

What is UP with the California Coast?

The making of productive habitat

What makes the California Coast so inviting for marine species?

There's just something about the California Coast. Is it the sunshine? The long sandy beaches? The palm trees? Not only are people drawn to this beautiful coastline, many marine animals are too. In this module, you'll investigate sea surface temperature, chlorophyll concentration, and migration data on the Ocean Tracks website to explore some of what makes the California coast such a popular ocean destination.

Anatomy of an OT-CE Module

Title

Subtitle

Guiding question

Brief overview of what the module is all about.

Engage

Why should you care about the content covered in this module? "Engage" slides are meant to pique your interest, spark curiosity, & set the stage for your exploration.

Take notes/answer questions in your "notebook."

Explore

Dive into Ocean Tracks!
"Explore" slides guide you through your investigation, helping you gather the information and images you will need to complete the "Synthesize" assignment at the end of the module.

Take notes/answer questions in your "notebook."

Synthesize

"Synthesize" slides guide you through how to put all the pieces together and share what you've learned (and gathered) from the "Engage" and "Explore" activities.

Extend (optional)

Some OT-CE modules will offer additional opportunities to Extend your knowledge and apply what you've learned to new situations. Your instructor will let you know if an "Extend" section is a required part of your assignment.

Staying On Track

KEEP TRACK OF YOUR WORK



Throughout the **Engage** and **Explore** sections, you will be asked to take notes, answer questions, and save screenshots. Create a “notebook” to write things down and a folder on your computer to store images. Look for the folder icon as a cue to make a notebook entry or save a screenshot.

NOTEBOOK

Your “notebook” can be an actual paper notebook, an electronic document, or some other format of your choosing—whatever works best for you. Your “notebook” will be a valuable (and time-saving) resource for preparing your final **Synthesize** assignment at the end of the module. You can think of your notebook as a way to “show your work.” Your instructor will let you know if and when you are expected to turn in your notebook for review.

SCREENSHOTS

When asked to save screenshots, save all images in a single folder on your computer where you can easily find them later. Name your image files in a way that makes them easy for you to identify when preparing your final **Synthesize** assignment. If you’ve never taken a screenshot before or need a quick refresher, check out <http://www.take-a-screenshot.org/>. If you decide screenshots just aren’t your thing, you can also snap a photo with your phone or camera.

Engage

In the 1958 cult classic film “The Blob,” a growing alien amoeba eats and dissolves the unsuspecting citizens of a small Pennsylvania town. Starting in 2013, and persisting well into 2015, a mysterious expanse of unusually warm water, dubbed the “blob” by scientists, invaded the Pacific Ocean, wreaking its own kind of havoc.

Increased sea surface temperatures brought on by the “blob” in the Pacific Ocean have been linked to some pretty scary stuff, like mass strandings of sea lion pups, the California drought, and rare sightings of tropical marine species as far north as Alaska. Life along the California coast (animal and human alike) is accustomed to a particular set of environmental conditions. When one or more of those conditions is changed over an extended period of time, there can be consequences. The blob is disrupting coastal processes that maintain the high productivity that is characteristic of the coast of California and is causing ripple down effects all over North America. Read more about the “blob” phenomenon: <http://1.usa.gov/1uxmWoP>



ENGAGE QUESTIONS

Answer these questions in your “notebook.”



1. What have you heard about the warm “blob” in the Pacific Ocean?
2. What other consequences might the warm “blob” have?
3. Imagine your own local environment was suddenly significantly warmer than usual for an extended period of time. How would it impact your comfort? Your food supply? Your recreational activities?

Explore

Wherever you call home, certain environmental factors contribute to where (and when) you can find the basic necessities for survival. Use Ocean Tracks to learn more about **upwelling**: an oceanographic process that is linked to high productivity along the California coast. You'll also learn how this process impacts one species in particular—the bluefin tuna.

- Read about **Oceanographic Factors and The North Pacific Ocean** in the Ocean Tracks Library:
<http://oceantracks.org/library/oceanographic-factors/>

EXPLORE QUESTIONS

While reading, answer these questions in your “notebook.”



1. What is upwelling?
2. What causes upwelling?
3. What causes the intensity of upwelling to differ between geographic locations and through time?
4. What sea surface temperature (SST) and chlorophyll (CHL) conditions would you expect during strong upwelling? During weak upwelling?

Learning Objectives

- Use SST and CHL data to describe the process of coastal upwelling
- Describe seasonality in coastal upwelling and use data to demonstrate this seasonality
- Identify the basic seasonality of Pacific Bluefin Tuna habitat usage using data
- Analyze data to relate tuna habitat usage to oceanographic conditions

Explore

Tracks

Tools

- Go to the Ocean Tracks map: <http://oceantracks.org/map/>
- Display SST and CHL maps for a few different months and years using the buttons in the Overlays tab. Inspect these maps.
- Select one month with SST and CHL conditions that you think best demonstrate that upwelling has occurred.
- Save screen shots of these maps and insert them in your “notebook.”

