Fishing for Answers

How does stress affect behavior in a threatened species?

Author: Lydia Wassink

Age Range: 7th – 9th grade (basic questions) or 10th – 12th grade (advanced questions)

Lesson Time: 50 minutes

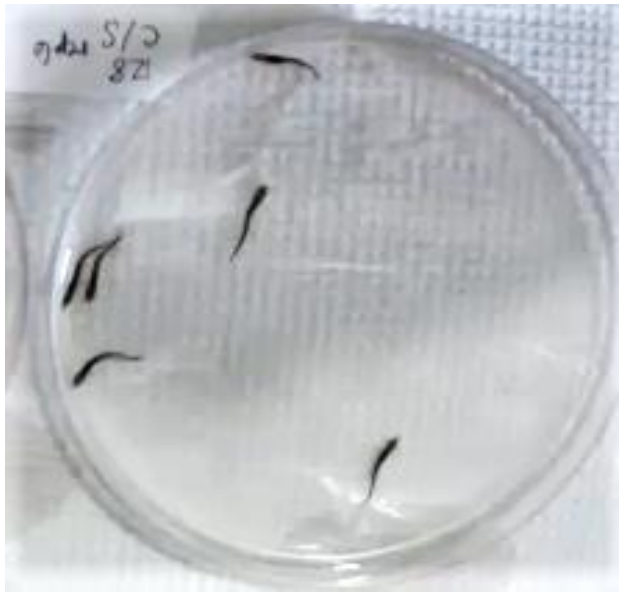


Image: https://fw.ky.gov/Fish/Pages/Lake-Sturgeon.aspx

Thank you to Shaley Valentine for contributing photos, and to Jonathan Hegna for help with learning objectives

Outline

- Lesson Objectives
- Lake sturgeon background
- Explanation of temperature experiment
- Activity instructions + Discussion questions

Objectives

Composite learning objective: Students will comprehend the connection between environmental stressors and relevance for wildlife conservation, through investigating the effect of temperature on swimming activity in lake sturgeon larvae.

Knowledge outcomes:

- Explain why stress affects behavior, and more specifically, why changes in temperature affect lake sturgeon
- Describe importance of understanding how environmental stressors affect wildlife

Skill outcomes:

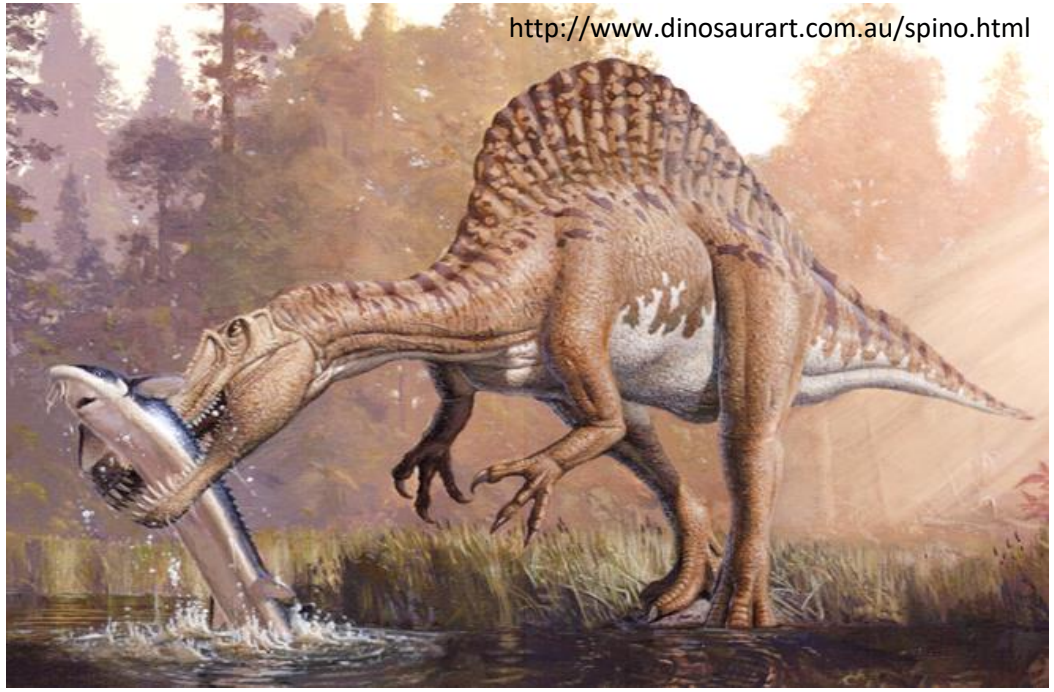
- Collect data from a video of lake sturgeon larvae swimming activity
- Calculate and visualize means of two treatments using a graph
- Compare two treatments using graphed data and draw a conclusion about the treatment effect

