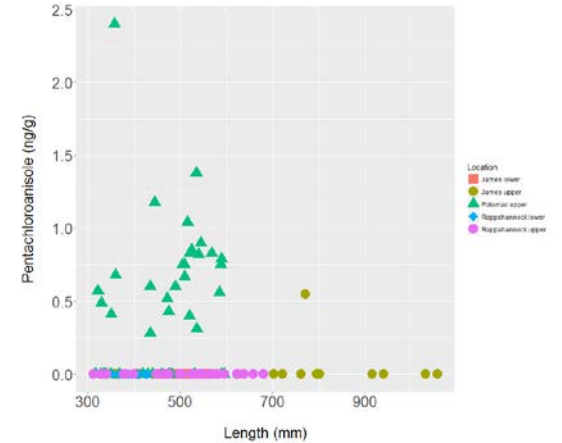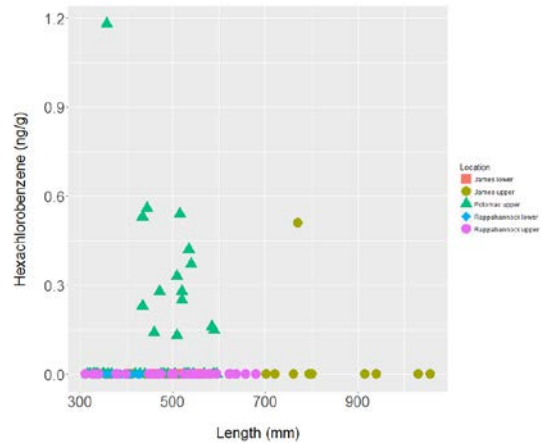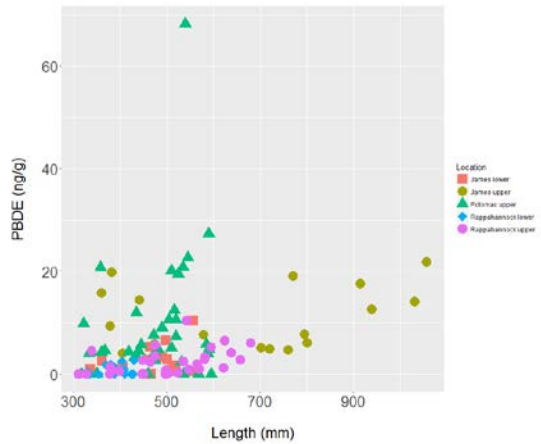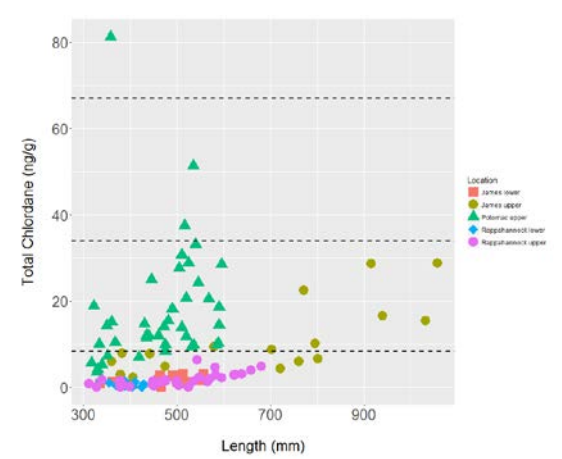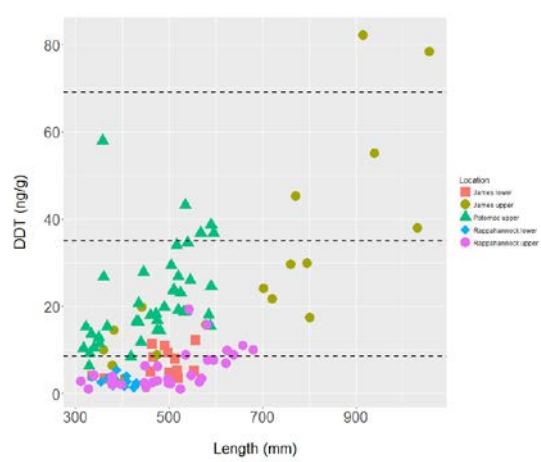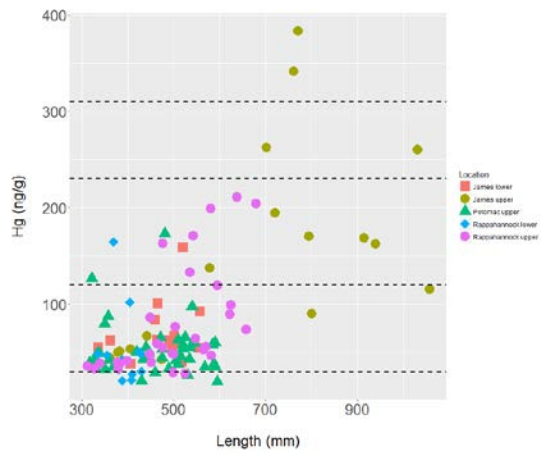
Are there additive or interactive effects of multiple contaminants on human health?

