WHERE IN THE WATER IS THE ATLANTIC STURGEON?

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Grade Level
High School

Subject Area
Environmental Science

The Virginia Scientists & Educators Alliance (VA SEA) is a project of William & Mary's Batten School & VIMS Office of Outreach and Engagement. The VA SEA project is made possible through funding from VIMS, Virginia Sea Grant, the National Science Foundation, and the MacWhorter Family.

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Sea Grant
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Title: Where in the Water is the Atlantic Sturgeon?

Focus:

While investigating where Atlantic sturgeon are found in the Chesapeake Bay, students will explore abiotic stressors and characterize habitat preference and use.

Grade Level:

Environmental Science

Virginia Standards of Learning:

ENV.1 The student will demonstrate an understanding of scientific and engineering practices.

ENV.5 The student will investigate and understand that the Earth is one interconnected system through which energy and matter flow.

a. An ecosystem is composed of both biotic and abiotic factors.
b. Biotic factors may limit population growth in a given area.

Learning Objectives:

The student will:

- Characterize an optimal, preferred habitat of the Atlantic sturgeon.
- Use simulated field data to draw conclusions.
- Create a defensible proposal to policy makers.

Total length of time required for the lesson:

60 min

Vocabulary:

Abiotic factor: non-living component of an environment.

Anadromous: a fish that migrates from the ocean to freshwater to spawn.

Biotic factor: living component of an environment.

Endangered: a species that is at risk of extinction.

Environmental DNA (eDNA): genetic material like skin cells, feces, urine, or eggs, that comes from a living organism and is put into the environment.

Estuary: a body of water semi-enclosed to the ocean that experiences a mixing of fresh water and salt water.

Hypoxia: low oxygen.

Migrate: to move from one area to another based on seasons.

Overfishing: the act of depleting a stock of fish.

Suboptimal: Less than the best possible quality.

Substrate: material that makes up the bottom or surface layer of an environment.

Tributary: a river that flows into a large body of water.

Background Information:

The Atlantic sturgeon (*Acipenser oxyrinchus*) is an ancient fish that as adults, move from the ocean into the Chesapeake Bay in summer months to feed, then upriver to spawn in the fall. Overfishing in the Chesapeake Bay has caused a heavy decline in Atlantic sturgeon populations, so as a response they have been placed under protection of the Endangered Species Act (ESA) in 2012. However, the population has not seen as much of a comeback as expected according to the Atlantic States Marine Fisheries Commission. With little to no fishing, there might be another cause for the lack of population growth. Habitat quality is vital for spawning sturgeons and early life stages when they are small and vulnerable. Temperature and oxygen are two abiotic factors that could be creating less than great habitat conditions as our climate changes. High temperatures and low oxygen are unfortunately climatic stressors that can hold back a population from thriving. It is important to understand what habitat conditions Atlantic sturgeons prefer to inform management, but how do we know what habitat they will prefer?

Environmental DNA (eDNA) is DNA that can be found in the environment after being shed from an organism. eDNA sampling is a low effort method for monitoring Atlantic sturgeon presence which can be difficult to track when there are so few and are migratory. The fieldwork involves going to different sites and sampling water. That water would then be brought back to a lab for filtration, followed by DNA extraction and quantitative PCR. These are just steps in a process that will produce a relative quantification of Atlantic sturgeon DNA. Using the relative number of sturgeon DNA, we can make assumptions of where in rivers they favor. When we pair location with environmental factors like temperature, dissolved oxygen, and sediment type, we get a further characterization of habitat preference and early life success.

Materials & Supplies:

- Plastic strainers
- Coffee filters
- Paper bowls
- Clear & colored transparent beads
- Small paper cups
- Paper towels (optional if using water)

Teacher Preparation (~30-45 minutes):

Teachers will need to assemble each site (8) and station for filtering for each group. Worksheets and handouts will need to be printed. Handouts can be laminated for continued use. This activity is suitable for a group of 4-5 students.

