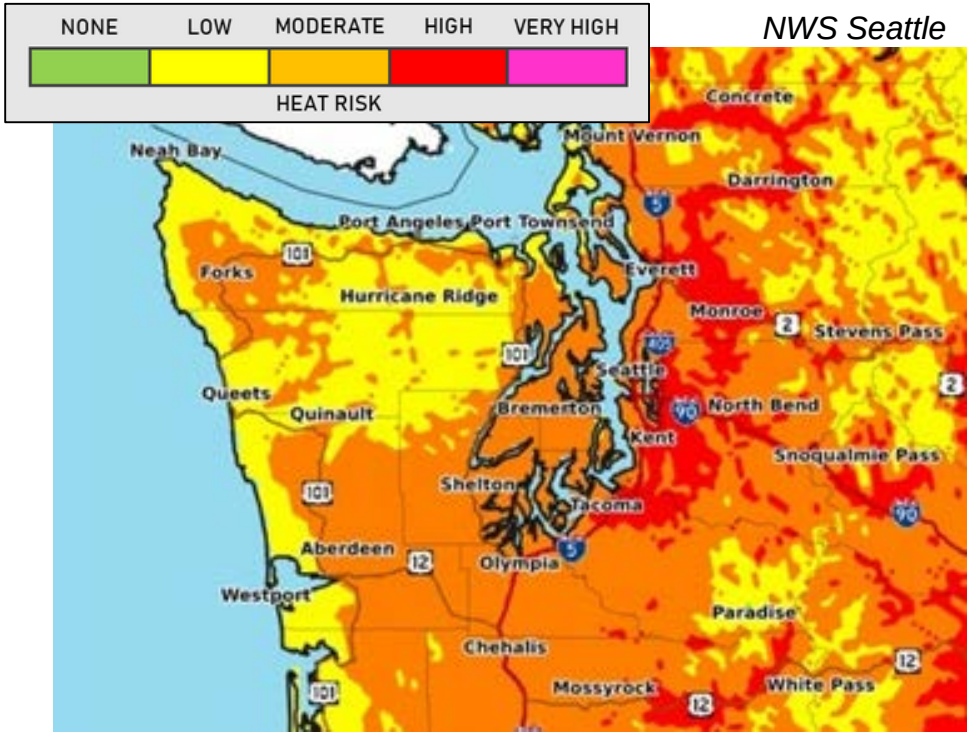
Marine Heatwaves

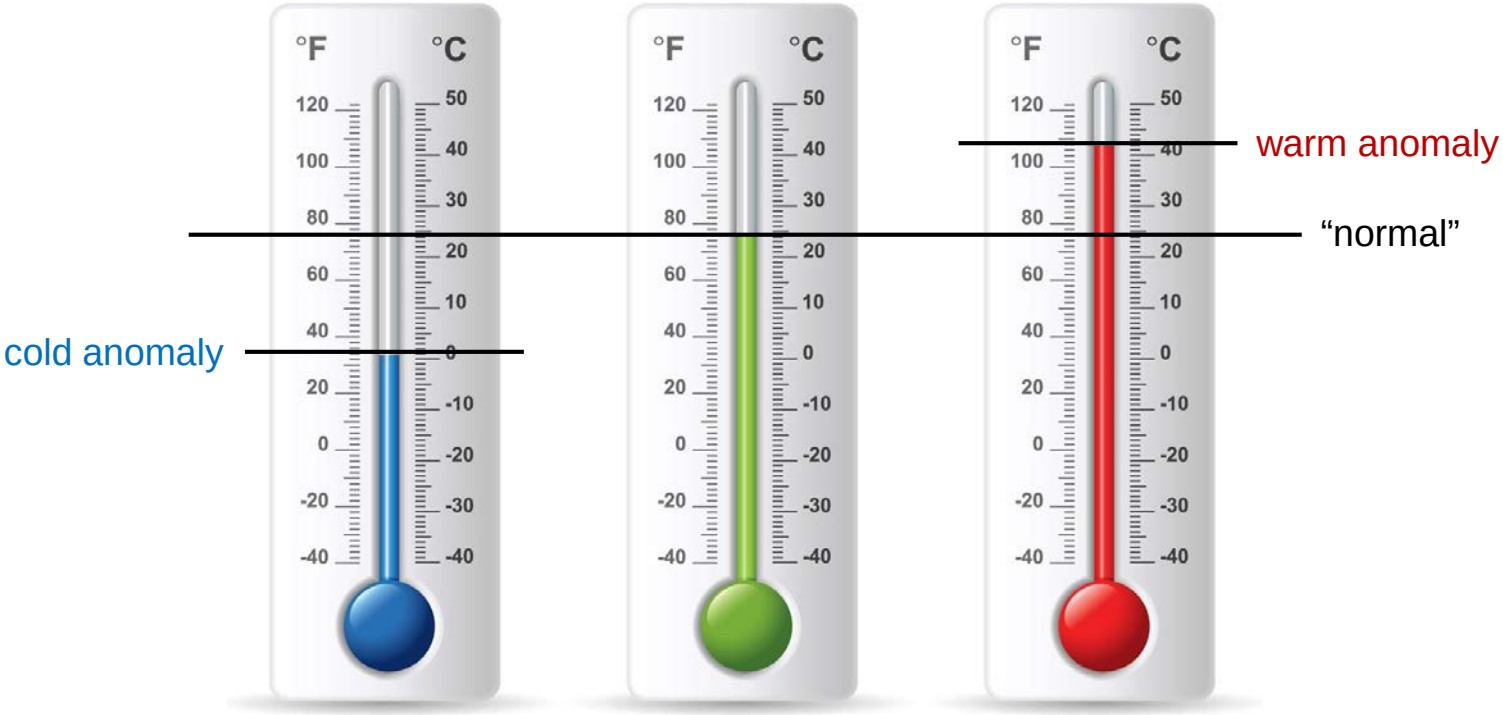

What is a Marine Heatwave?

Can you imagine or remember a heatwave on land?



NWS Seattle

How do we know what is “normal”?



Vocabulary of Heatwaves

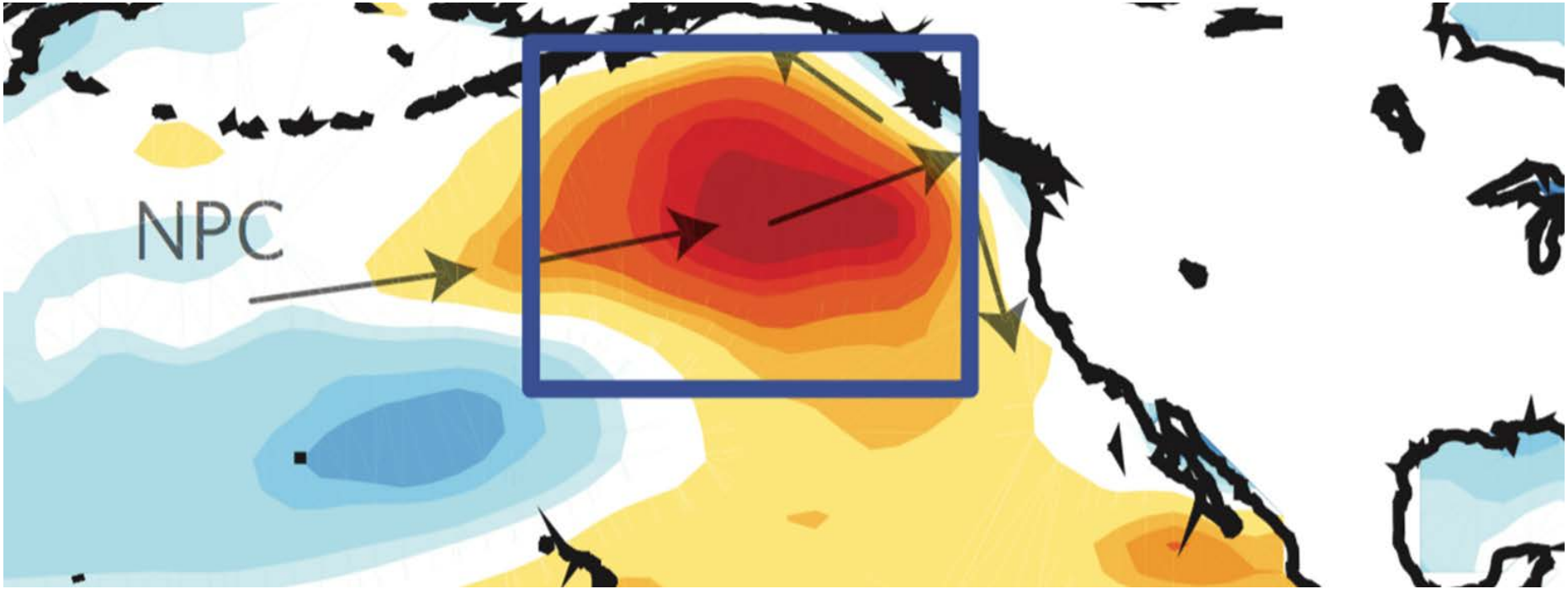
Anomaly = difference from “normal”

Climatology = long term “normal”

Red = warmer than normal
White = normal
Blue = cooler than normal

NASA

What is a Marine Heatwave (MHW)?



A marine heatwave is a period of unusually high ocean temperatures and is defined by its duration and intensity.

MHWs have killed off kelp forests and coral, and produced significant impacts on marine ecosystems, fishing and aquaculture.

Credit: https://english.kyodonews.net/news/2018/04/78ae9aeae8a9-one-third-of-great-barrier-reef-corals-killed-in-mari

Dungeness Crabbers Hit Hard By Algae Bloom On Washington Coast

By ASHLEY AHEARN · 18 HOURS AGO

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Crabber Tom Petersen would rather have his crab pots on the floor of the Pacific, but a toxic algae bloom has prompted health officials to close the south Washington coast to commercial and recreational crabbing.