Luellen et al. 2018

Contaminants Study

| Location	n	Fork length (cm)	Weight (g)	Age (yr)
James River	31	34 – 106	407 – 15,250	5 - 18
Rappahannock River	44	31 - 68	408 – 5,933	5 - 17
Potomac River	41	32 – 60	423 – 2,611	-

Luellen et al. 2018

Growth & Cumulative GDD

- Immature blue catfish (≤ 4 y) from the James & York rivers during early (1998-2000) and recent (2015-2017) periods


Nepal & Fabrizio 2020
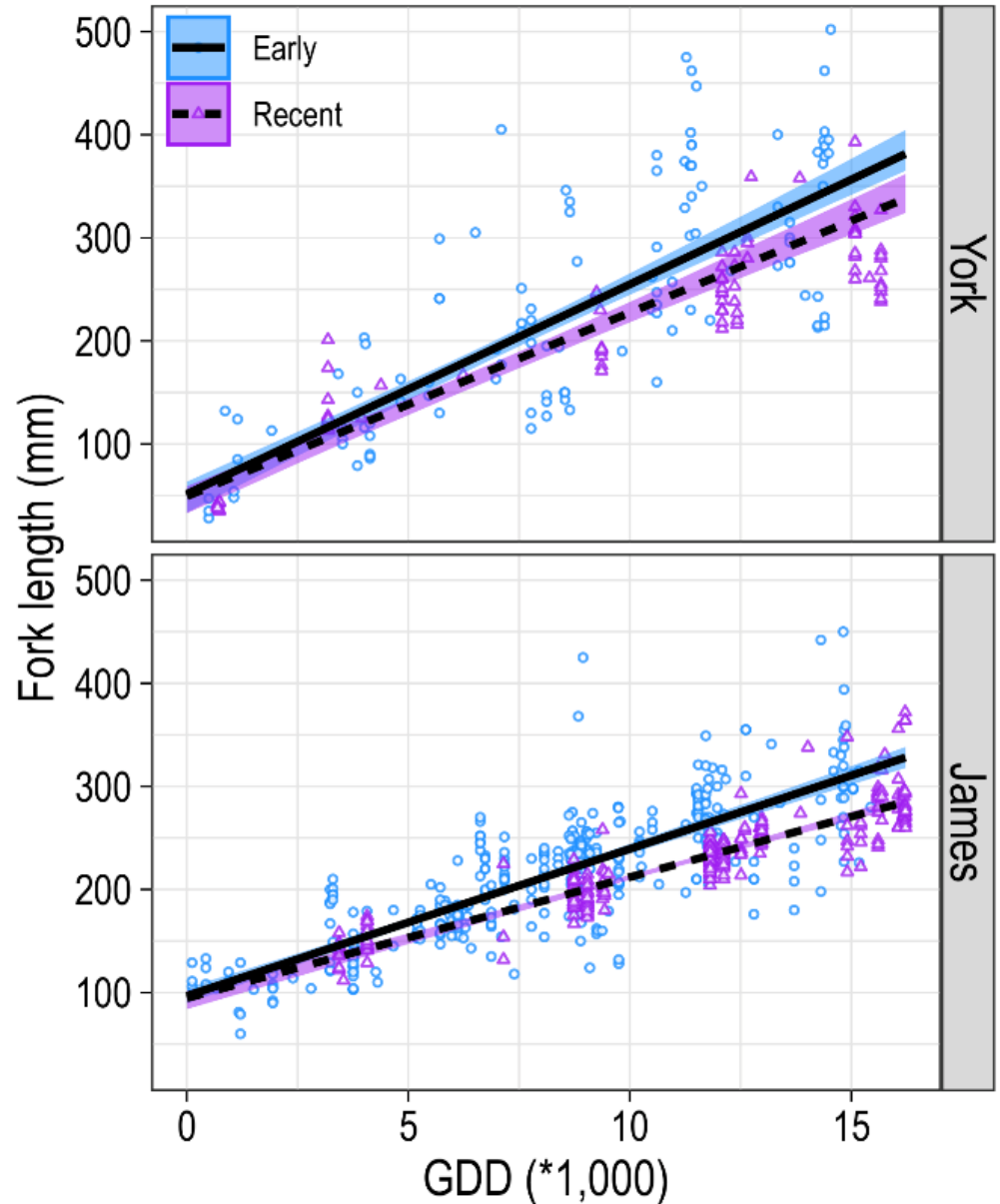
Von Bertalanffy growth curves for blue catfish: James & York rivers, 2015-2017