Disposition outcomes:

- Develop awareness of how environmental stressors related to climate change have a profound effect on threatened wildlife species
- Develop an appreciation for using animal behavior studies to help inform conservation and management efforts
- Develop an appreciation for quantifying stress or behaviors to gain a more complete picture of developmental mechanisms

Sturgeon background

- Sturgeon have been around since the Triassic, but are now threatened
- Lake sturgeon were overharvested for caviar
- Habitat disturbance and climate change are also a problem for their populations



http://www.dinosaurart.com.au/spino.html

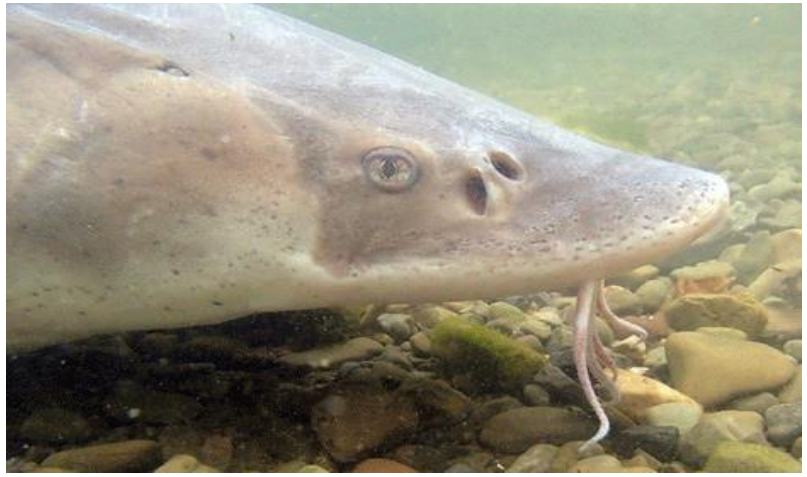
https://rainiervalleyangler.org/2014/08/26/upper-yakima-teanaway-mouth-to-thorp-dam/

https://www.caviarrusse.com/products/siberian-sturgeon

Sturgeon background

- Lake sturgeon are cartilaginous fishes (like sharks)
- They are bottom feeders and have no teeth, using sensory organs called barbels to find food
- Rows of bony, armor-like scutes along back and sides
- Can grow to 200 pounds and over 6 feet long!

Photo credit: Shaley Valentine



https://www.fws.gov/fisheries/fishmigration/lake_sturgeon.html

Sturgeon background

- Sturgeon can live 80+ years, and don't start spawning until in their 20s
- To spawn, sturgeon leave their lake and swim upriver to lay eggs

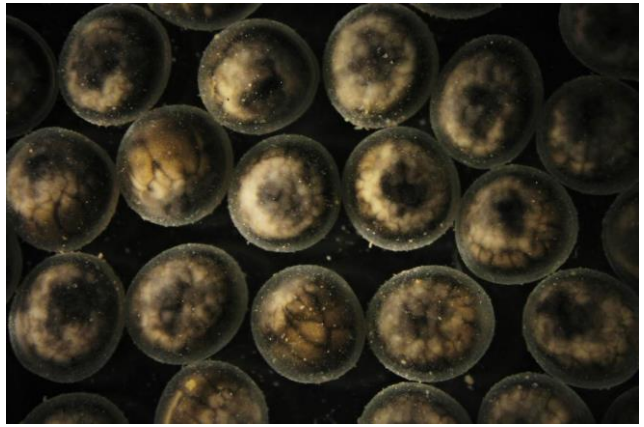
Photo credit: Shaley Valentine

https://dnr.wi.gov/topic/Fishing/Sturgeon/sturgeonguard.html

- The spawning season is usually May-June
- Spawning is cued by water temperature, river discharge, and other signals from the environment