Credit: Photograph: D. Derickson/COASST

Credit: Bennett, Santana-Garcon and Wernberg

Slide from Stephanie Moore, NOAA NWFSC

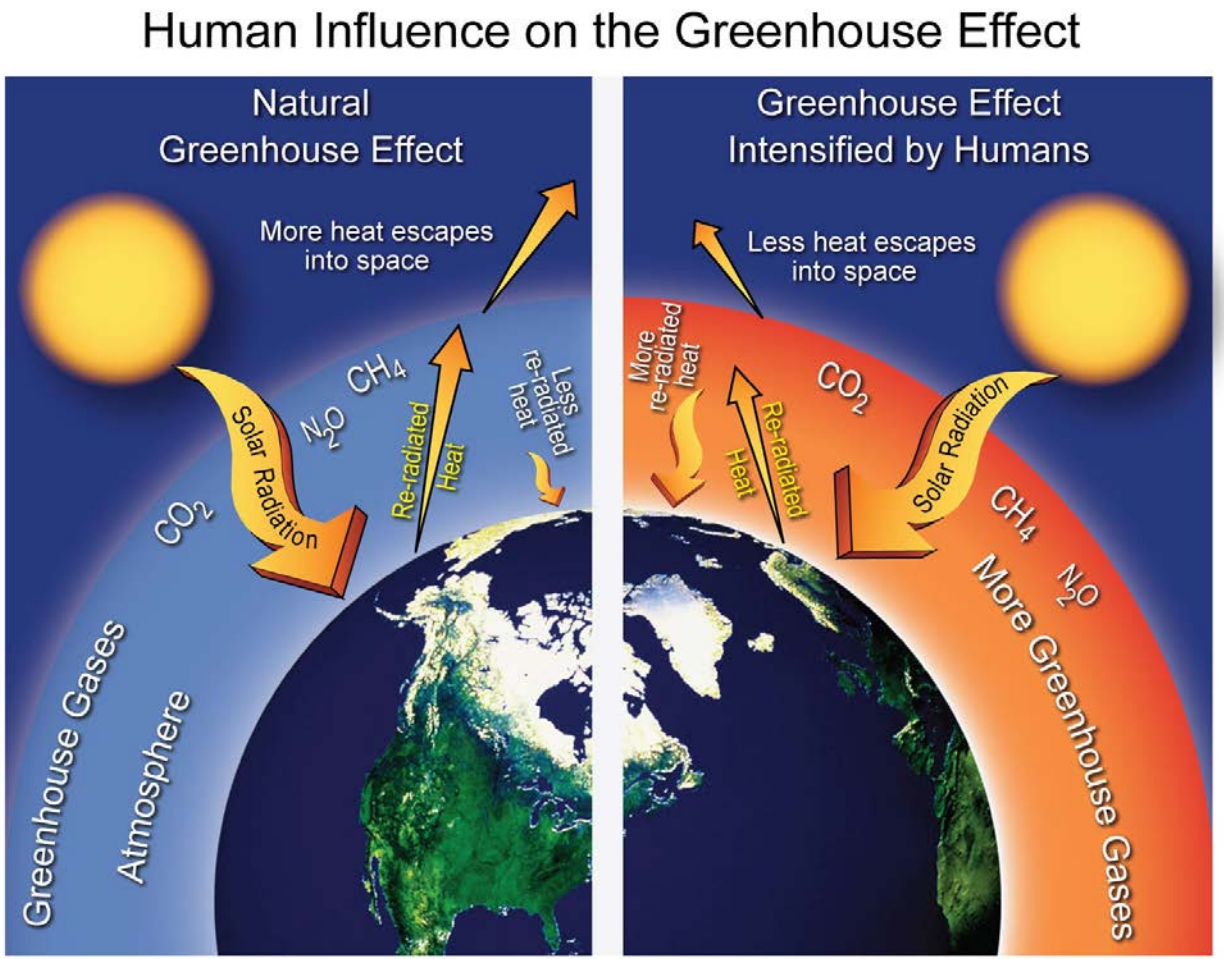
What are some causes of marine heatwaves?

Recipe

- *1 part expected climate cycles, like El Nino or La Nina*
- *1 part human-caused climate change, like increased Greenhouse Gas Effect*
- *Stir to combine using the ocean-atmosphere connection, otherwise known as winds & currents*