- Males grow faster and reach larger asymptotic sizes than females

- Fish in the York had smaller asymptotic sizes (but faster growth) than those in the James
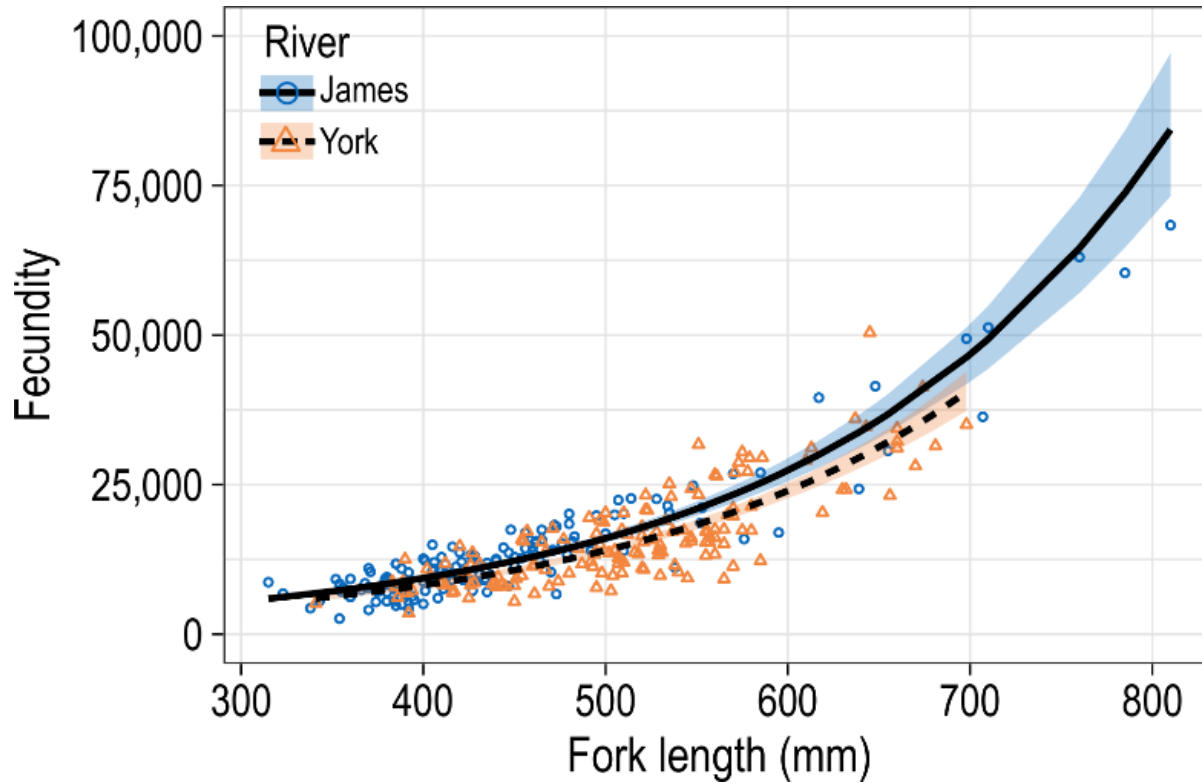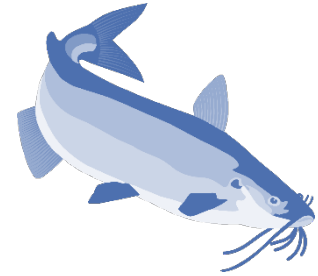