1

Select Environmental Overlays

Sea Floor

SST

CHL

2 Year:

Select a Year & Month for SST, Chlorophyl, or Currents

02 03 04 05 06 07 08 09 10 11

12 13 14 15

Month:

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov

Overlays

EXPLORE QUESTIONS

Referring to your maps, answer the following question in your “notebook.”




5. Provide evidence for how these maps show that upwelling has occurred. Use specific data values (SST and CHL), read from the maps, as evidence.
6. In paragraph form, describe how the evidence you chose demonstrates that upwelling has occurred (i.e. your rationale).

Explore

- Inspect the CHL and Sea Floor overlays from June 2007.

EXPLORE QUESTIONS

Referring to these overlays from June 2007, answer the following questions in your "notebook."

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- How do CHL levels compare between Monterey Bay and Morro Bay, near San Luis Obispo?
 - What clues do the Sea Floor data provide about why Monterey Bay and Morro Bay experience different intensities of upwelling?

1

Select Environmental Overlays

Sea Floor

SST

CHL

2 Year:

Select a Year & Month for SST, Chlorophyll, or Currents

03

04 05 06 07 08 09 10 11 12 13 14

15

Month:

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov

Overlays

Monterey Bay

Morro Bay

Add Marker

Redding

Reno

Sacramento

San Francisco

Palo Alto

San Jose

Fresno

CALIFOR

San Luis Obispo



Concentration Of Chlorophyll In Sea Water (mg m⁻³)
Chlorophyll-a, Aqua MODIS, NPP, East US (1 Day Composite)
2007-04T12:00:00Z, Altitude=0.0 m
courtesy of NOAA CoastWatch, West Coast Node

Explore

The intensity of upwelling along the California coast varies across geographic locations and through time. The diagram below depicts typical seasonal patterns in Northern (north of San Francisco) and Central/Southern California (south of San Francisco).

	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Northern California	strong upwelling			relaxation				weak upwelling				
Central/Southern California	strong upwelling				relaxation			weak upwelling				

- Pick a year in the Ocean Tracks interface and examine SST and CHL maps from one month during each of the different upwelling seasons (strong, relaxation, weak).
- Save a screen shot of each map and insert them in your “notebook.” Be sure to include information about the year and month of each map.

EXPLORE QUESTIONS

Referring to your maps, answer the following questions in your “notebook.”



9. Describe any seasonal patterns in SST and CHL evident in your maps, referring to specific data values.
10. Compare your maps to the typical seasonal patterns depicted in the diagram above. Describe how well they match.

Explore

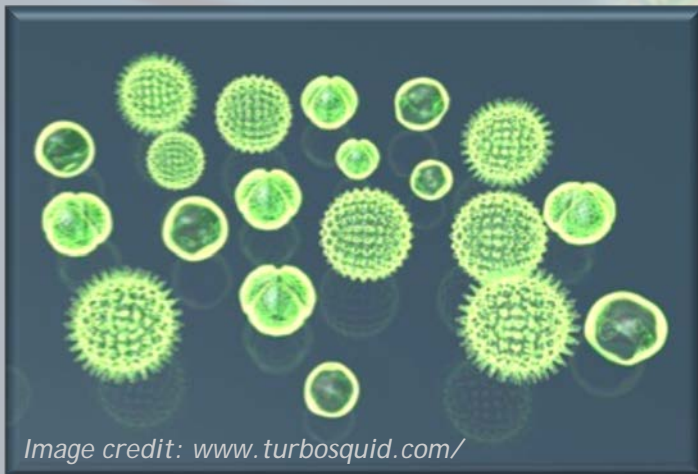
- Read about the link between upwelling and productivity in the section on **Upwelling and the California Current** in the Ocean Tracks Library:
<http://oceantracks.org/library/oceanographic-factors/>

EXPLORE QUESTIONS

Answer the following question in your “notebook.”



11. How does upwelling and high CHL influence organisms that are higher up the food chain, like zooplankton and fish?



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Explore

Bluefin tuna are among the fastest swimming and widest ranging fish species on the planet. When they're not making champion migrations across the ocean, they're often found lingering along the California coast. Why might that be?

EXPLORE QUESTIONS

Answer the following question in your "notebook."



12. Based on what you've learned about upwelling, **predict** where bluefin tuna are most likely to be found during four different months of the year: January, March, June, and September. Create a table like the one below to format your answer.