Sturgeon background

- Baby sturgeon hatch in the river as a free embryo, with yolk sac attached
- After burrowing into riverbed and using up their yolk sac, sturgeon reach the larval stage
- Sturgeon larvae drift downriver back to the lake, and are vulnerable to predators on the way



Sturgeon background

- During their first year, lake sturgeon experience 99% mortality, due in part to predation
- Most that are large enough will eat sturgeon larvae (burbot, crayfish, and pike, pictured below, are all sturgeon predators)

- As they grow, lake sturgeon develop rows of armor-like bony scutes along their backs and sides that protect them from predators

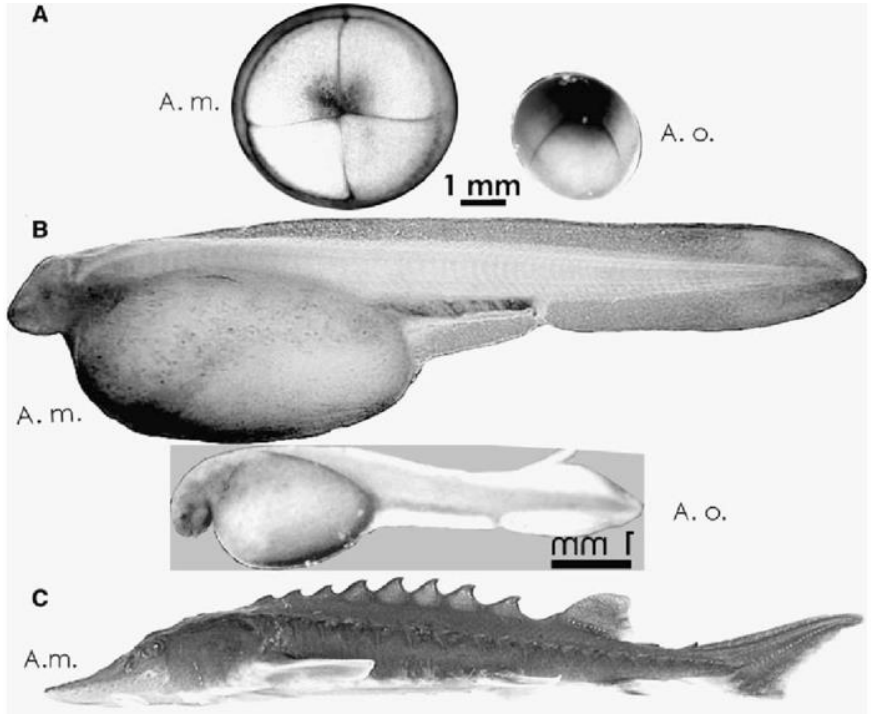
https://dnr.wi.gov/topic/fishing/sturgeon/lakeSturgeonIdentification.html

