hot herring:
exploring the effects of temperature on juvenile river herring

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Eighth Annual Meeting
Oct 18, 2018

USGS science for a changing world

Note: all results are from a pilot study and are preliminary.

- These results are currently unpublished.
- Please contact Lian Guo (lguo@umass.edu) if you have questions about this research.


Tributaries, Lakes, Ponds (nursery habitat)
Emigration
Adult run timing and size
UNIVERSITY OF MASSACHUSETTS
AMHERST 1863
ENSE PETIT PLACIDAM SUB LIBERTATE QUIETEM

River Herring
Research Team
Graphic by Vasili Luzanau

what affects river herring productivity?

survival

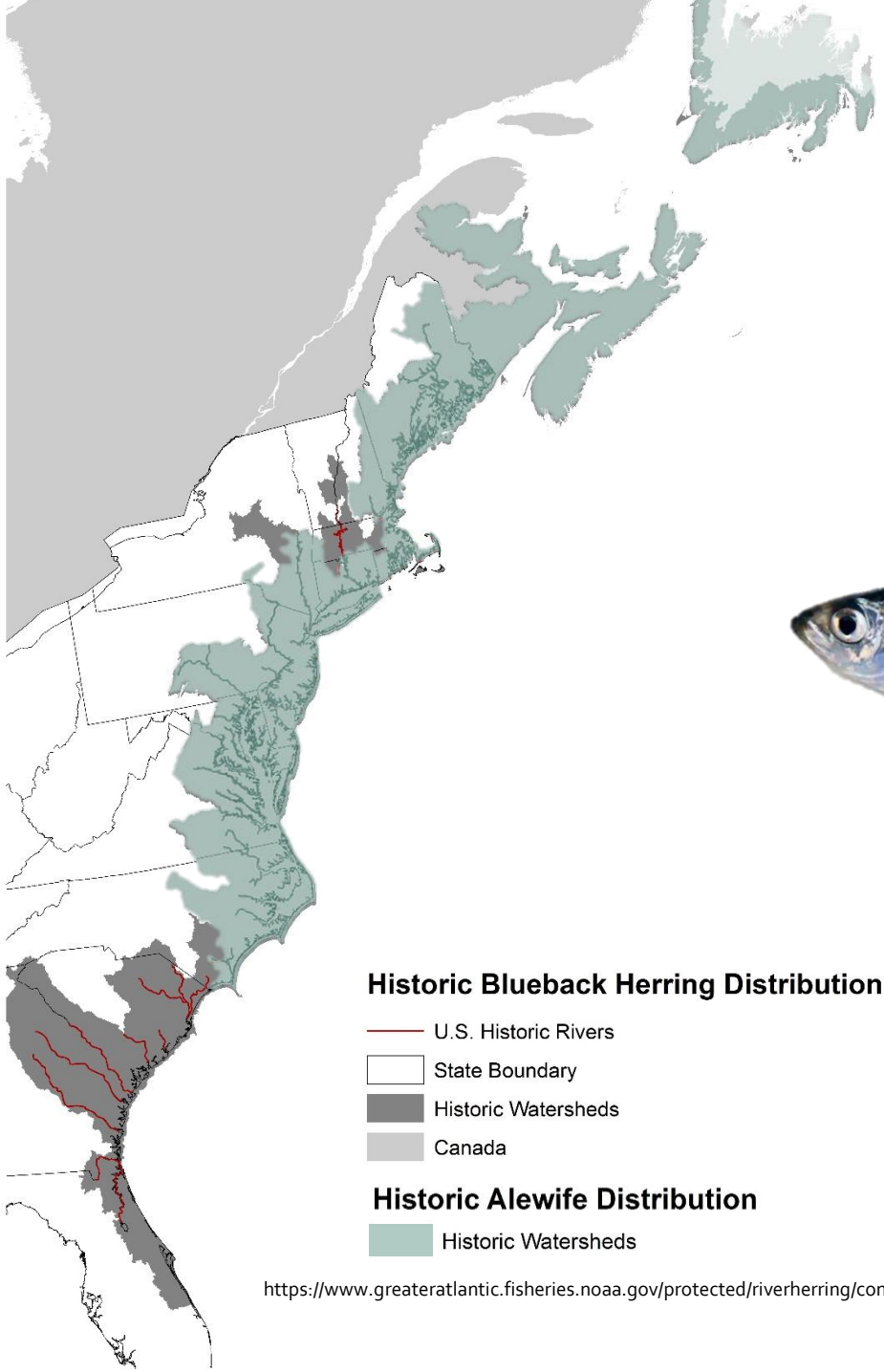
growth

reproduction

Blueback herring (*Alosa aestivalis*)

Alewife (*Alosa pseudoharengus*)