Month	Location	Rationale
August		
November		
February		
May		

Optional, to learn more: Read [Boustany et al. 2010. Movements of Pacific Bluefin Tuna in the Eastern North Pacific revealed with archival tags. Progress in Oceanography 86:94-104](#)

Explore

- Show and Graph Bluefin tuna track #001.
 - Animate the track using “Show Animal Movement” in the Tools tab.
13. In your “notebook,” record where this individual is during the months of August 2002, November 2002, February 2003, May 2003, and August 2003 in a table formatted like the one below. Note that the date is displayed in the upper right hand corner of the map while the track is animating.



Month and Year	Location	Activity	Curviness	CHL
August 2002				
November 2002				
February 2003				
May 2003				
August 2003				

- Also characterize the animal’s activity for each month as either lingering (curvy track) or travelling (straight track) using the curviness tool (tutorial here: <http://oceantracks.org/library/video-tutorials/the-tools/>). To measure the track’s average curviness for one month, enter dates for the beginning and end of the month into the spaces above the graph. The average value is shown below the graph.
- Using the **Graph** tool, measure average chlorophyll values for each month using the same method as for curviness.

Explore

EXPLORE QUESTIONS

Referring to your table, answer the following questions in your “notebook.”



14. Does the seasonality you observed in the data fit with your predictions? Describe how these data are consistent or inconsistent with your predictions.
15. Are there any patterns in the data that suggest a relationship between CHL values and where Bluefin tuna spend their time? Describe these patterns and relationships, including whether or not they are consistent throughout the year.

Synthesize

What makes the California Coast so inviting for marine species like the Pacific bluefin tuna? Use the answers from your notebook to construct a simple infographic or 1 page “poster” that illustrates what you’ve learned about upwelling and its influence on Pacific Bluefin tuna migration patterns.

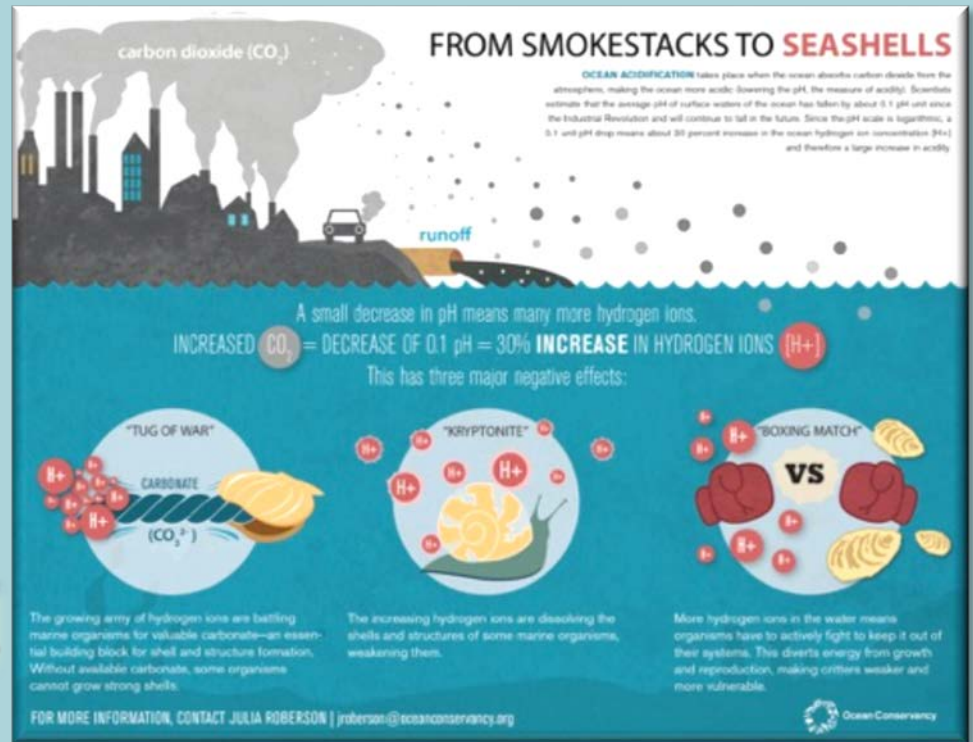
Your infographic or poster should convey the following information, through diagrams, maps and written descriptions.

- How upwelling works
- The factors that influence the intensity of upwelling across geographic locations and through time
- How upwelling seasonality influences bluefin tuna migration patterns in the Pacific Ocean
- You should also include your thoughts on how the “blob” might influence bluefin tuna. Remember, the “blob” is thought to reduce the occurrence of upwelling.



GUIDELINES

- You may prepare your infographic or poster in the format of your choice (e.g., a JPG image, a 1-page Word document, a single Power Point slide, or a scan of a handwritten/hand drawn document) as long as it can be easily submitted to your instructor.



(Example of an infographic)

RESOURCES

Free online infographic tools with templates:

- <http://piktochart.com/>
- <https://www.canva.com/>

