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Catching fish with sound

Featured scientist: Mei Sato (she/her) from Woods Hole Oceanographic Institution and Northeast U.S. Shelf LTER (NES-LTER)

Research Background:

In our ocean, the connections between the environment and marine organisms are intricate and complex. The watery surroundings connect each level of the food web - including marine mammals, large fish, schooling fish, phytoplankton, and more.

Climate change is causing our ocean to become warmer, and organisms are already starting to respond. When ocean waters change, the effects cascade through different levels of the food web. In order to understand how marine organisms, and their interactions, are affected by changing climate, we need accurate measurements that tell us what populations are like today and continue monitoring into the future.

As a biological oceanographer, Mei's research focuses on organisms in the middle of marine food webs. These are the small **schooling fish**, like anchovies and herring, that consume other organisms, but are also vulnerable to predation. Growing up in Japan, the ocean was always a part of Mei's life through hobbies such as swimming, fishing, and also from knowing the cultural importance of eating seafood and learning to prepare for tsunamis. She was first introduced to ocean science through a local fisher who had an oyster farm near her hometown. Since then, she has pursued her career as an oceanographer across three different countries - Japan, Canada, and the United States - both in academia and industry.

Mei next to the research vessel, *Endeavor*

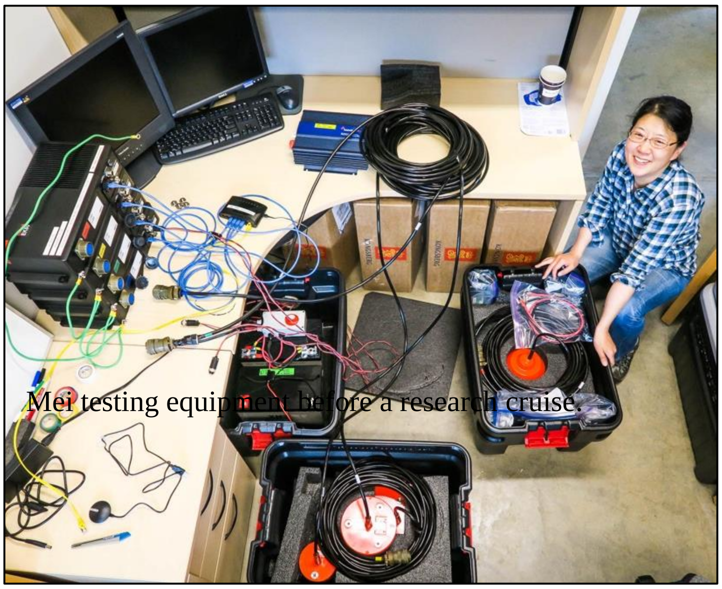
Mei now does research as part of a Long-Term Ecological Research project out of Massachusetts. This means that Mei is part of a scientist team working together to study long-term patterns in the ocean. Looking at data over time allows Mei and others to better identify and understand the consequences of climate change. This information will help fishers and fisheries managers make decisions and prepare for the future.

In August 2023, Mei went to sea on one of the project's research cruises. She wanted to take a closer look at one of the fastest-warming ocean areas and richest fisheries in the world – the continental shelf of the Northeast U.S. She boarded a large research ship for 6 days with a team of 14 other scientists who specialize in different areas of oceanographic research.

To more accurately collect these data, Mei used sound! **Echosounders** bounce sound off marine organisms, such as fish. This tool is similar to fish finders that are used by most fishing boats. However, the technology used by Mei is more sensitive and provides more detailed data.

The amount of sound that comes back to the ship after bouncing off fish or anything in the water is called **volume backscattering strength**, and is measured in decibels (dB). The intensity of what comes back can serve as a measure of **fish abundance**. If there are more fish, the number becomes larger (less negative).

While the echosounder is operating, other members of the research team measure water temperature and other parameters from the surface to near the bottom. Temperature is measured in degrees Celsius (ºC), and depth is recorded in meters (m). Mei wanted to use these data to give her a snapshot in time of where fish are located.