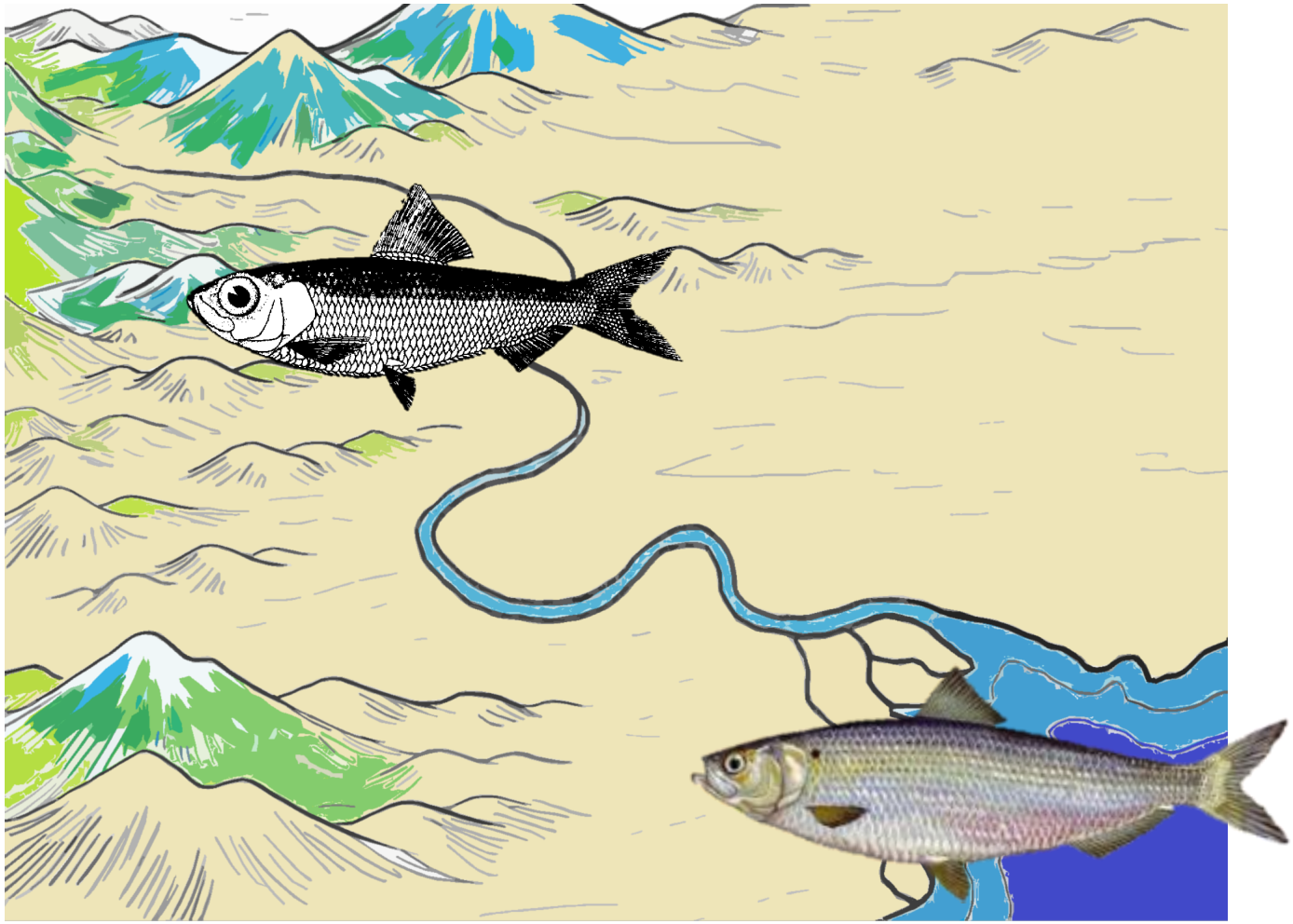
- **decreasing** populations across range
- **disappearing** populations at southern edge
  - related to climate change



https://www.greateratlantic.fisheries.noaa.gov/protected/riverherring/conserv/background/background.html

Nye et al., 2012

why is productivity decreasing in the south?



freshwater systems

- more extreme
- more variable

early development is sensitive

- temperature
- flow

Tommasi et al., 2015

↑ air temperature

how are juvenile river herring affected by temperature and food availability?

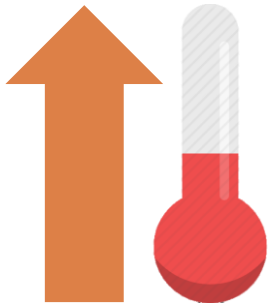
↑ surface temperature

max increase of 0.9°F per decade

↑?↓? food availability

decrease in food amount and quality over summer

linking temperature, food, and physiology



energy use increases

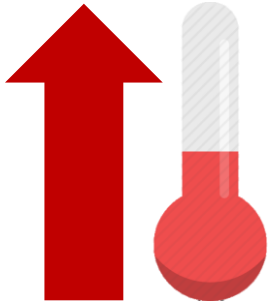
- body processes ↑ rate
- requires more food!

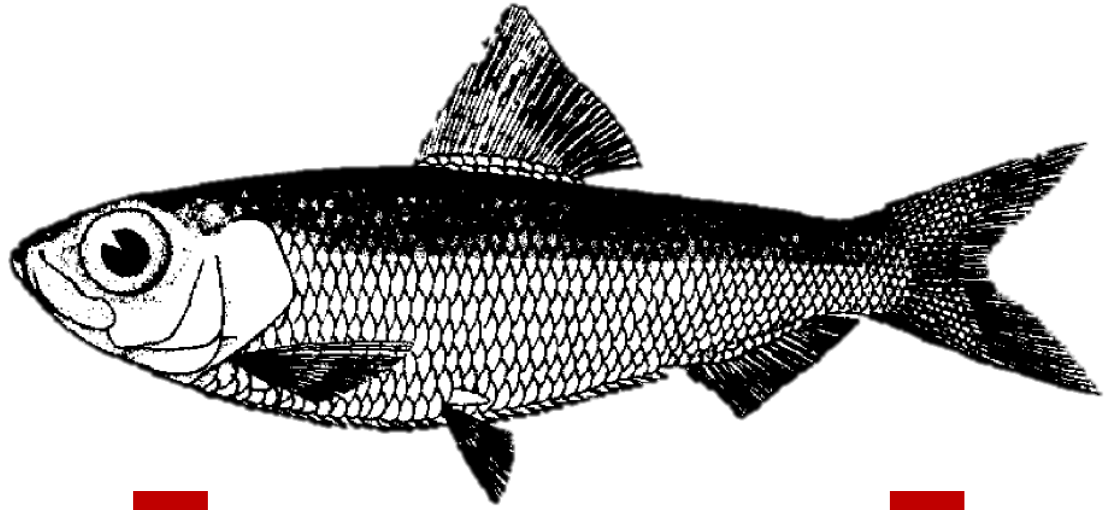
energy supplies many important traits!