Site Set Up

1. Each group needs eight small paper cups, labeled 1-8.
2. Each cup should contain 20 beads made of a mix of clear white beads and clear colored beads as laid out below:

Beads	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Clear white beads	4	2	10	6	16	12	14	8
Clear colored beads	16	18	10	14	4	8	6	12

3. Each cup will be filled with water, just enough to cover the beads.
    a. Water is optional.
4. Each group will get a plastic strainer, one paper bowl, eight coffee filters, and the eight cups of beads.
    a. Paper towels may be needed if using water.
5. Each group will get one set of handouts, and each person will get a worksheet to fill out.
6. Optional: If on hand, give each group gloves and forceps to emphasize sterile technique.

Procedure:

1. Work through slides and give time for students to answer questions when appropriate.
2. Have students filter one sample at a time.
    a. Place a filter in the plastic strainer.
    b. One student will hold the filter and strainer over the paper bowl, while another student can pour a sample/cup of water through the coffee filter.
3. They will then pick out from the filter all the clear WHITE pony beads, count and record them on their work sheet.
4. They will repeat this process for all eight cups making sure to change out their coffee filter each time to emphasize the idea of sterile technique.
5. They will also record any field data from the provided mock field data sheet by filling in the table on their work sheet.
6. Once completed they will fill in a bar graph and answer some questions about their findings.

Assessment:

1. Questions will be asked during the PowerPoint presentation for groups to discuss and answer verbally.
2. Students will complete a worksheet with a data table, short answer questions and one long answer question.

References:

Atlantic Sturgeon. Atlantic States Marine Fisheries Commission. (2025, February 11). https://asmfc.org/species/atlantic-sturgeon/

Bemis, W. E., & Kynard, B. (1997). Sturgeon rivers: an introduction to acipenseriform biogeography and life history. *Environmental Biology of Fishes*, *48*, 167-183.

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Wang, S., Yan, Z., Hänfling, B., Zheng, X., Wang, P., Fan, J., & Li, J. (2021). Methodology of fish eDNA and its applications in ecology and environment. *Science of the Total Environment*, *755*, 142622.

Handouts/Worksheets:

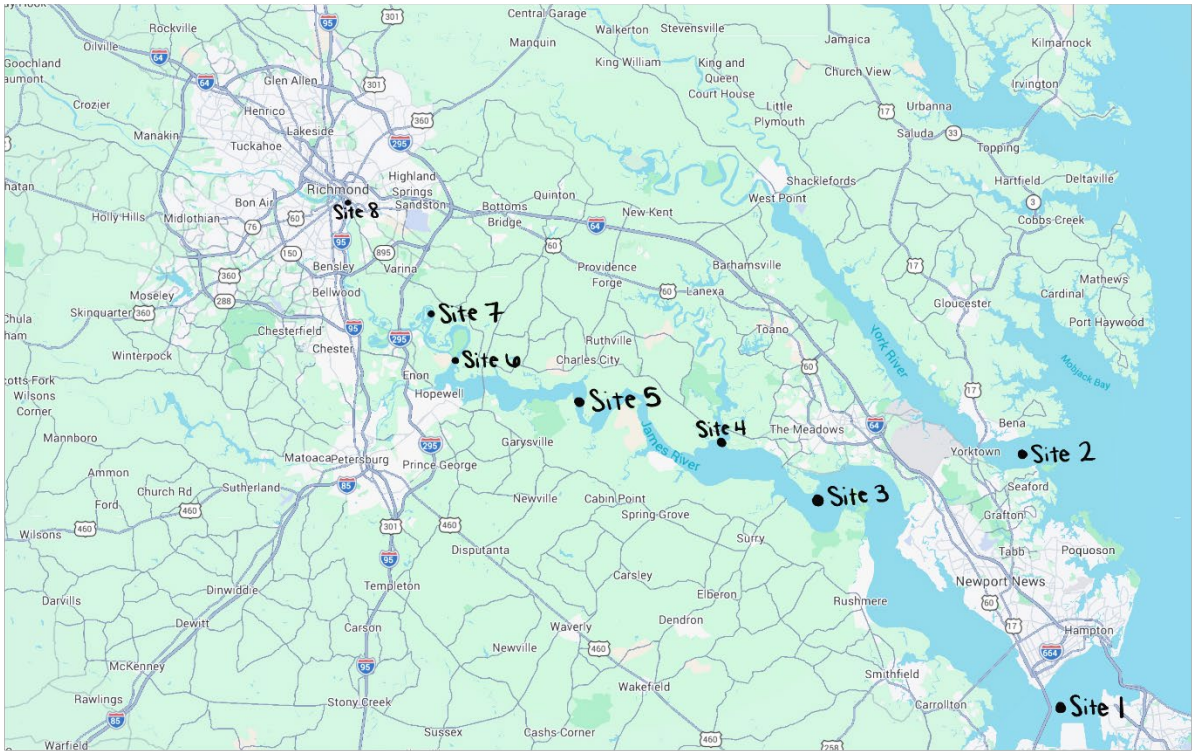
Begins on the following page.

