Northwest Association of Networked Ocean Observing Systems

Upwelling Data Scavenger Hunt

SUMMARY

Seasonal upwelling is a very important process not just to the Pacific Northwest but to many coastal regions in the world.

During the summer in the Northern Hemisphere, upwelling is driven by winds blowing ***from*** the North ***to*** the South (Northerlies) that, combined with the Coriolis effect, push surface water off-shore and out to sea. This pulls deep ocean water up to the surface making the surface coastal ocean more salty, cold, and nutrient rich. The added nutrients in the sunny surface waters trigger fast phytoplankton growth and reproduction, which is the base of the food web and supports the important fisheries along the West Coast of the US.

Is upwelling currently happening? Follow this scavenger hunt to see if you can find the clues and signs of upwelling in the data!

GET STARTED

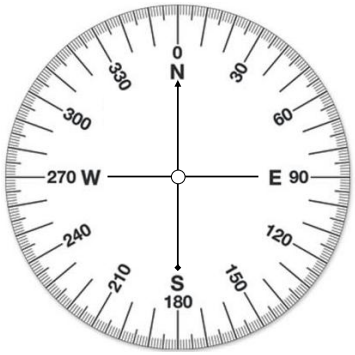
1) Go to www.nanoos.org
2) On the left side under "Data Explorer", click on "NVS"
3) Click on the "Click here to view all assets" button
4) Orient yourself to:
    a. Utilities checkboxes (left-hand side) – you can select data based on Region, sensor Type, or data Variable
    b. Assets checkboxes (left-hand side) – you can select data based on Asset type: Cruises & Gliders; In-Situ Assets; and Overlays
    c. Icon Legend (lower right-hand corner)

FIND THE SIGNS

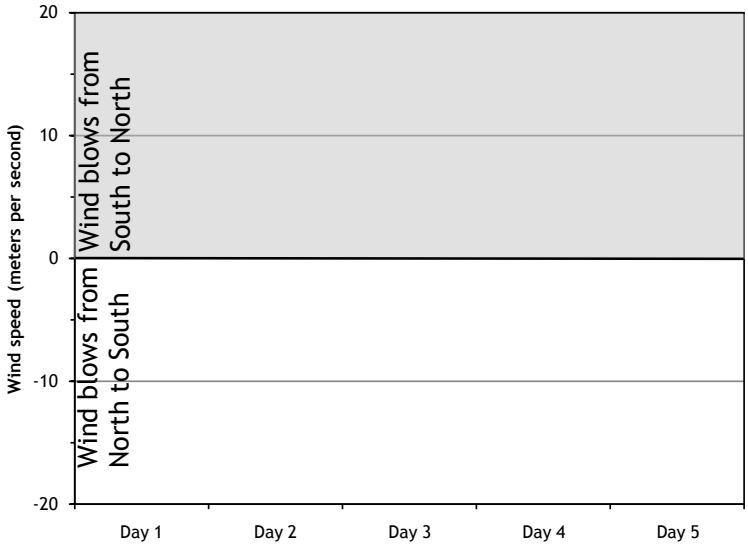
Indicator #1: Wind direction

Wind direction is most important. Winds blowing from the _____, as indicated as **0 or 360 degrees** on NVS, start the upwelling process.

Find an asset in WA that measures wind direction. On the compass rose below, draw in the general direction wind has been blowing ***to and from*** for the past 7 days:



Find the OSU buoy that measures wind direction and speed and *Explore the Asset*. Using the arrow graph that combines wind direction and speed, draw one line for each of the past 5 days of the general wind speed and direction ***the wind is blowing to*** for that day.



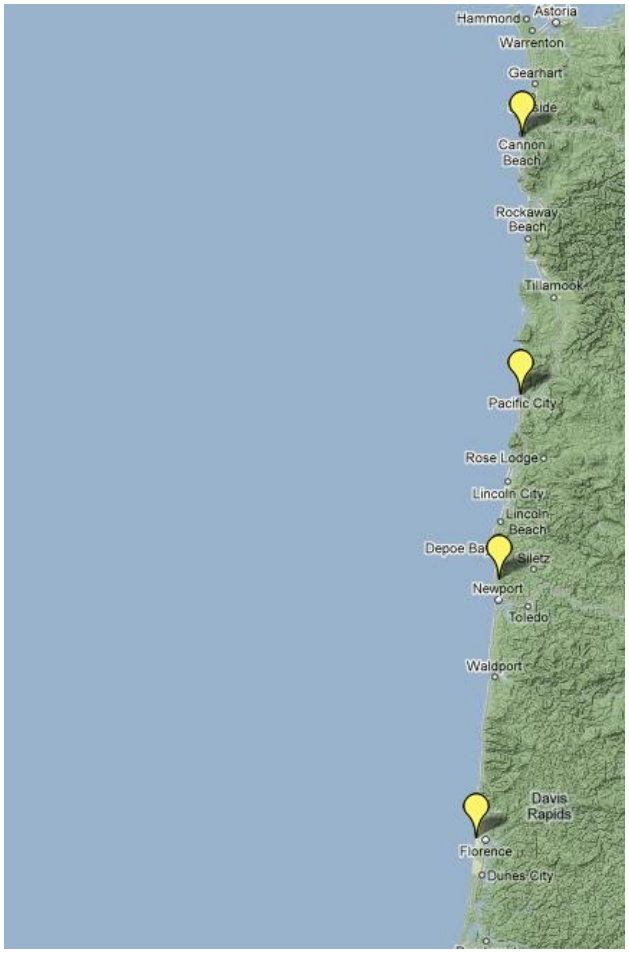
		Yes	No
Indicator #1	Wind direction **from** is within 50 degrees on either side of 0 or 360 degrees		

Indicator #2 Surface Currents

Wind directly affects the surface currents of the ocean. Because of the Coriolis effect, south-blowing, upwelling favorable winds move surface waters towards _____.