- grow
- swim
- make babies
- and others…

what energy is left for these important traits?

as temperature and food levels change, how does that affect…





Energy

Fat content
Protein content

affects

Performance

Growth rate
Swimming ability

affects

Population Success

Survival
Reproductive capacity


high level of control


more natural, repeat measures possible


low control, natural

lab

field enclosures

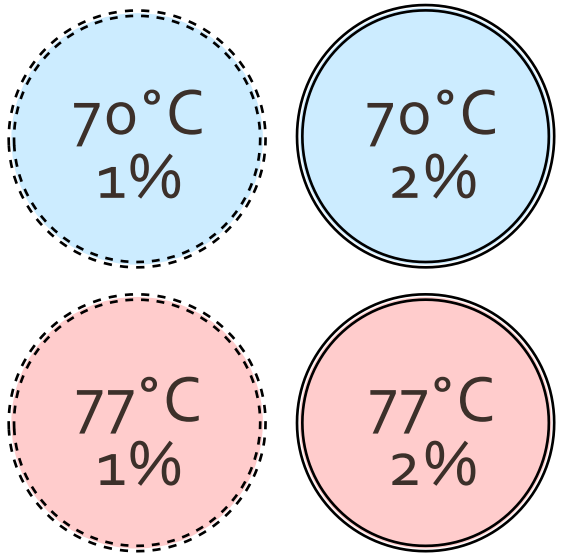
collections

summer 2017 – lab experiment

Juvenile alewife, collected from Upper Mystic Lake, MA in July 2017

Treatments:

Temperature	*Food Ration*
70°C – max growth	2% - high
77°C – high in June in MA ponds	1% - low