Where in the Water is the Atlantic Sturgeon?

Introduction:

The Atlantic sturgeon or the *Acipenser oxyrinchus*, is an ancient fish that was at one time abundant in the upper rivers of the Chesapeake Bay, but due to overfishing, their population has declined and is still struggling. Researchers want to know what is holding them back. Is it climate change? Is it insufficient habitat? We want to be able to characterize their whereabouts and where they like to hangout, but the migratory species can be difficult to find. We need help finding where sturgeons prefer to live and what could be preventing the population from growing.

Below is a map of the James River and some neighboring rivers with labeled locations of where our researchers have gathered water samples. Each water sample is labeled with site number and some environmental information that was recorded on the day the water was sampled.



Base image from Google Earth

Field Data: Collected on October 10th, 2025

Site #	Temperature (°C)	Dissolved Oxygen (%)	Substrate	Depth
Site 1	25°C	70%	Rocky	3 meters
Site 2	26°C	30%	Soft, silty	5 meters
Site 3	25°C	80%	Soft, silty	7 meters
Site 4	22°C	60%	Soft, silty	9 meters
Site 5	20°C	100%	Rocky	8 meters
Site 6	25°C	98%	Rocky	2 meters
Site 7	20°C	98%	Soft, silty	5 meters
Site 8	19°C	60%	Rocky	3 meters

Name: _____

Instructions:

You have received eight water samples taken by our researchers from sites mainly in the James River, but also the York and Chickahominy rivers. These water samples contain lots of DNA, but we're looking for the Atlantic sturgeon DNA! Pour each water sample through a filter (careful not to cross-contaminate your samples) and extract the Atlantic sturgeon DNA (the clear beads). After each extraction, count how many clear white beads there are to know what the sturgeons' relative abundance is!