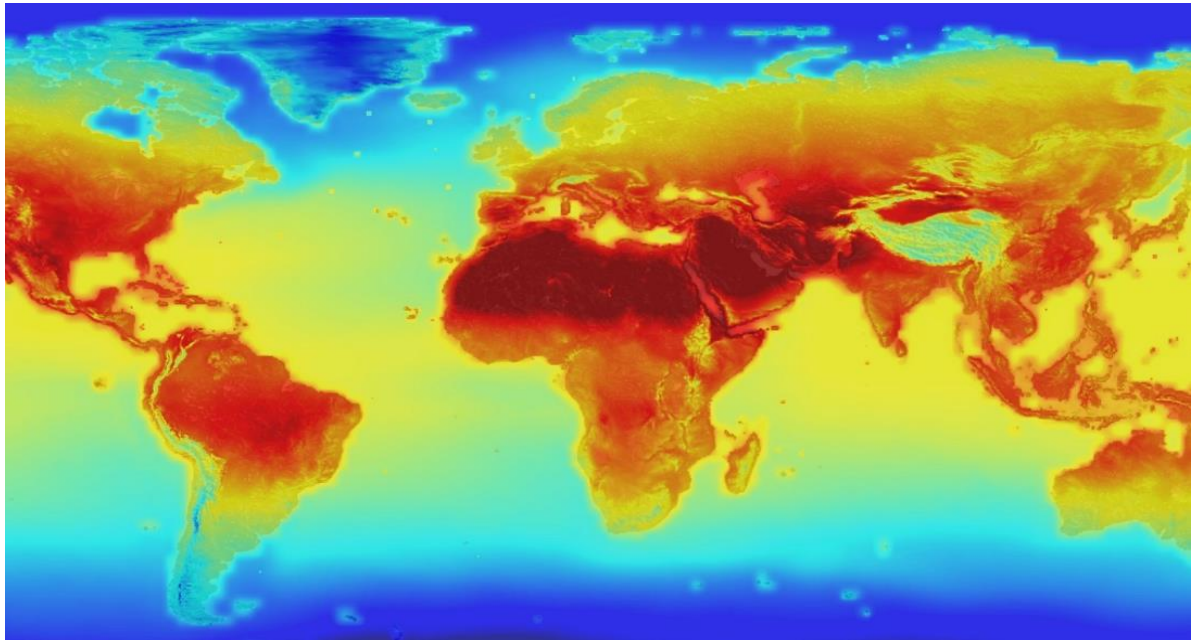
Stress and Behavior

- Stress causes changes in behavior in many animals
- These changes usually have to do with reduced risk-taking, social withdrawal, or intensified responses to a threat
- Scientists are interested in what these stress-related changes mean for animals in real-life contexts in nature
- For example, what do these behaviors mean for animals in the face of threats like a predator?

Temperature and Stress

- High temperatures have been shown to cause stress to sturgeon during early life stages
- During the sturgeon spawning season in May-June, temperatures in the river range from 50 to 65 degrees F
- The warmer temperatures may affect stress, behavior, and survival of hatching sturgeon
- Especially important to understand in light of climate change





Black Lake Sturgeon Research

- Conservation programs are trying to help sturgeon populations
- The Black River Streamside Facility near Cheboygan, MI is a hatchery that raises sturgeon every summer to release in the fall

https://upnorthlive.com/news/local/thousands-of-lake-sturgeon-released-to-increase-population

Black Lake Sturgeon Research

- Every spring, the Black Lake crew capture the sturgeon spawning in the Black River
- We collect data to learn more about the sturgeon population - their movements, genetic structure, and individual growth
- We also collect eggs and sperm to take to the hatchery and produce hundreds of offspring for release

https://www.freep.com/picture-gallery/news/local/michigan/2018/05/24/volunteers-keep-look-out-over-sturgeon-in-black-river/35312885/

Black Lake Sturgeon Research

- Eggs are taken back to the hatchery and fertilized
- Every field season, we design experiments on behavior, ecology, and genetics of our lake sturgeon
- Experiments in the hatchery help us understand threats to lake sturgeon populations and what we can do to protect them

Photo credit: Shaley Valentine

Temperature Experiment

What we already knew: Larval sturgeon are stressed by warm temperatures. In other animals, stress causes changes in behavior (higher activity, reduced risk-taking) that can affect survival.

Observations!

What we wanted to find out: Does stress from high temperature affect sturgeon behavior?

Research question!

What we thought was happening: Warm temperature during early life stages changes development of the stress axis, a physical process that controls reactions to stress. Changes to stress axis development in turn change an individual's stress-related behaviors.

Hypothesis!

What we expected to see: Sturgeon larvae raised in warm temperature have higher activity levels (they spend more time swimming).