2 replicate tanks, 16-23 fish/tank

timeline: 20 day experiment

Growth rate – 13 days

- Average growth per tank

Weights measured

Start treatment

Day 0

Weights measured

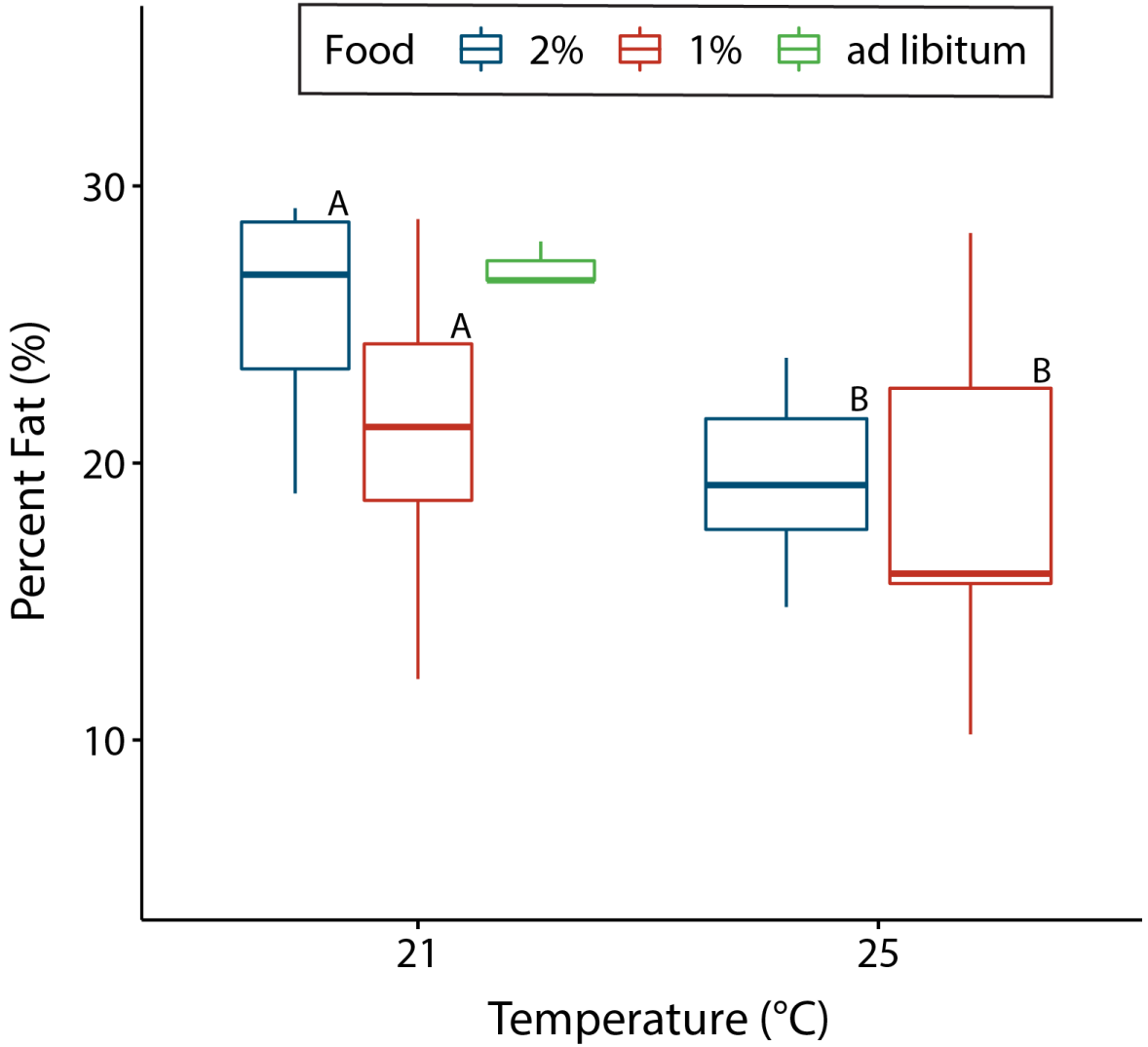
Day 7

Fish weighed and sampled

Day 20

Energy storage

- Fat and protein content per individual



fat storage

less food -> lower fat content

***higher temp. -> lower fat content**

larger fish have higher fat content

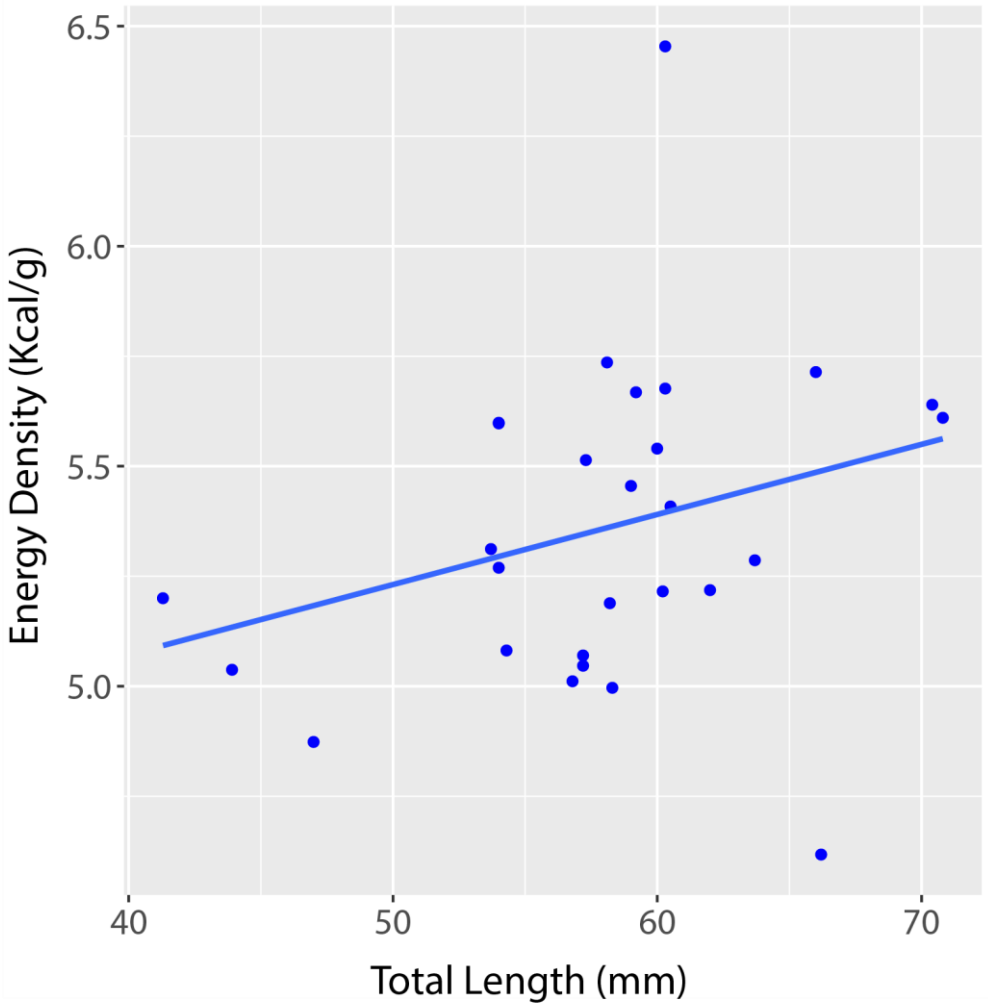
2-way ANCOVA | food: F=2.51, **p = 0.13**, temperature: F=5.98, **p=0.022** [A vs. B], length: F=2.985, **p=0.097**); n=7