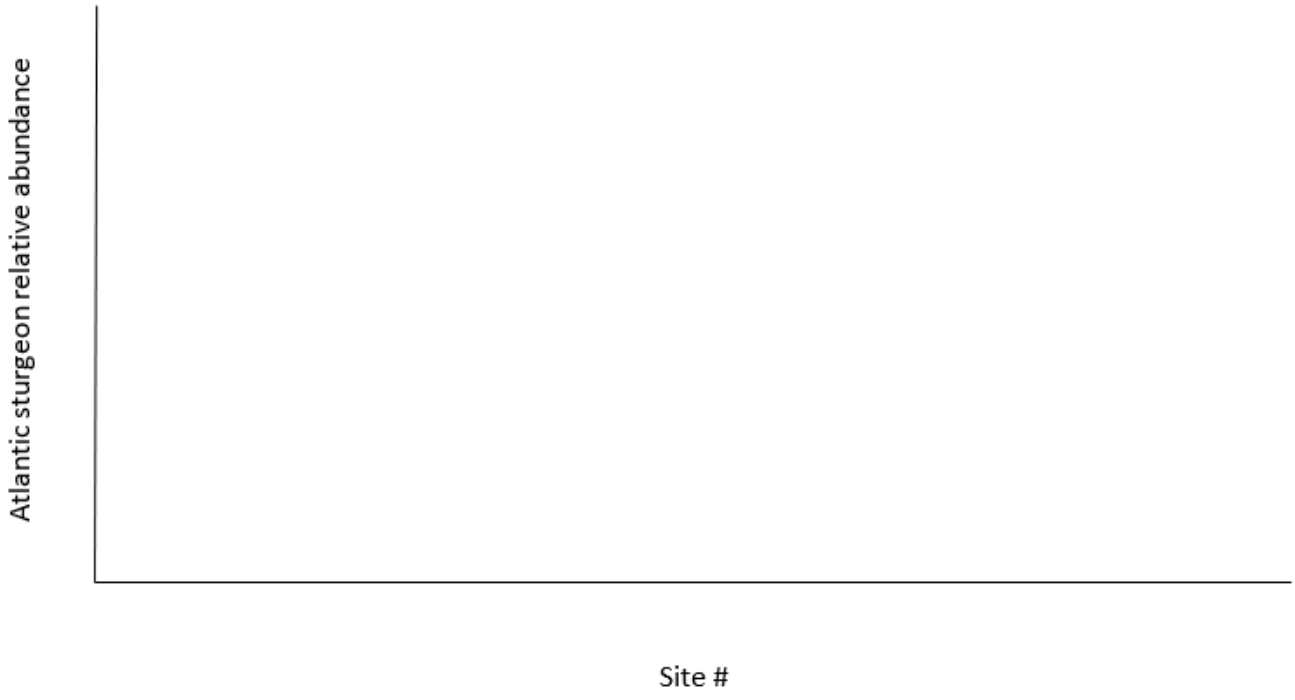
While analyzing each site, take good lab and field notes by filling in the information on your worksheet. Based on the provided handout, indicate whether you think the recorded temperatures are high or normal, and if the dissolved oxygen levels are low or normal.

Data Collection:

Site #	Temperature (°C) High or Normal?	Dissolved Oxygen (%) High or Normal?	Substrate Soft or Rocky?	DNA #
Site 1				
Site 2				
Site 3				
Site 4				
Site 5				
Site 6				
Site 7				
Site 8				

Graph it:

Graph your results below as a bar graph:



Analysis:

1. Circle which site had the highest relative abundance of Atlantic sturgeon DNA?

   Site 1 Site 2 Site 3 Site 4 Site 5 Site 6 Site 7 Site 8

2. What environmental factors supported a higher abundance at this site?

3. Circle which site had the least relative abundance of Atlantic sturgeon DNA?

   Site 1 Site 2 Site 3 Site 4 Site 5 Site 6 Site 7 Site 8

4. What environmental factors supported a lower abundance at this site?

Conclusion:

1. Based on your data, what is the optimal temperature range for sturgeon success?

2. What is the suboptimal temperature range?

3. Based on your data, what is the optimal dissolved oxygen range for sturgeon success?

4. What is the suboptimal dissolved oxygen range?

5. Think about the relative abundance and abiotic factors you observed at each site. What predictions can you make about the greatest limitation to Atlantic sturgeon presence?

6. The state government wants to know what the best location is for a habitat restoration project. Based on your findings, which site would be the best option? Explain why you would choose this location.

7. Protecting the environment needs everyone's help! List some action items the community (farmers, industry, and individuals) could do to help their environment and sturgeon.