Nepal & Fabrizio 2020
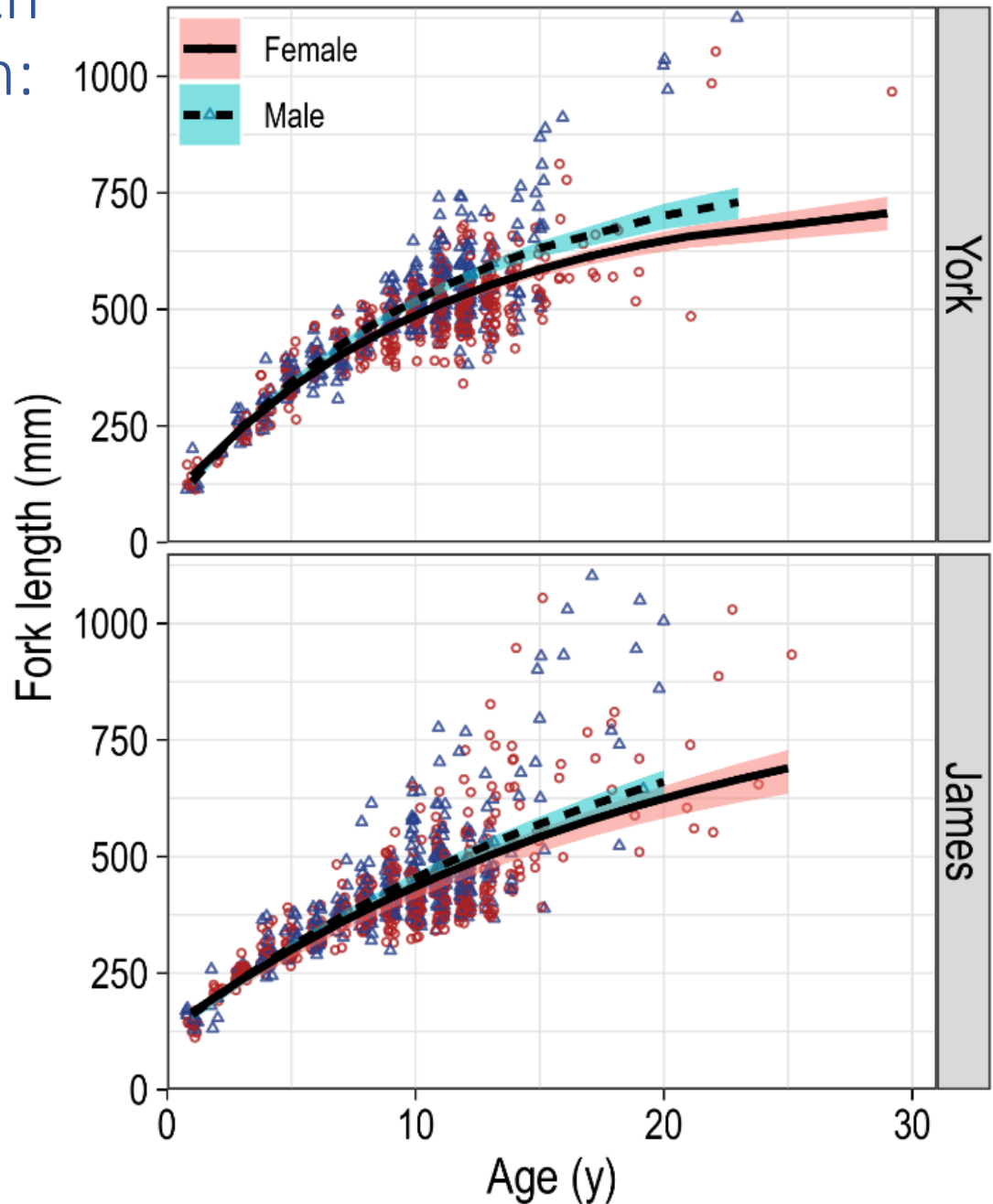
Female Growth Based on Lester's Biphasic Growth Model: James & York Rivers, 2015-2017

- Maturity occurs at the point of inflection, where growth changes from linear to von Bertalanffy

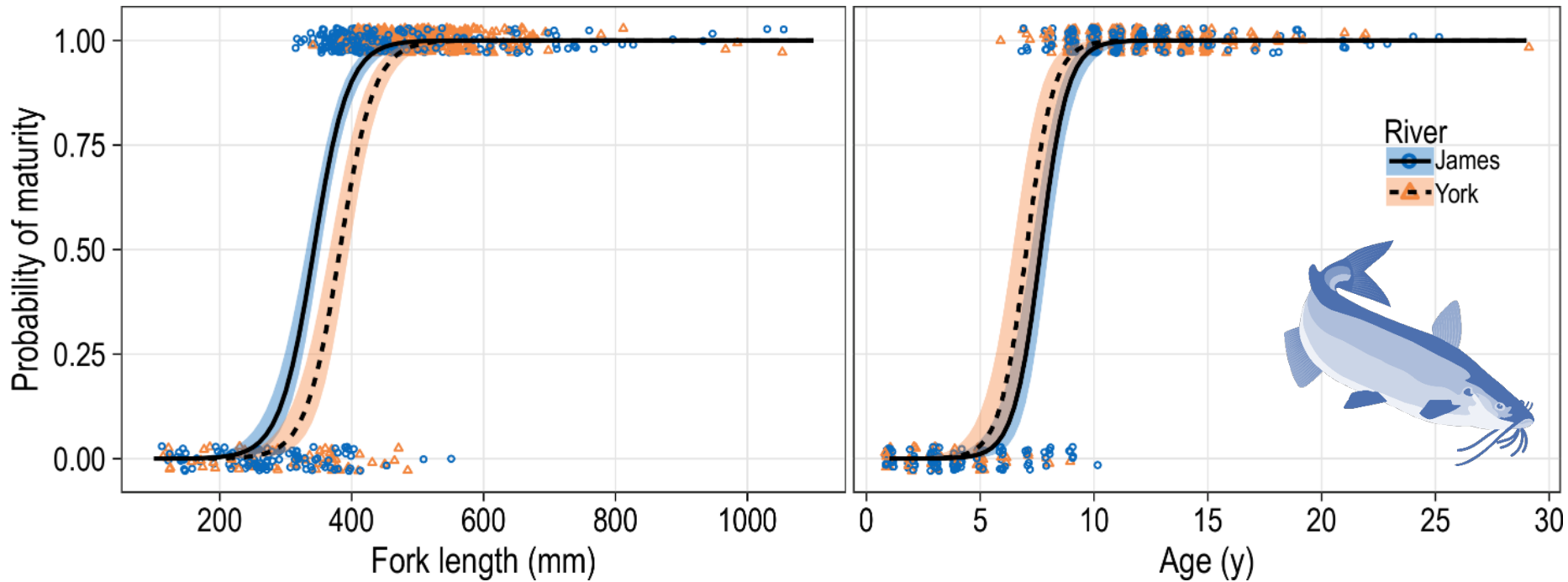- The two stages are delineated in the graph by the horizontal and vertical dashed lines