Prediction!

Temperature Experiment

Photo credit: Shaley Valentine

Eggs were collected from 4 female lake sturgeon, fertilized, and raised in either a warm (high-stress) or cold (low-stress) temperature until the larval stage

10 degrees C incubation

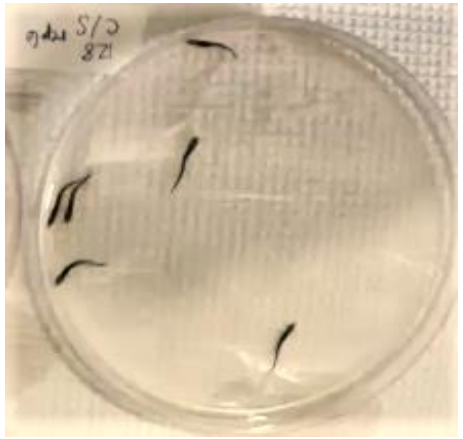
low stress

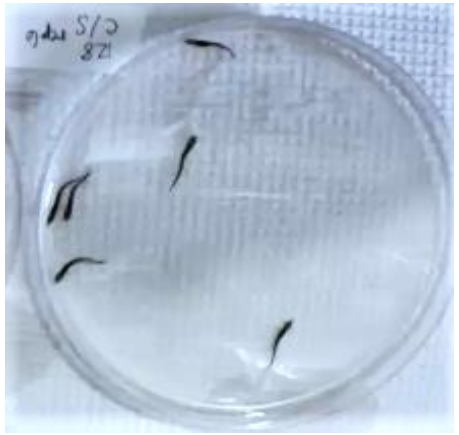
18 degrees C incubation

high stress

Temperature Experiment

- Videos were recorded of sturgeon larvae from warm temperature and cold temperature
- The swimming activity of larvae from each treatment can now be compared to answer our research question
- **Do you think we'll see a difference between treatments? What will the difference be? What will this tell you about effects of temperature and stress in lake sturgeon?**





Discussion questions (before activity)

Basic questions (7th to 9th):

- What kinds of behaviors or swimming activity do you expect to see in stressed sturgeon larvae? In non-stressed sturgeon larvae?
- What kinds of behaviors or swimming activity do you think might be important for sturgeon to avoid predators?

Discussion questions (before activity)

Advanced questions (10th to 12th grade):

- How can understanding the connection between stress and behavior help inform lake sturgeon conservation programs?
- We usually think of stress as a bad thing, but some stress-related behaviors can help animals avoid predation. However, behaviors that are helpful in the short-term can have long-term costs. Come up with three stress-related behaviors that were mentioned today. For each one, propose a short-term advantage and a long-term cost.

Activity Instructions

- Access the videos here: https://drive.google.com/open?id=1LkE5rBLDTpakxYxSAT7SblMvaVIbxXxo
- There are 10 “Cold Treatment” and 10 “Warm Treatment” videos
- Each video shows 4 petri dishes, each containing 6 larvae. Students can analyze any of the petri dishes and choose any of the larvae.

Activity Instructions

- Once you've identified an individual to track, use an online stopwatch to record the number of seconds the individual is active
- When the larva is moving, the stopwatch should be running
- Pause the stopwatch when the larva stops
- Track your larva for the first minute of the video, then pause. Go back to 0:00 and pick another individual to track. Repeat until you have tracked 4 different larvae
- You should now have 4 datapoints, each of which is the total # seconds of activity for a larva during the first minute of the video

Pick one sturgeon larva to track, and keep your eye on this one for the first minute of the video