Mei testing equipment before a research cruise.

Scientific Question: How is fish distribution below the ocean surface related to temperature at different depths?

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Scientific Data:

In the table below, you will explore a dataset from one location along a long transect of data collected as the research cruise traveled across different latitudes of the Northeast Shelf, United States. The full dataset is shown in Figure 1, and the subset of data used in this activity are shown in the grey rectangle enlarged within the figure.

Use the data below to answer the scientific question:

Figure 1: Northeast U.S. shelf acoustic data collected in August 2023.

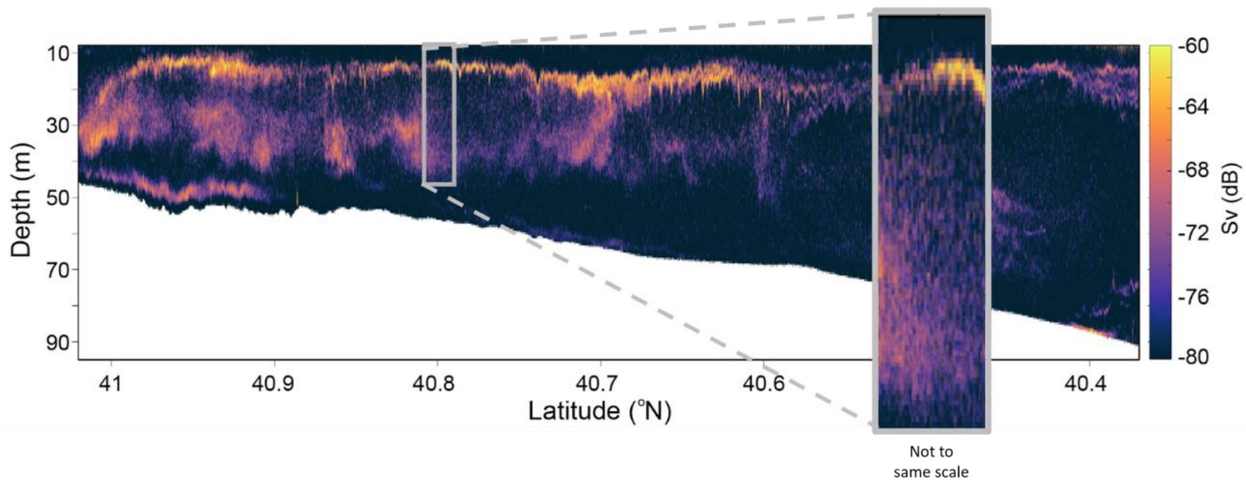

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Table 1: Volume backscattering strength (Sv) from fish found between 8 - 46 m depth on the Northeast U.S. shelf. Grey rectangle in Figure 1.

Depth (m)	Temperature (C)	Volume backscattering strength (dB)
8	21.6	-94.9
10	21.5	-89.5
12	18.8	-77.2
14	16.0	-69.3
16	11.9	-67.0
18	11.6	-77.5
20	11.6	-88.1
22	11.5	-92.4
24	11.4	-92.3
26	11.3	-90.5
28	11.2	-89.7
30	11.1	-88.1
32	11.0	-85.1
34	10.9	-79.5
36	10.8	-77.6
38	10.8	-79.9
40	10.8	-84.5
42	10.7	-89.7
44	10.4	-92.1
46	10.4	-96.3

What data will you graph to answer the question?