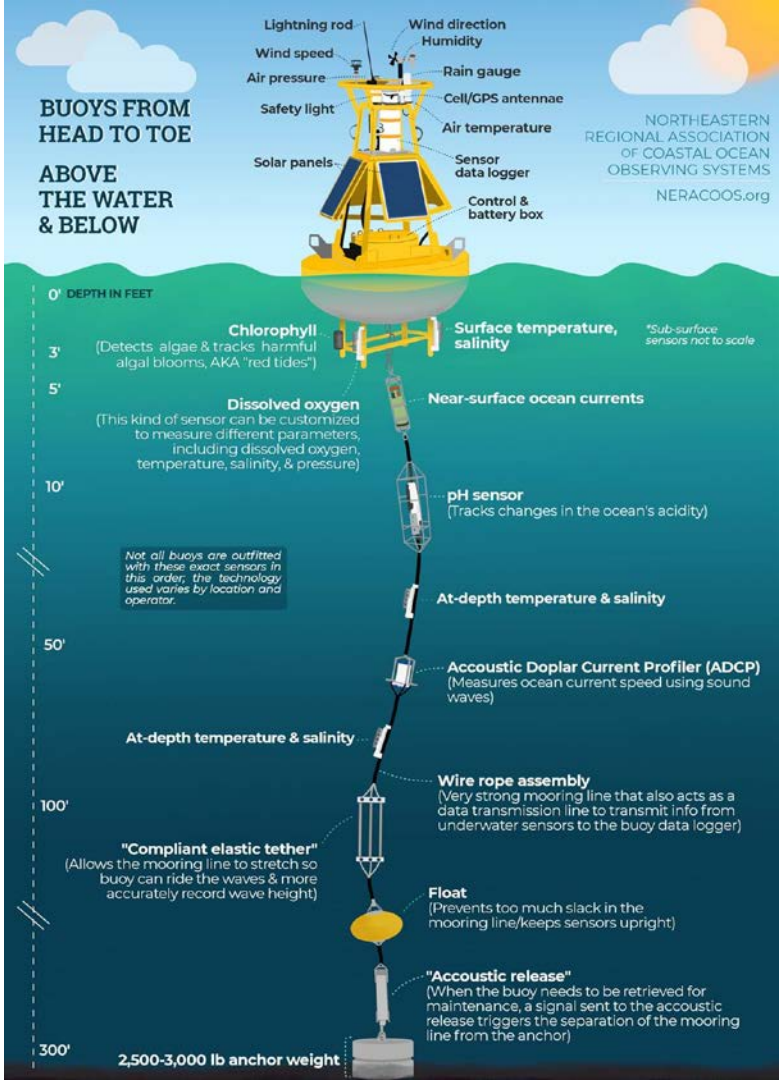
“The fact that about 93 percent of the heat trapped by greenhouse gas pollution ends up being stored in the oceans is a key contributor to marine heat waves.”

-Kevin Trenberth, a senior climate scientist with the National Center for Atmospheric Research.

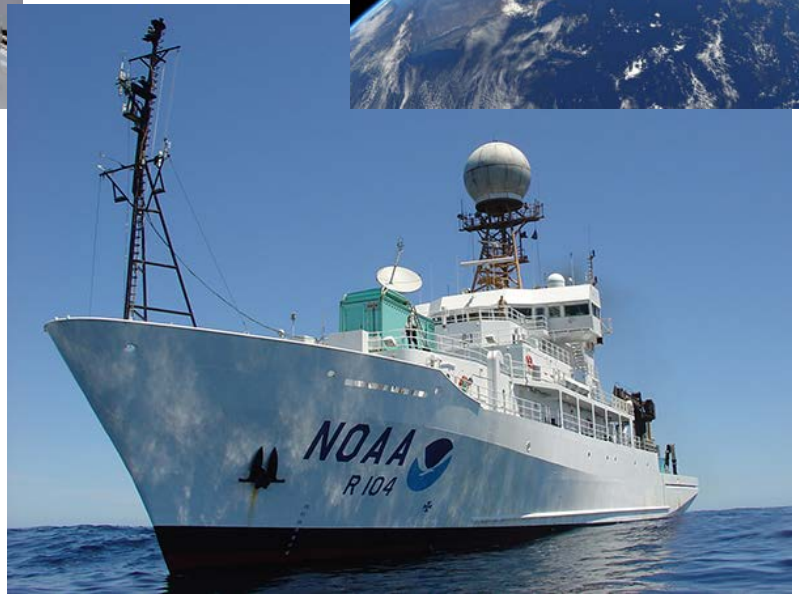


How do we measure the ocean & Puget Sound to see a temperature anomaly?

- Moored buoy system
  - At the surface
  - At the bottom
  - In between



Other ways to collect measurements?



- Buoy
- Cruise
- Float Plane
- HF Radar
- Land Station
- Model
- Moored Array
- River Gauge
- Satellite
- Seabed Sensor
- Seaglider
- Shellfish Raft
- Shore Station

It's A Problem

One of the most obvious connections people have with the ocean is seafood. Pacific albacore tuna are a highly migratory species that visits our coasts July to November. Some tuna fisheries in the Pacific Northwest have seen declines in tuna catches with marine heatwaves. This impacts jobs, the economy, and food security.

Project Time

Tuna Fishing Data Scavenger Hunt

Where and when is it warm enough, but not too warm, for tuna?