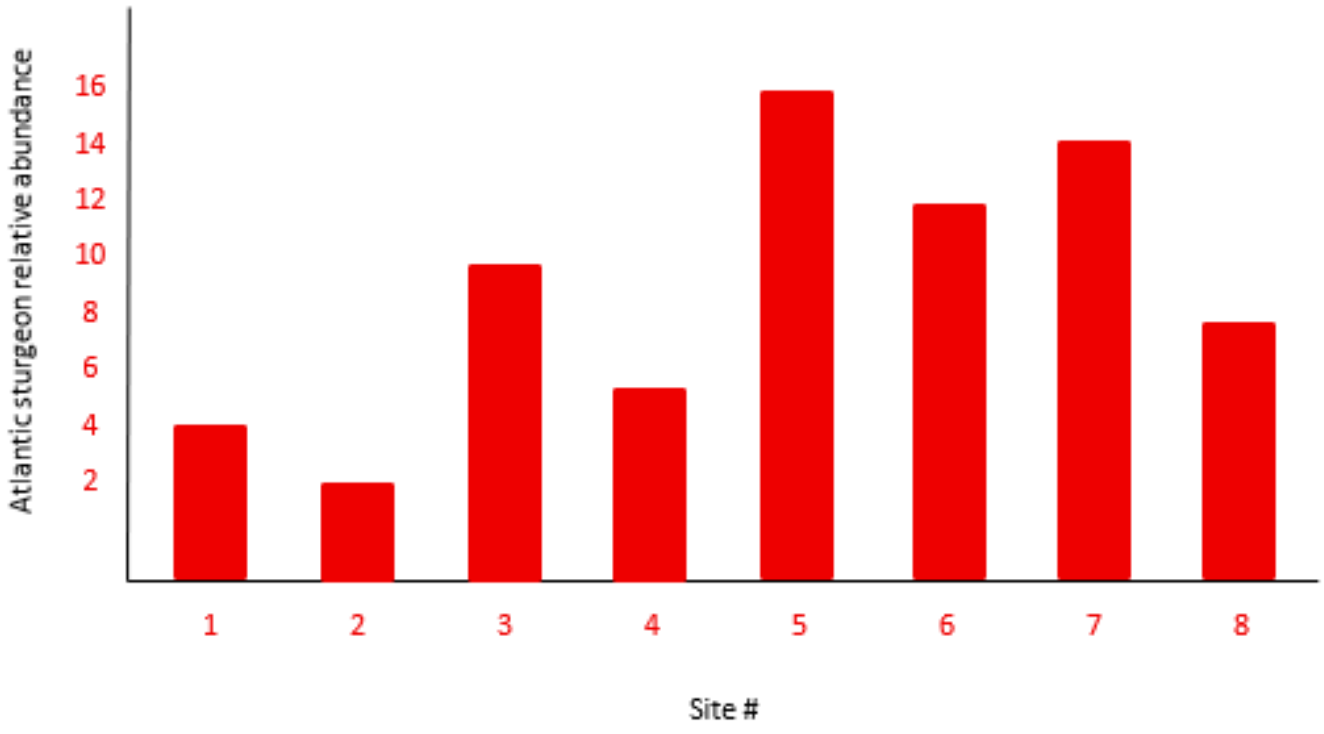
Answer Keys:

Data Collection:

Site #	Temperature (°C) High or Normal?	Dissolved Oxygen (%) Low or Normal?	Substrate Soft or Rocky?	DNA #
Site 1	High or 25°C	Low or 70%	Rocky	4
Site 2	High or 26°C	Low or 30%	Soft, silty	2
Site 3	High or 25°C	Normal or 80%	Soft, silty	10
Site 4	Normal or 22°C	Low or 60%	Soft, silty	6
Site 5	Normal or 20°C	Normal or 100%	Rocky	16
Site 6	High or 25°C	Normal or 98%	Rocky	12
Site 7	Normal or 20°C	Normal or 98%	Soft, silty	14
Site 8	Normal or 19°C	Low 60%	Rocky	8

Graph it:

Graph your results below as a bar graph:



Analysis:

1. Circle which site had the highest relative abundance of Atlantic sturgeon DNA?

   Site 1 Site 2 Site 3 Site 4 Site 5 Site 6 Site 7 Site 8

2. What environmental factors supported a higher abundance at this site?

   Normal temperature, normal dissolved oxygen, and hard substrate.

3. Circle which site had the least relative abundance of Atlantic sturgeon DNA?

   Site 1 Site 2 Site 3 Site 4 Site 5 Site 6 Site 7 Site 8

4. What environmental factors supported a lower abundance at this site?

   High temperature, low dissolved oxygen, soft substrate.