Find the overlay that shows surface current data. Turn on the overlay by clicking the boxes next to "Surface Currents" and zoom in to the area between Cannon Beach, OR and Florence, OR. Examine the surface currents at 4 locations: Cannon Beach,

Pacific City, Newport, and Florence. For the 4 locations, on the map below mark the surface current direction 1) next to the shore and 2) the farthest out to sea the current was measured.



		Yes	No
Indicator #2	Surface currents moving south and/or west		

Indicator #3: Water temperature and salinity

During upwelling, water temperature and salinity along the coast are next to show a change. Predict how these will change during upwelling: water temperature will (fill in the correct arrow) ⇧ ⇩ and the salinity of water will ⇧ ⇩.

Find the OSU buoy that measures both temperature and salinity. Do you see a change in temperature or salinity of the surface water (-2m) in the past 7 or 30 days? How about in deeper water (-60m or -73m)? Record data below:

⇧⇩Change in **surface** water temperature:

⇧⇩Change in **surface** water salinity:

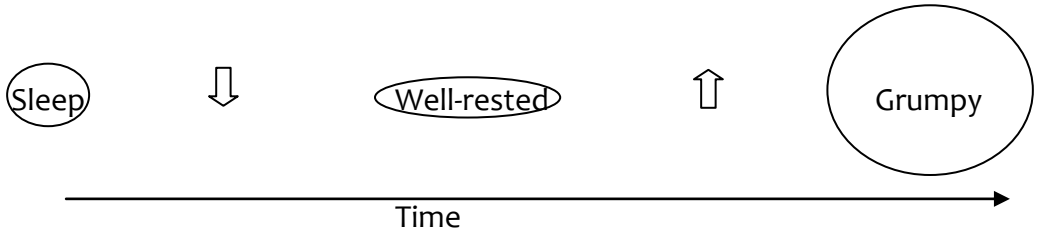
⇧⇩Change in **deep** water temperature:

⇧⇩Change in **deep** water temperature:

		Yes	No
Indicator #3	There was a decrease in surface temperature in the past month		
	There was an increase in surface salinity in the past month		

Indicator #4: Nutrients

are brought to the surface through upwelling, and one of the most abundant nutrients in the coastal ocean is **nitrate**. Nitrate fertilizes the sunny surface water causing phytoplankton to bloom which (circle one) produces/uses nitrate. Using the example as a guide, draw the relationship between nitrate and phytoplankton.



Example relationship reads: A small amount of sleep will decrease how well-rested you are in the morning which will increase how grumpy you are throughout the day.

Nitrate Phytoplankton Nitrate

Time

The nitrate/phytoplankton relationship reads:

Find the LOBO buoy in Yaquina Bay, OR and select the nitrate graph. Ocean water has about 30 umol nitrate per liter of water (umol/L), so on the 30 day graph upwelling should look like pulses of nitrate up to 30 umol/L that last for a few days (a umol, or micromole, is 10^{-6} moles or .000006 mol).

In the 30 day graph, if there is a upwelling pulse, how many days are between the start of the pulse and the end of the pulse?

Why does the nitrate decrease after a few days?

What do you think the other pulses that happen twice a day are?

		Yes	No
Indicator #4	A nitrate pulse up to 30 umol/L lasted for more than 2 days		

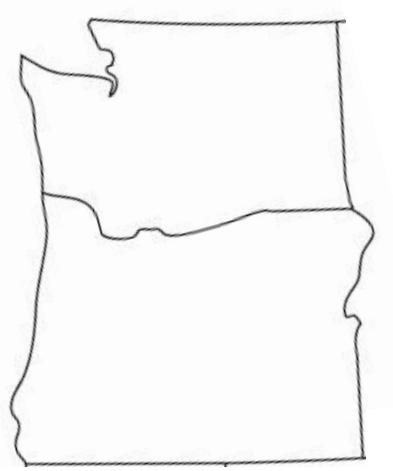
Indicator #5: Phytoplankton

The abundance of phytoplankton, the base of the coastal ocean's food web, is measured by **chlorophyll**, a photosynthesizing pigment in plant cells. As mentioned previously, phytoplankton need, like all plants, _____ and _____ to grow and reproduce.

Use the NOAA CoastWatch MODIS Overlay to find out if the phytoplankton are blooming. Click the boxes next to "1 month chlorophyll a" to turn on the overlay.

What is the highest concentration of chlorophyll (mg of chlorophyll per cubic meter of water (mg/m^3)) next to the coast?

How are the other composites different than the 1 month? Do you see different chlorophyll patterns? Draw on the map below where the highest chlorophyll concentrations typically are.



		Yes	No
Indicator #5	Chlorophyll concentrations are above 25 mg/m^3		

PUTTING IT ALL TOGETHER

Now that you have sleuthed through the data for clues, your final task is to determine if upwelling is in fact happening.

Remember there is a time lag between when the winds start upwelling to when we see the resulting chlorophyll increase so all of the indicators may not be in the yes category yet. If that is the case, check back in a few days to see if anything changed! The faster the winds are, the faster the ocean will respond to the upwelling conditions.

		Yes	No
Indicator #1	Wind direction **from** is within 50 degrees on either side of 0 or 360 degrees		
Indicator #2	Surface currents moving south and/or west		
Indicator #3	There was a decrease in surface temperature in the past month		
	There was an increase in surface salinity in the past month		
Indicator #4	A nitrate pulse up to 30 umol/L lasted for more than 2 days		
Indicator #5	Chlorophyll concentrations are above 25 mg/m^3		