Tuna Facts: *A Goldilocks Story*

Oregon and Washington's commercial and recreational fishing fleets catch Pacific albacore tuna (Thunnus alalunga) in coastal areas from about **July through November** depending on the surface water temperatures. **Most catches occur when sea surface temperatures range 16 to 18 C (60.8 to 64.4 ºF)** (Beamish et al., 2005) and sea surface chlorophyll-a concentrations range 0.2 to 0.4 mg m^3 (Zainuddin et al 2008). **NANOOS' Tuna Fishers App** allows users to visualize where and when these conditions exist.

Tuna Facts

NOAA's FishWatch describes Pacific albacore tuna as a **highly migratory fish species**. This migration typically begins in the spring and early summer in waters off Japan, continues through the late summer into inshore waters off the U.S. Pacific coast, and ends in late fall and winter in the western Pacific Ocean. *The timing and geographic extent of the albacore's migration in a given year is strongly influenced by ocean conditions.*

Troll and pole-and-line albacore fisheries in U.S. and British Columbia waters are certified sustainable by the Marine Stewardship Council, and are given a "Best Choice“ rating by the Monterey Bay Aquarium’s Seafood Watch Program.

1) Go to www.nanoos.org

2) Navigate to the NANOOS Visualization System (NVS).

3) The homepage of NVS will take you to a variety of Apps. For this exercise select the “Tuna Fishers” button.

4) Follow the instructions on your worksheet.

Let's Share Out!

What can we do to prevent Marine Heatwaves?

Everyone can help slow down climate change!

How to minimize your carbon footprint:

Use/purchase more sustainable items

Reduce
Reuse
Recycle

Take public transportation, walk, or bike when you can

Maybe write to your local or national policy makers?

Marine Heatwave Worksheet

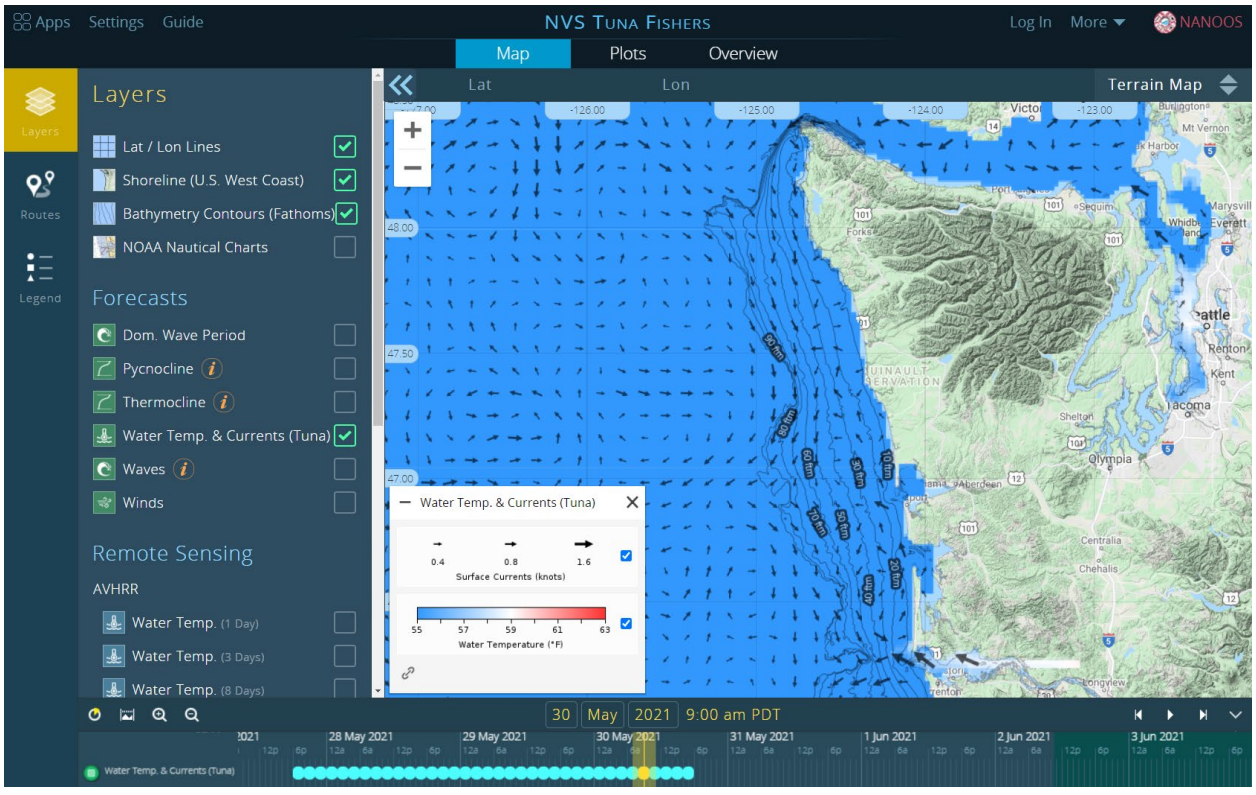
Problem Statement: When and where is the water warm enough, but not too warm, for tuna?