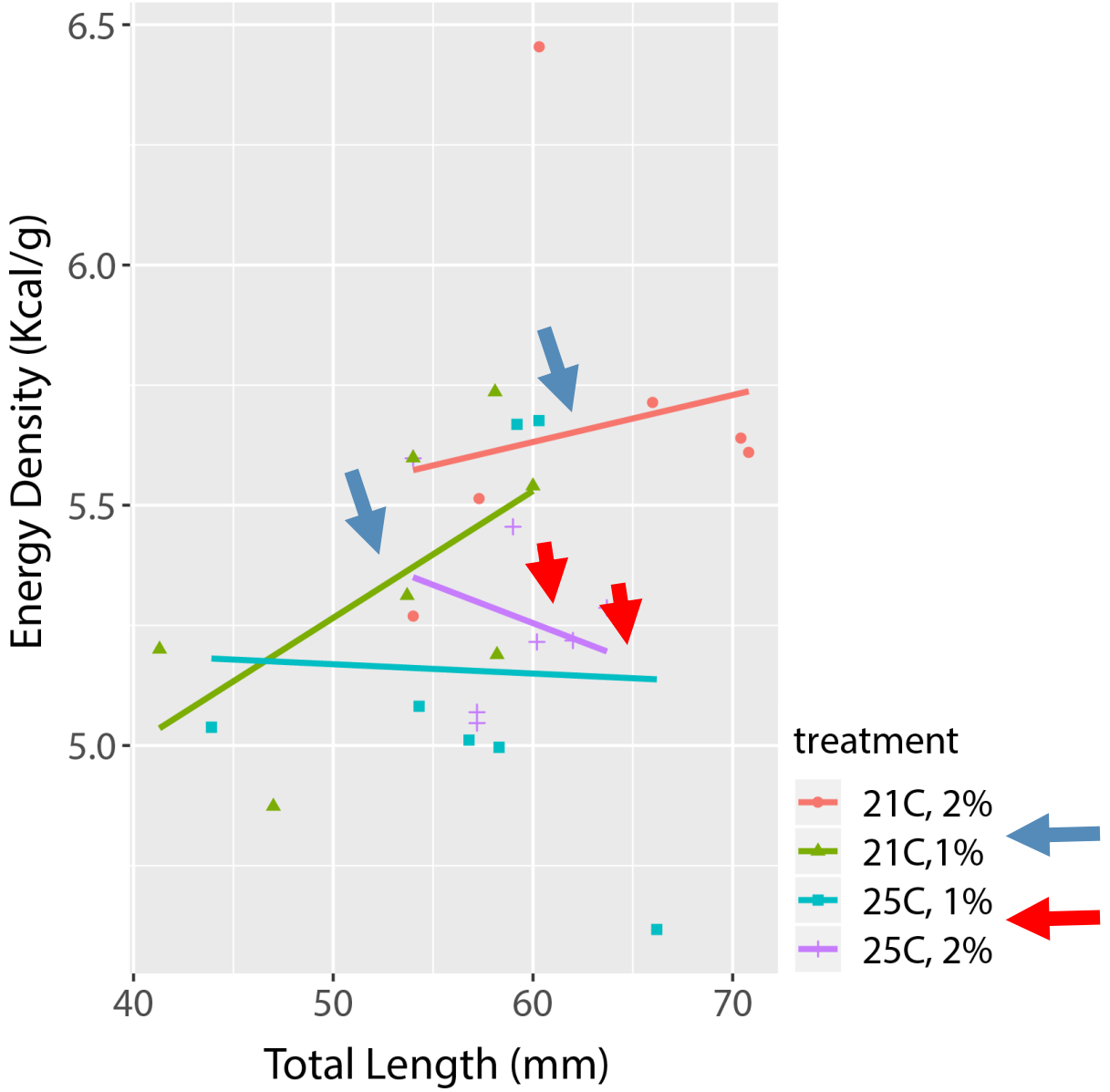
equations

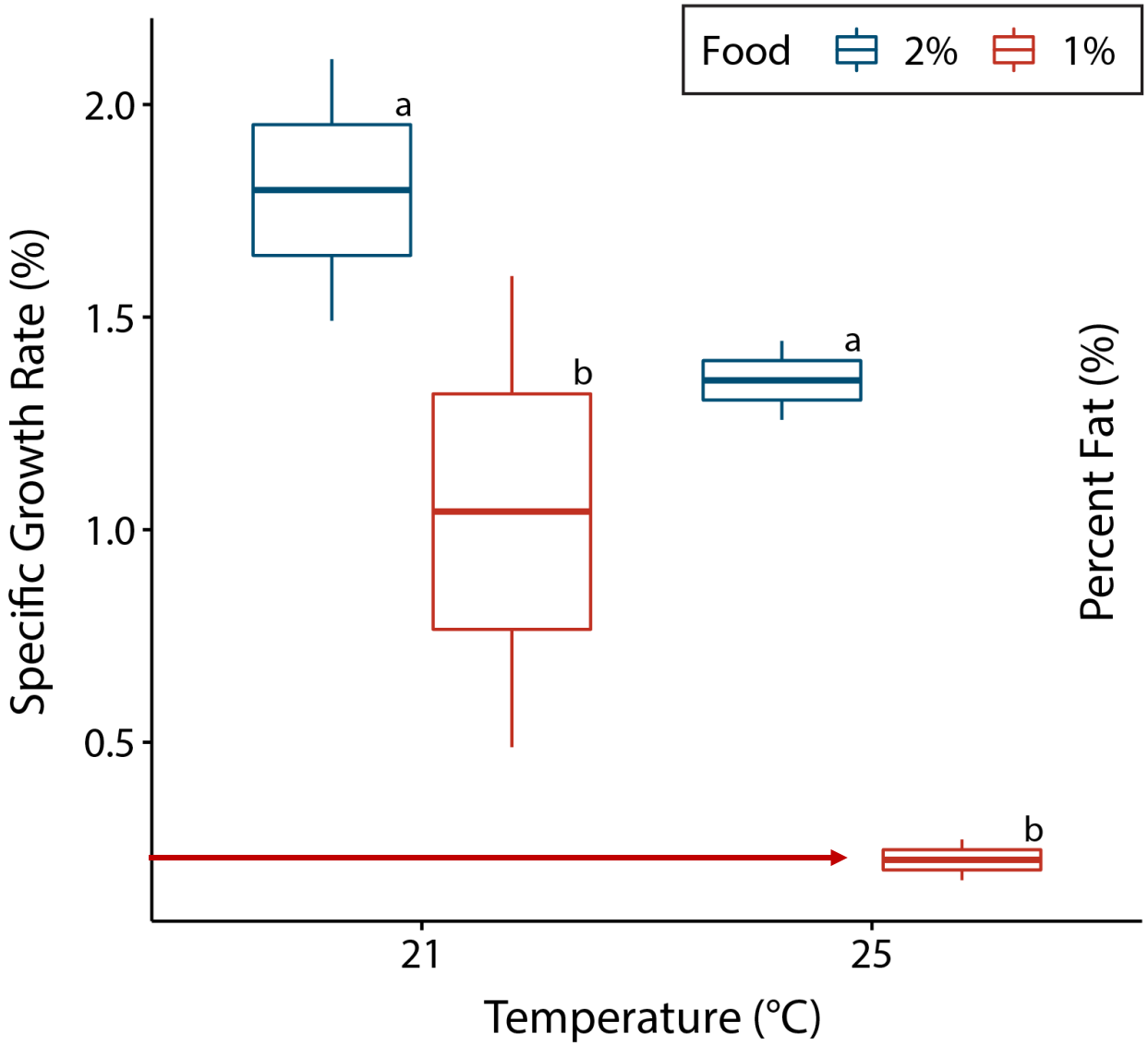
Fat Content

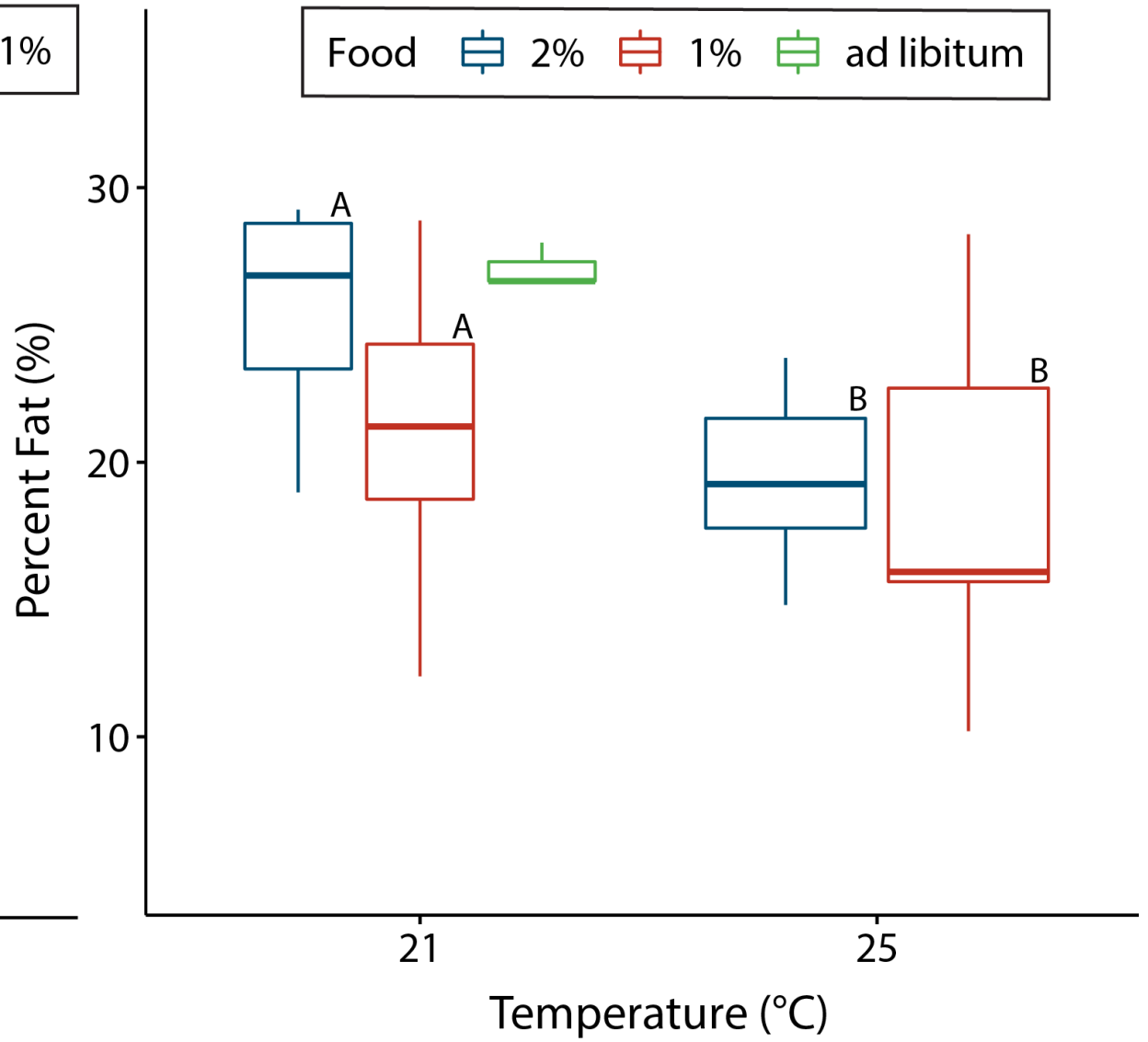
$$f = \frac{\text{g dry fat}}{\text{g dry weight}} \times 100$$

Total energy per gram (fat + protein)