Conclusion:

1. What is the optimal temperature range for sturgeon success?

   19°C - 22°C

2. What is the suboptimal temperature range?

   25°C - 26°C

3. What is the optimal dissolved oxygen range for sturgeon success?

   80 – 100%

4. What is the suboptimal dissolved oxygen range?

   Anything at or below 70%

5. Think about the relative abundance and abiotic factors you observed at each site. What predictions can you make about the greatest limitation to Atlantic sturgeon presence?

   Possible answers, correct as long as it's defensible:

- High temperature and low dissolved oxygen are limiting factors for presence.
- The combination of high temperatures and low dissolved oxygen are the most limiting conditions.

6. The state government wants to know what the best location is for a restoration project. Based on your findings, which site would be the best option? Explain why you would choose this location.

   Possible answers, correct as long as it's defensible:

- Protect site 5, it has the best conditions for Atlantic sturgeon so we know they will do well in this habitat.
- Protect site 2, it has the worst conditions, so therefore we should restore the habitat to promote an optimal habitat.

7. Protecting the environment needs everyone's help! List some action items the community (farmers, industry, and individuals) could do to help their environment and sturgeon.

   Farmers

- Use organic pesticides
- Know where runoff goes

   Industry

- Better regulate waste water
- Properly dispose of waste

   Individual

- Don't pour toxic materials down the drain
- Use alternative transportation methods like walking or riding your bike

WANTED

Acipenser oxyrinchus oxyrinchus

aka: the Atlantic sturgeon

$$$ REWARD $$$

SCIENTIFIC ADVANCEMENT

HABITAT PREFERENCES:

- **19°C - 22°C**
- **80-100% dissolved oxygen**
- **Hard bottom substrates**

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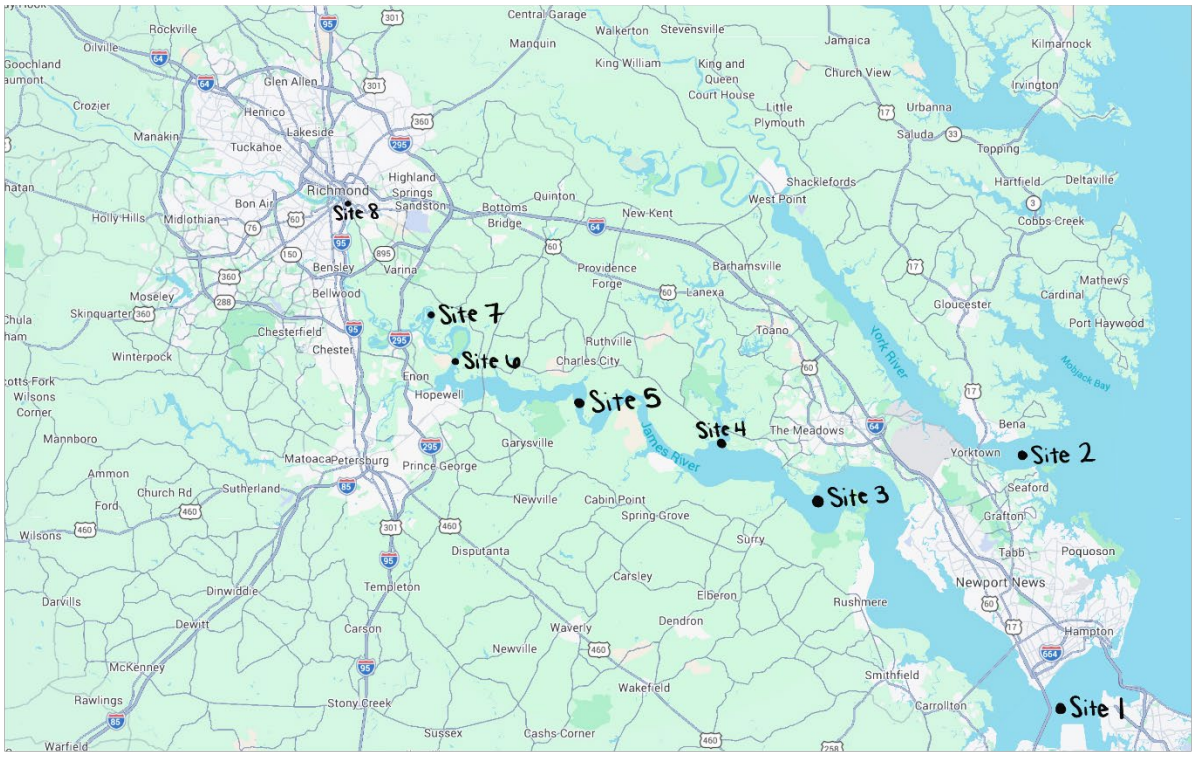