WARM UP EXERCISE

Pretend you are a tuna fisher and want to find out whether you should go fishing today. You are going to use the NANOOS Visualization System (NVS) to see if tuna are likely in the area.

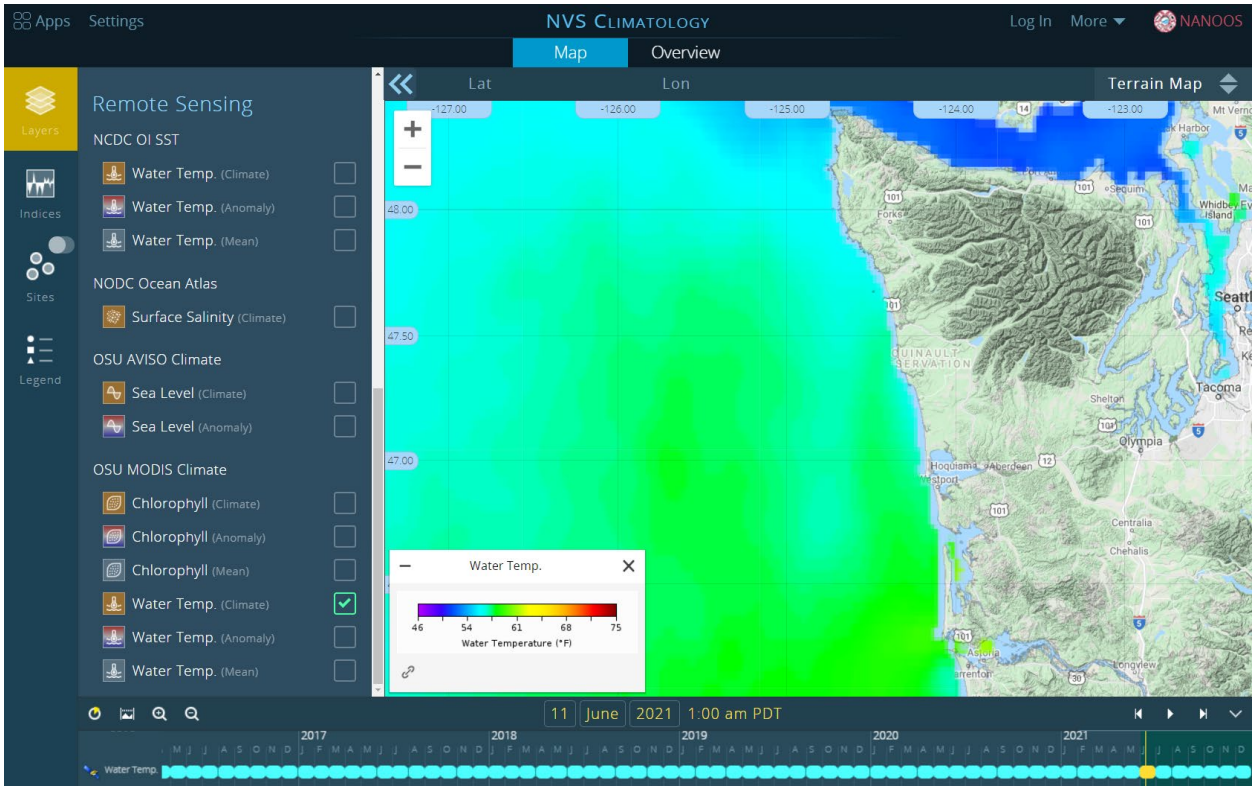
Remember, most tuna catches off the Washington and Oregon coasts occur when sea surface temperatures range **16 to 18 C (60.8 to 64.4 °F) (Beamish et al 2005). Tuna are in the Pacific Northwest region July-November.*

1. Go to nvs.nanoos.org/TunaFish
    a. Use the zoom buttons to adjust your view to only the WA coast, from the tip of the Olympic Peninsula to the Columbia River.
2. Under Forecasts, select Water Temp & Currents to show surface temperature (color) and surface currents (arrows) data from a computer model (information everywhere).



a. At the bottom of your screen, click through the forecast timeline for the most recent 3 days.
    i. What changes do you see?
    ii. If you were a tuna fisher, would you expect to catch tuna in WA coastal waters right now?
    iii. Is this what you would expect, given what you have learned about tuna migration and timing?

3. There is not a lot of variation visible over the course of just three days. What if we look month-to-month as the seasons change? To do this we will use the Climatology App. This is the app you will use in the breakout rooms.
4. Go to nvs.nanoos.org/Climatology
    a. Use the zoom buttons to adjust your view to only the WA coast, from the tip of the Olympic Peninsula to the Columbia River.
5. Under Remote Sensing and OSU MODIS Climate, select Water Temp (Climate) to show the long-term normal temperatures for each month as measured by the MODIS satellite.