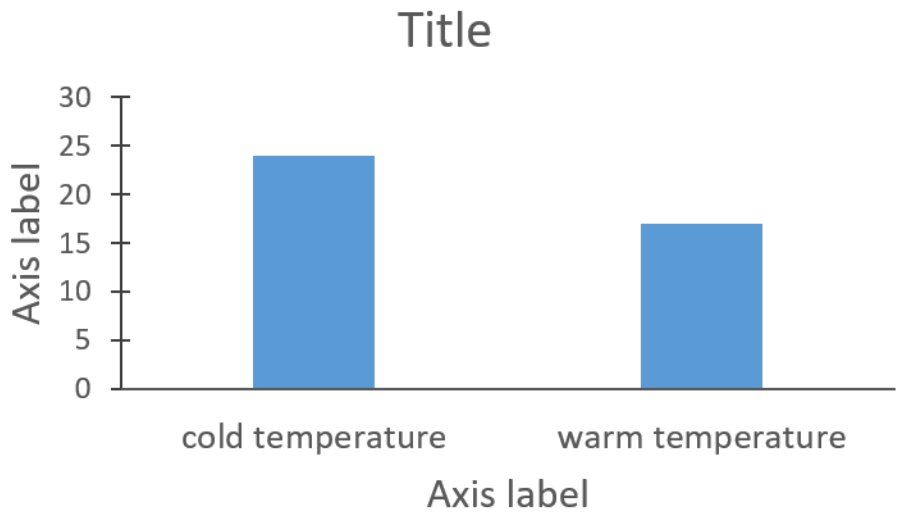
Dataset

Warm Treatment

Cold Treatment

Activity Instructions

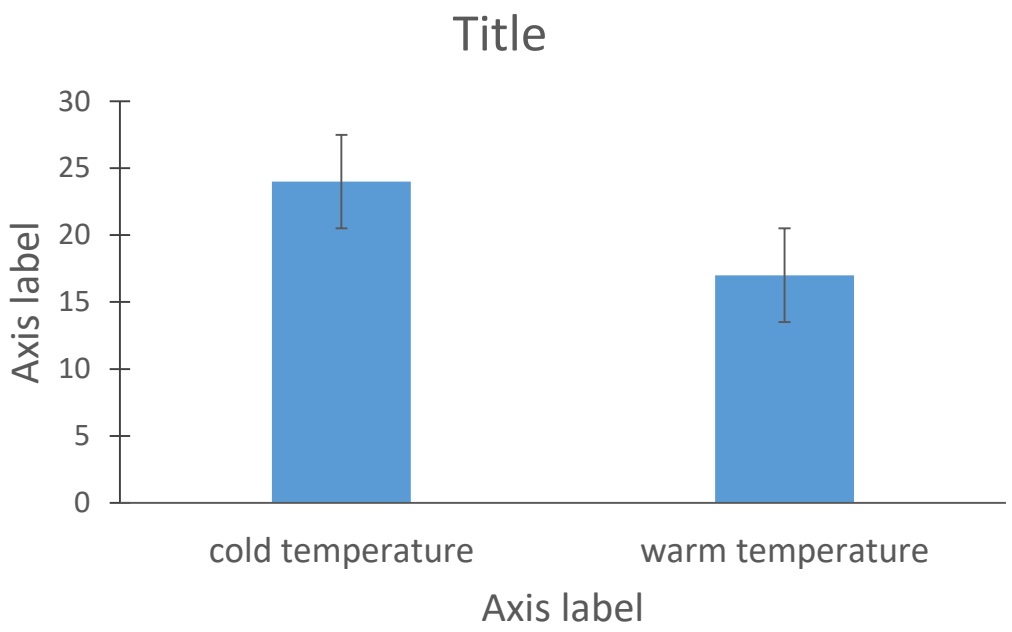
- Combine the individual datapoints collected by the class to form a dataset - one for Cold Treatment, one for Warm Treatment
- Calculate the mean seconds active for Cold Treatment, and mean seconds active for Warm Treatment
- Graph the means using a bar graph, with axes numbered and labeled. Graph paper or lined paper can help you draw it. Don't forget units!
- Use the graph to draw a conclusion – what does this experiment tell you about how temperature affects larval sturgeon?



Activity Instructions (advanced)

- Calculate standard deviation along with the mean
- Add error bars to your graph to show the variation around the mean
- **Why is it useful to know the variation? What does it tell you about the effect of the temperature treatment?**

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$



Discussion questions (after activity)

Basic questions (7th to 9th):

- What's the difference in activity between the two treatments? What does this tell you about how temperature affects lake sturgeon?
- How do you think the behaviors you observed will influence the sturgeon larvae's ability to avoid predation?