Nepal & Fabrizio 2020
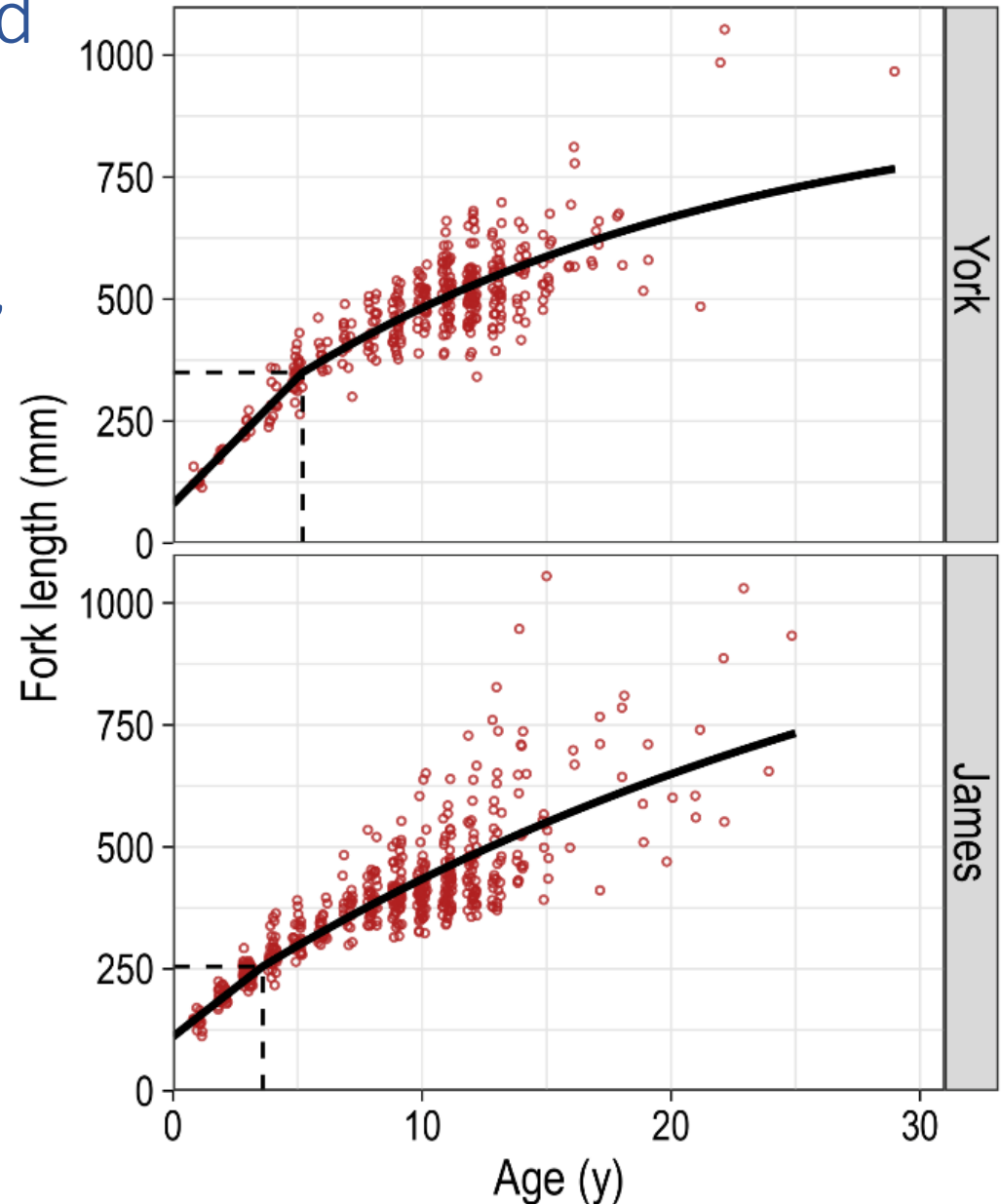
Fecundity increases with size