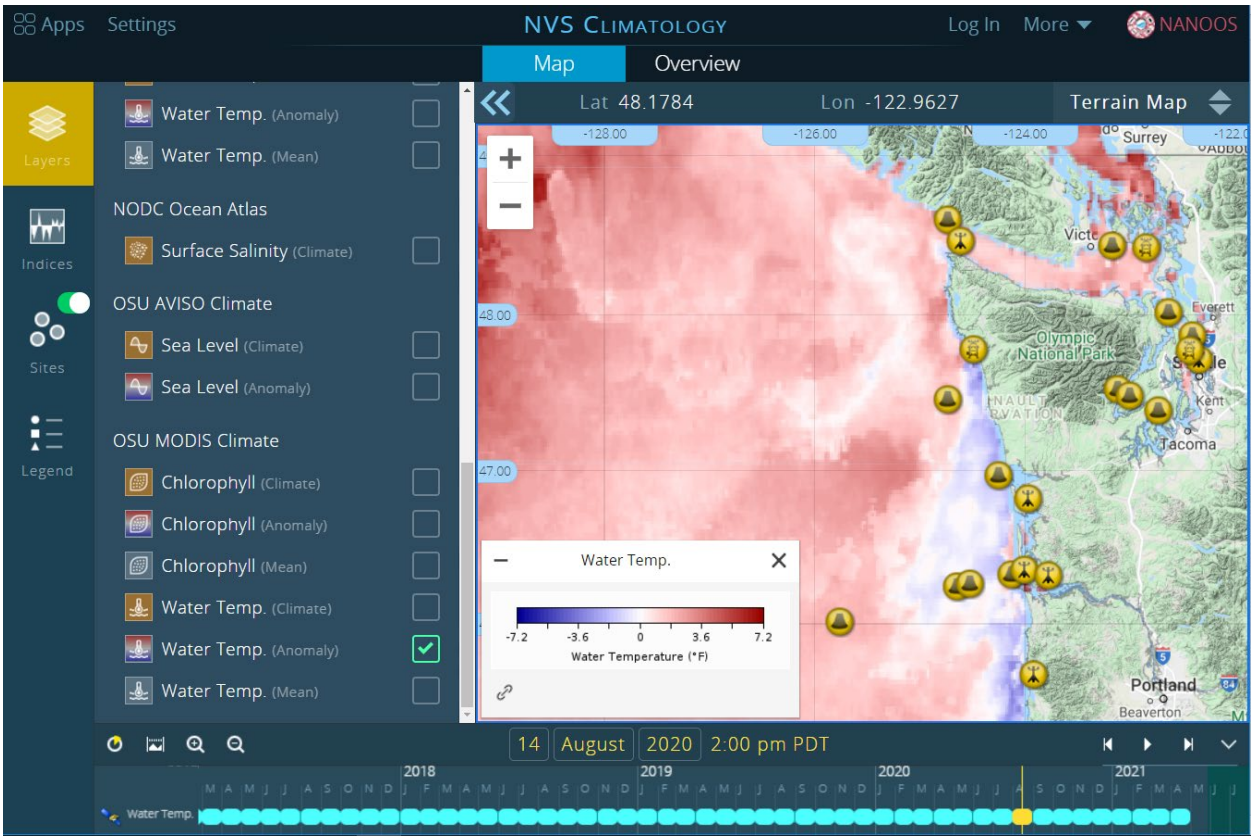
a. Use the timeline at the bottom to investigate the “normal” temperatures seen off the WA coast during the year.
    i. What color represents good tuna temperatures?
    ii. When (which months) in the annual cycle is the long-term normal temperature, or climatology, suitable for tuna?

Climatology shows us what temperatures are normal, but for marine heatwaves, we need information about what is going on now and how that compares to “normal”. We will look at the anomalies in our breakout groups to investigate just that.

BREAKOUT ROOM EXERCISES

Remember, most tuna catches off the Washington and Oregon coasts occur when sea surface temperatures range **16 to 18 C (60.8 to 64.4 °F) (Beamish et al 2005). Tuna are in the Pacific Northwest region July-November.*