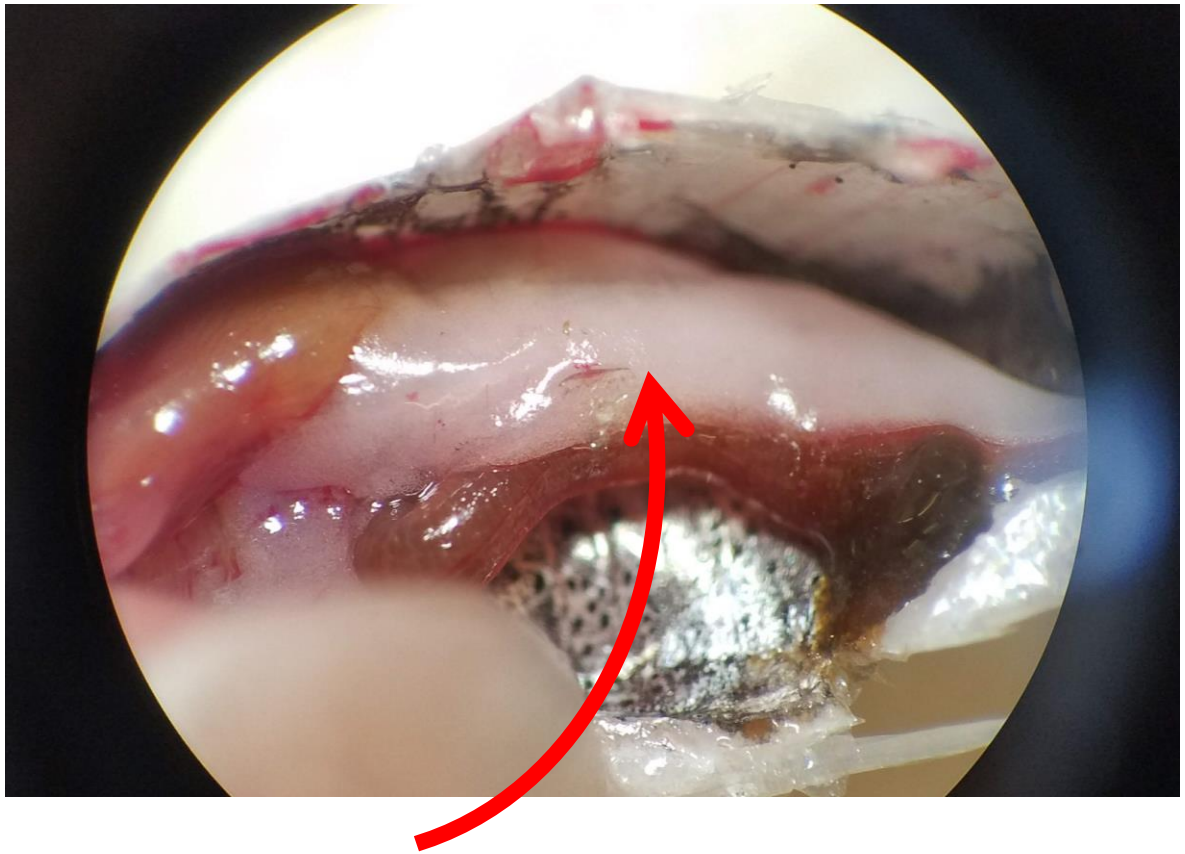






2-way ANOVA | food: F=9.93, **p = 0.025** [a vs. b], temperature: F=4.49, **p=0.088**); n=2

if we see smaller fish, with lower fat content… how does that affect productivity?