Mean fecundity at 486 mm:

James: 14,377 eggs/fish

York: 12,568 eggs/fish

Gamma GzLM with log link

Nepal & Fabrizio, *in review*

Blue Catfish from the James River (n=493) mature at a smaller size, but older age than those in the York (n=438)

- James: mean FL = 343 mean age = 7.7
- York: mean FL = 382 mean age = 7.0

Nepal & Fabrizio, *in review*

Fecundity and Lifetime Fecundity

For a given size, fecundity of James River fish is greater than that of York River fish
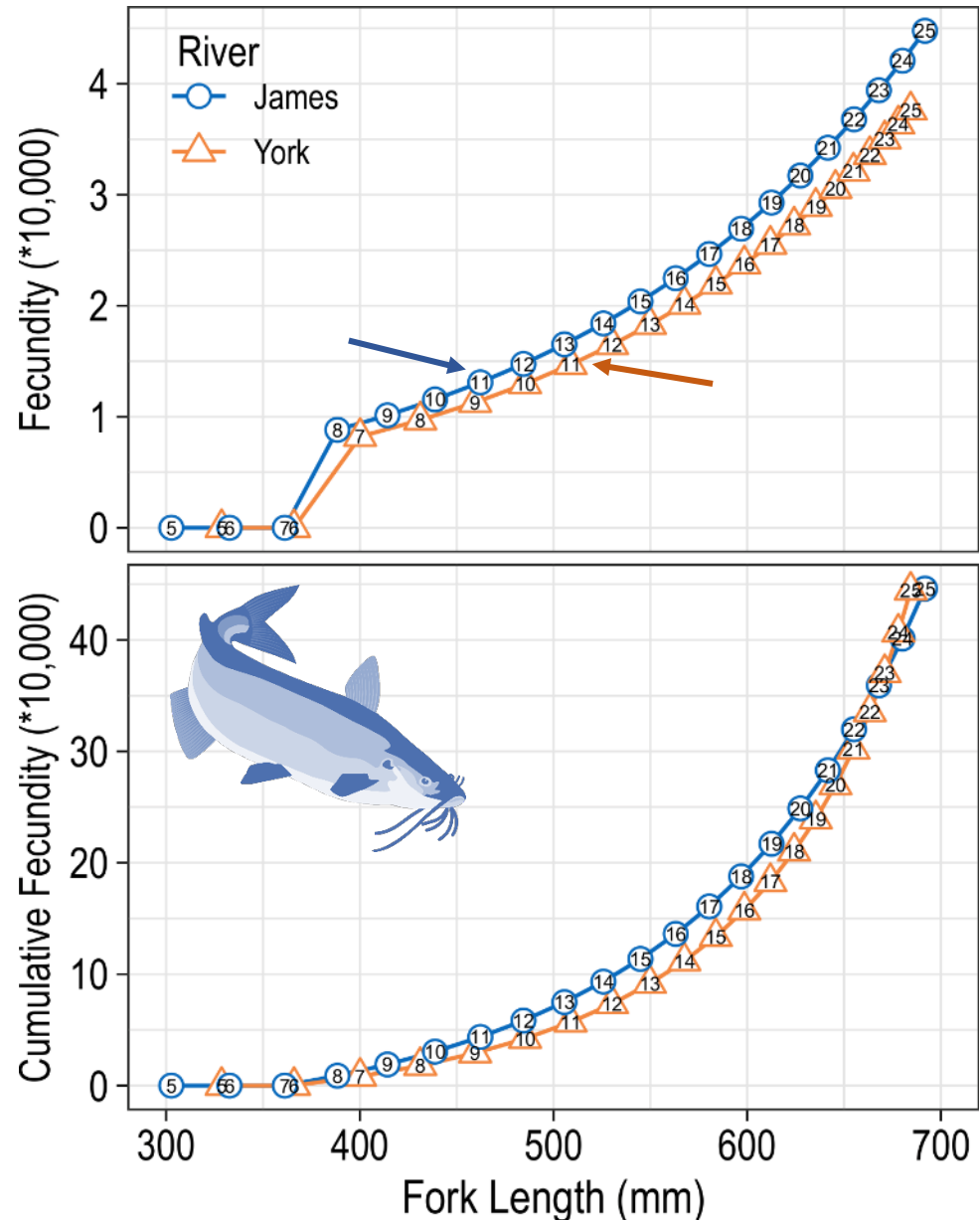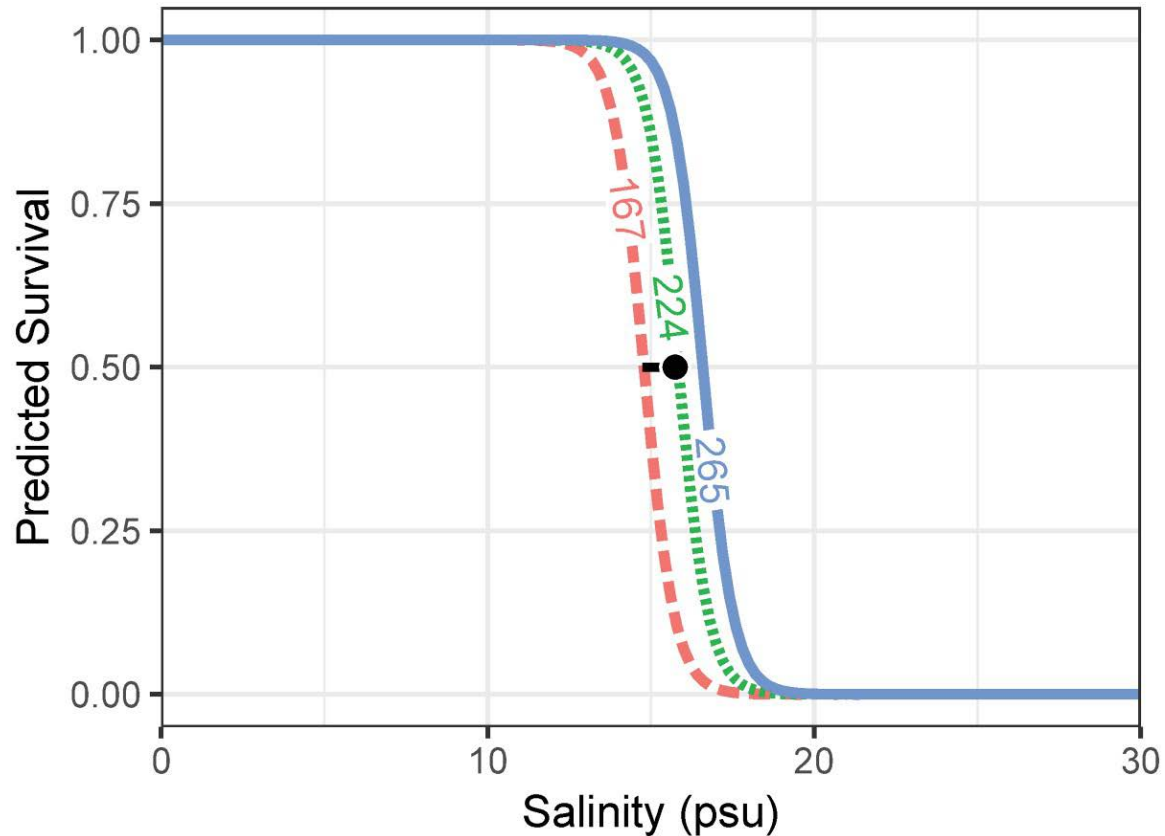At 486 mm --
James: 14,377 eggs/fish
York: 12,568 eggs/fish

Cumulative lifetime fecundity-at-size is greater for James River fish up to age 24

A 25-year old fish can produce 444,000 - 446,000 eggs in her lifetime
(York - James)


Nepal & Fabrizio, *in review*

Predicted survival of blue catfish based on Firth Logistic regression fit to data from the 72-hour salinity tolerance experiment. The point and the bar correspond to the predicted salinity at 50% mortality (LC$_{50}$) and the corresponding 95% confidence interval based on the logistic regression. Numbers along the line represent the minimum, median and maximum length (mm) of blue catfish used in this study.