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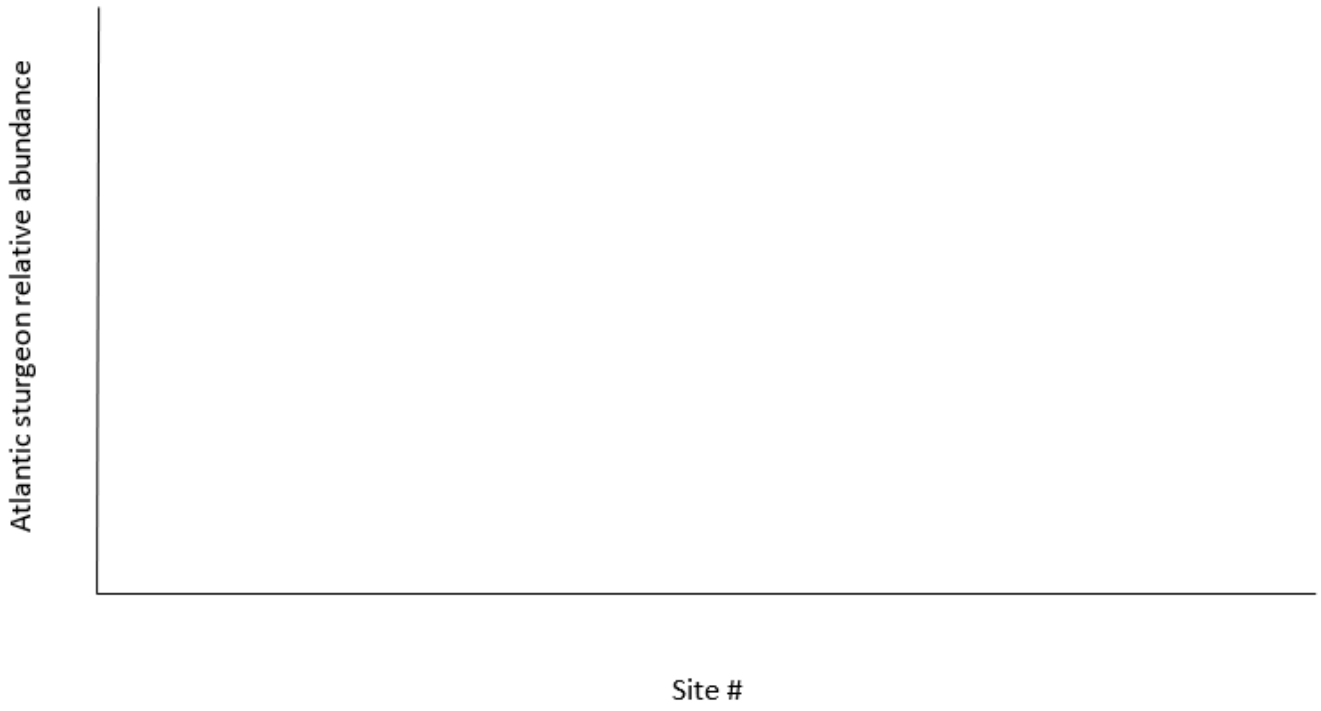

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Image sourced from Animalia