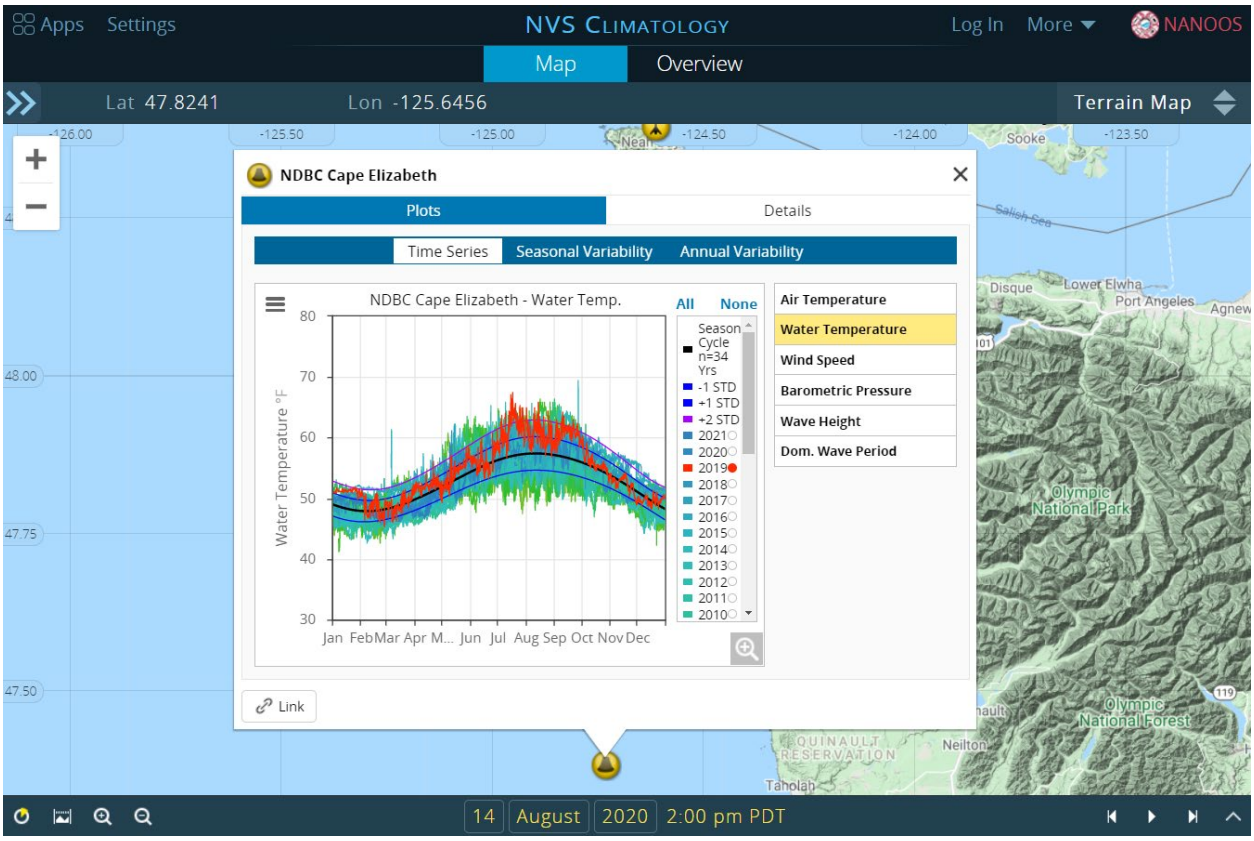
1. Go to nvs.nanoos.org/Climatology
    a. Use the zoom buttons to adjust your view to only the WA coast, from the tip of the Olympic Peninsula to the Columbia River.
2. Under **Remote Sensing** and **OSU MODIS Climate**, select **Water Temp (Anomaly)** to show the difference between the measured mean temperatures and the long-term "normal" temperatures by the MODIS satellite.



    a. Let's start with last year; click through the months: In general, are the ocean surface temperatures mostly normal, colder than normal (cold anomaly), warmer than normal (warm anomaly), or mixed for each month July-November?
    b. Does your answer vary if you look near the coast versus offshore?
    c. Would you prefer to fish close to shore or farther away?

d. What about 2019? Do you notice any differences in the monthly anomalies?

3. We saw in the anomalies that 2019 was hotter than average throughout the months that we would expect tuna in our region. Let's look at more detailed information at just one point to see if there are any data that indicate there was a marine heatwave.



a. Locate the **Cape Elizabeth NDBC buoy** off the coast near the Quinault Indian Nation Reservation.

b. Click on the buoy icon and select **Water Temperature** from the options along the right-hand side. Then, click on the **magnifying glass** in the bottom right corner to see the plot bigger.

c. Select the **2019 dot** from the legend on the right.

d. To qualify as a Marine Heatwave, the water temperature must be above the ***purple line***, which represents twice the expected variability of the data from the long-term "normal" conditions (thick black line), for at least 5 days in a row.

    i. Do you see any events that would qualify as a Marine Heatwave in 2019?

ii. If so, in what month(s) does this occur?
iii. Is this a month that you would expect tuna in the WA coastal waters?
iv. What is the maximum temperature reached at this location, and is that temperature too cold, too hot, or just right for tuna?
v. Now, what about last year?

WRAP-UP QUESTIONS (back in large class group)

1. What can you learn from models or satellite data that you cannot learn from buoy data?

2. What happens to the tuna population when the water temperature in their usual areas is not "just right" (could be too cold or too hot)?

3. How could Marine Heatwaves be a problem for tuna fishers?

4. How could Marine Heatwaves benefit tuna fishers?

Beamish, R.J., G.A. McFarlane, and J.R. King, 2005: Migratory patterns of pelagic fishes and possible linkages between open ocean and coastal ecosystems off the Pacific coast of North America. Deep Sea Research Part II: Topical Studies in Oceanography, 52 (5-6), 739-75