Nepal & Fabrizio 2019

Trends in predicted mean fork length (FL), Fulton's body condition (K), maximum metabolic rate (MMR), standard metabolic rate (SMR) and factorial scope (FS) of juvenile blue catfish fed ad libitum, two-thirds of ad libitum or one-third of ad libitum ration size over 124 days. Polygons around each line denote the corresponding 95% confidence intervals. Note different y axis scales in different panels.
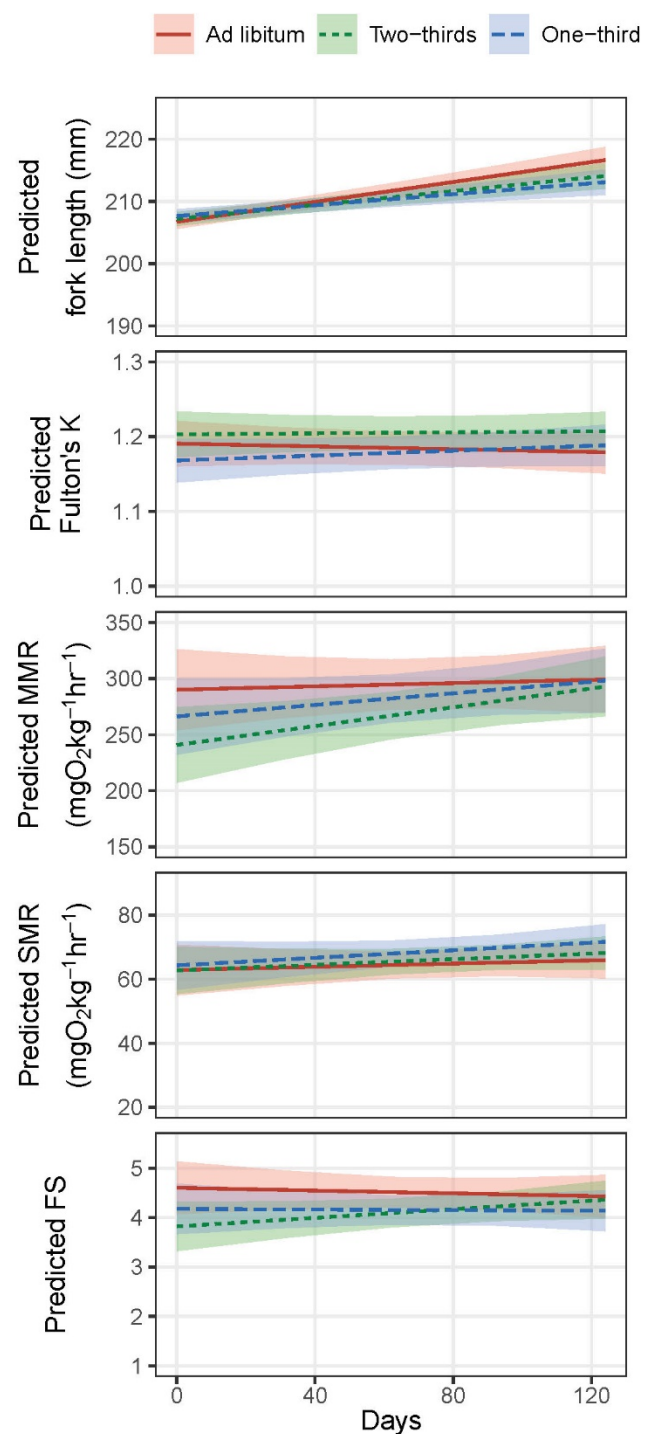
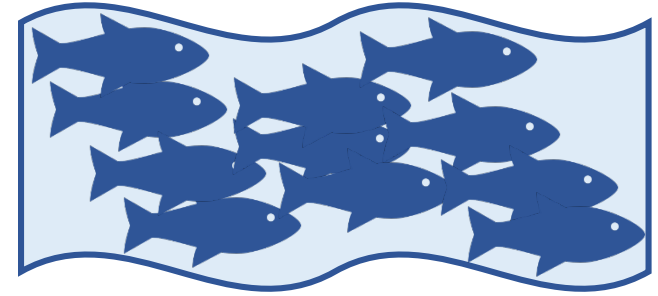# Life-history Characteristics of Blue Catfish during Two Stages of Invasion
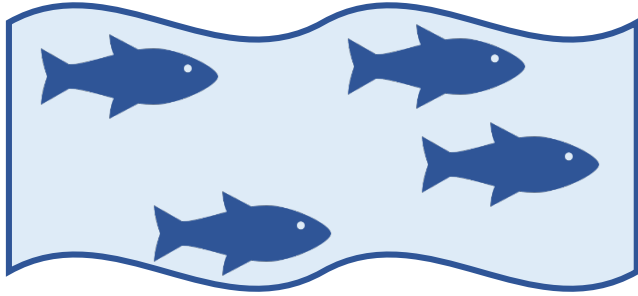
Early (1998 – 2000)
James & York rivers
N=364

Somatic growth rate
Body condition
Reproductive allocation
Mean size-at-maturity

Recent (2015 – 2017)
James & York rivers
N=1,726

*Reduced densities will diminish the negative impacts of blue catfish on native species, but this will be offset by increased growth rates & higher reproductive output