Independent variable: ____

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Dependent variable(s): ____

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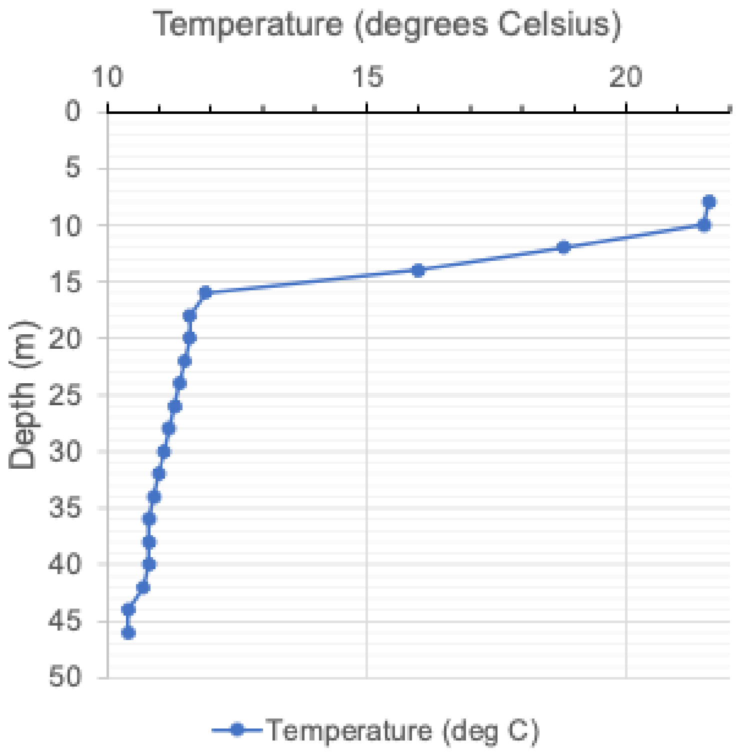
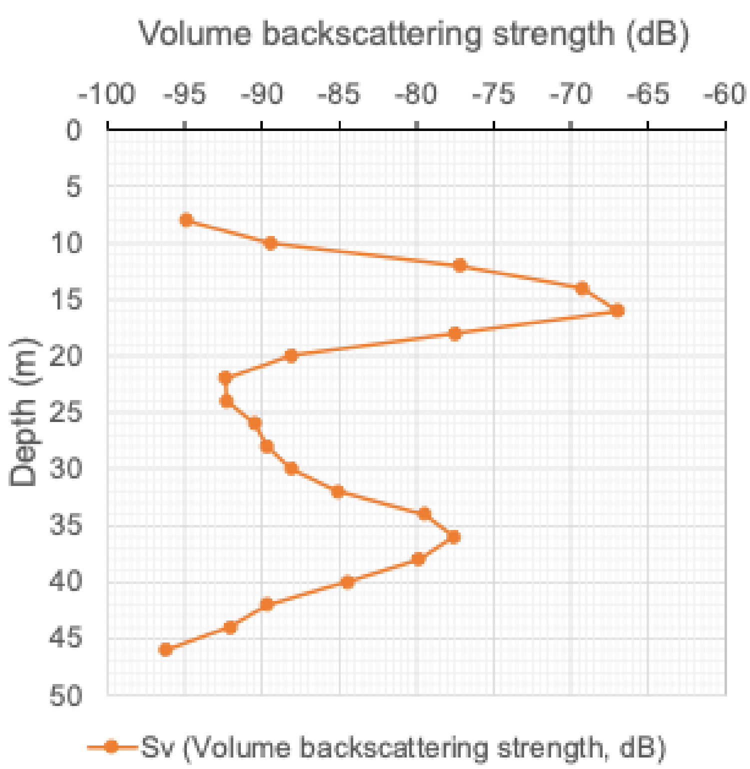
Name____________________

Below are graphs of the data: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.





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Interpret the data:

Make a claim that answers the scientific question - how is fish distribution below the ocean surface related to temperature at different depths?

What evidence was used to write your claim? Reference specific parts of the tables or graphs.

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how sound can be used to detect fish locations.

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Your next steps as a scientist:

Science is an ongoing process. What new question(s) should be investigated to build on Mei's research? How do your questions build on the research that has already been done?

What future data should be collected to answer your question?

Independent variable(s): ____

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Dependent variable(s): ____

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For each variable, explain why you included it and how it could be measured.

What hypothesis are you testing in your experiment? A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.