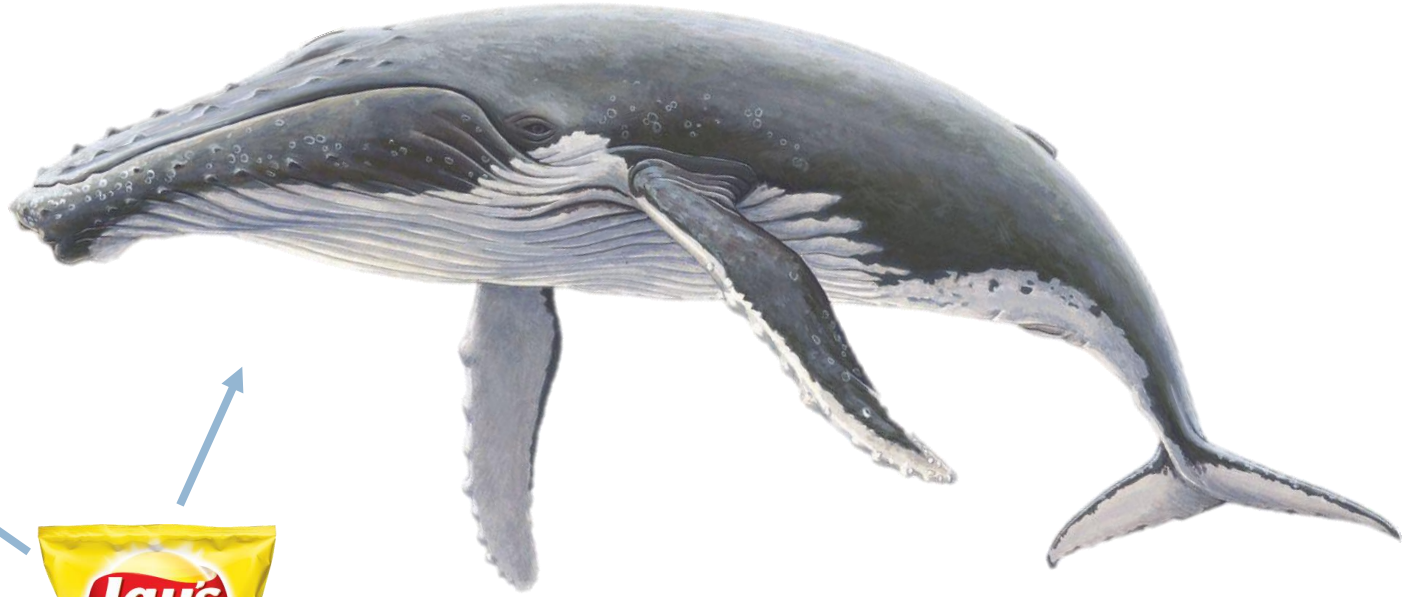
river herring beer belly

survival & growth

- swimming ability
- predator evasion
- emigration
- overwintering

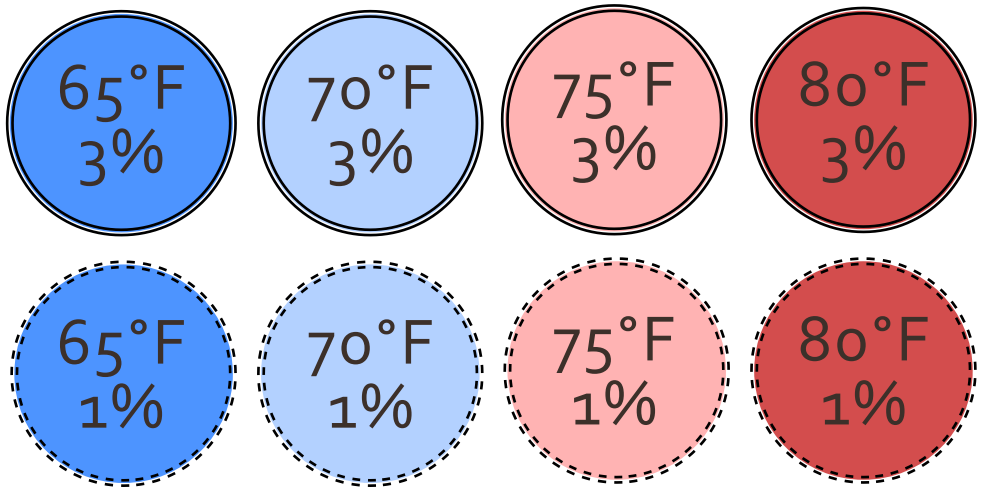
fecundity

- recruitment



less energy for everyone else as well…

planned lab experiments



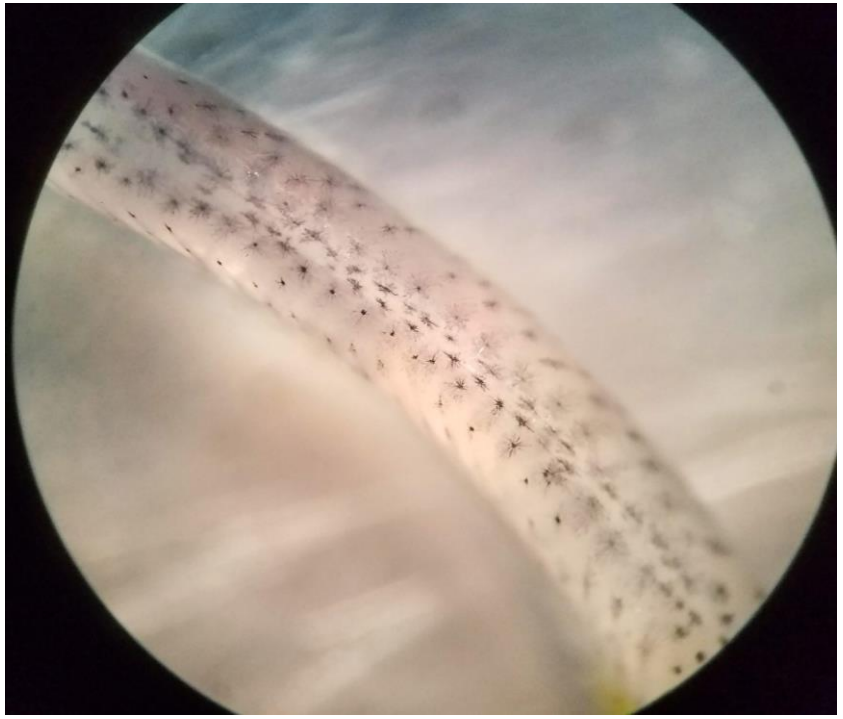
- 4 temperatures
- 2 food rations (% of tank biomass)
- 21 days in experiment

planned fieldwork

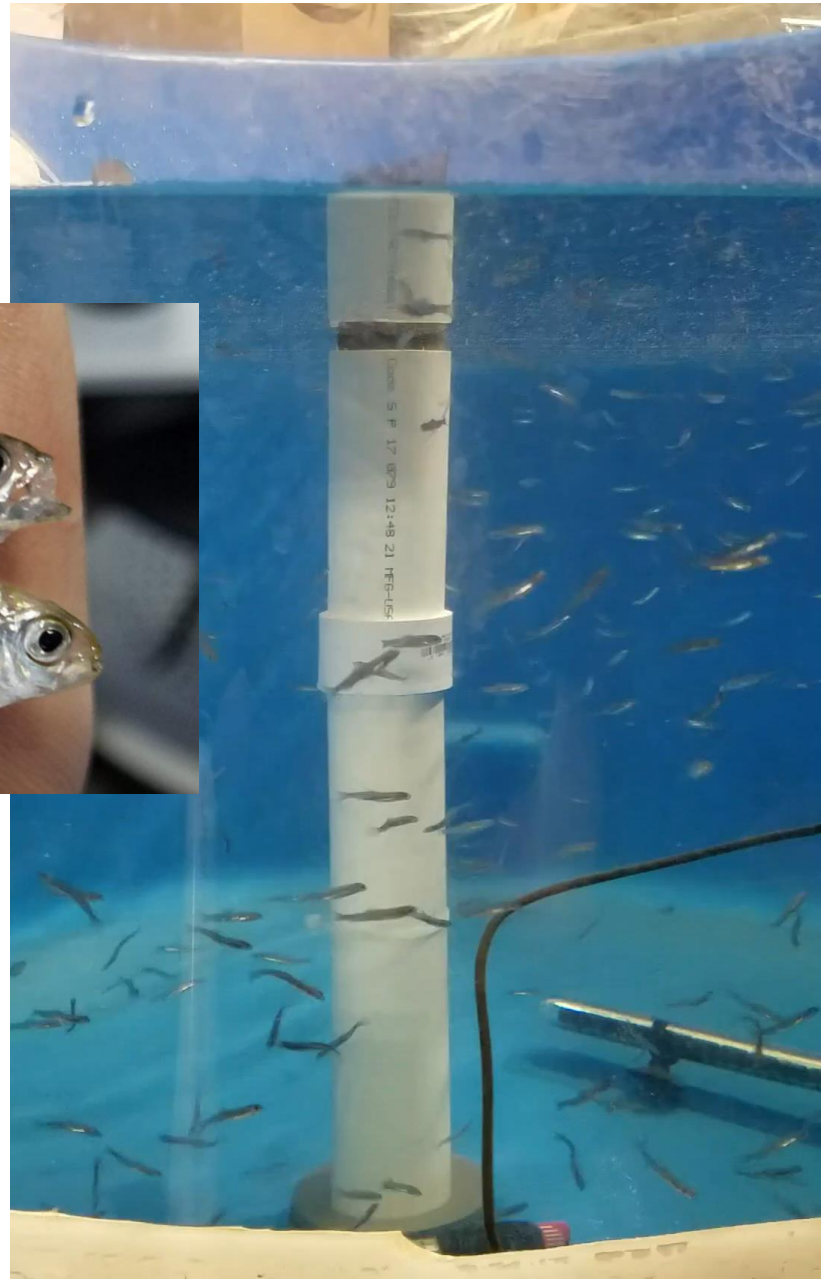
effects of
…natural variability
…multiple stressors

river herring baby photo book

river herring baby photo book



river herring baby photo book



acknowledgements

Dissertation Committee:

Adrian Jordaan, Steve McCormick, Eric Schultz, Alex Gerson

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Amy-Mei Lynch, Kate Froburg, Ashleigh Novak, Matthew Devine, Jason Carmignani, Jessica Norstog, Ciaran Shaughnessy, Vishwa Patel, Bia Dias, Michael Long, Derrick Alcott, Allison Roy, Lisa Komoroske, Brian Cheng, Ayla Skorupa, and Virginia Sowers

Plus…

Charles Forsdick, Jon Velotta, David Berlinsky, Linas Kenter, Yangfan Zhang, Nishad Jayasundara

Fish and Wildlife Service:

Ken Sprankle, Michael Odom, David Dorough, Tim Warren, David Perkins, Keith McGilvray, Kevin Sullivan, Michael Dionne, and Michael Brown

USGS (Conte):

Shannon Bayse, Amy Regish, Matt O'Donnell, Steve Walk, John Noreika, Michael Hayden, Andrew Weinstock, Sam Parker, Marty Garcia, Diogo Martins, and Dan Hall

Funding Sources:

Equal Opportunities Section Travel Award, SNEC Student Travel Award, OEB and ECo graduate programs, UMass Amherst Graduate School

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