Discussion questions (after activity)

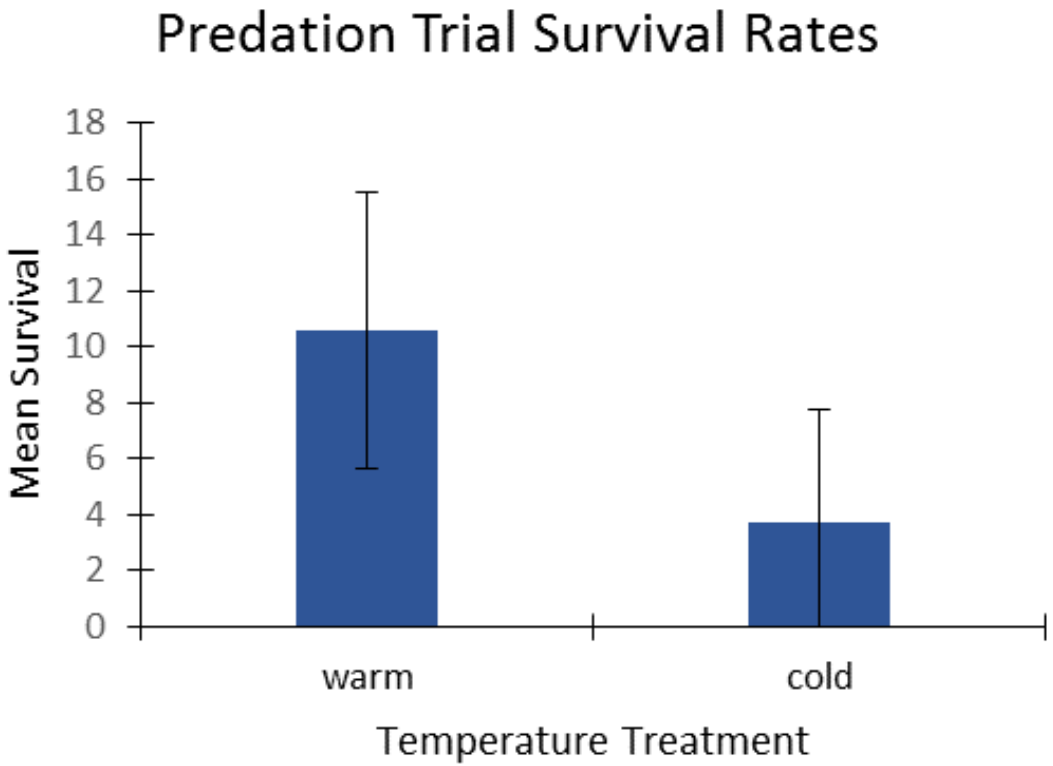
Advanced questions (10th to 12th):

- What is the broader implication of our discoveries from this experiment? What kind of "big picture" do we now have about how climate change might be affecting threatened wildlife species like lake sturgeon? What pieces of the picture do we still need?
- How are the results of this information useful to conservation and management for lake sturgeon specifically? How about for threatened wildlife generally?
- If you want to better understand the effects of temperature on lake sturgeon behavior and predation, what kind of experiment would you design next?
  - What is your hypothesis?
  - What kind of data would you collect?
- If you want to better understand how climate change may be changing predation rates of a threatened species, what other kinds of studies would be useful?

(For example, how is the population and behaviors of the predator being affected? Also mention that ecological factors are complex and usually there are interactions between factors.)

Temperature and Survival

- In another part of the temperature experiment, we exposed larvae from warm and cold temperatures to a crayfish
- We found that larvae from the warm temperature had much higher survival rates
- **Why do you think this happened? (Use your behavior video findings to interpret the predation results!)**



Visit our website for more sturgeon-themed lesson plans, as well as other resources for K-12 classrooms!

https://www.glsturgeon.com/