

## Education



Cassin's Auklet chick: Credit: PRBO

### Grade Level

- 9-12

### Timeframe

- 2-3 hours

### Materials

- Computer and Internet access
- Group data collection sheets: *Bathymetry, Bird and Mammal, Zooplankton, and Physical Oceanographer Student Data Sheets*
- Student groups (4 Total)
- Post-it Notes
- Poster Board or Chart Paper

### Key Words

- Density Dependent Limiting Factor
- Density Independent Limiting Factor
- Bathymetry
- Population Dynamics
- Abiotic / Biotic Factor
- Hoop net
- Tucker Trawl
- CTD logger
- Upwelling
- Zooplankton/Phytoplankton
- Euphausiids
- Cassin's Auklet
- CA Current

# What Influences a Marine Food Web?



Humpback whales and seabirds in a "feeding frenzy" Credit: Carol Keiper/ONMS/ PRBO

### Activity Summary

Students will investigate how oceanographic processes influence the ecology of a California marine ecosystem. A common misconception: *Living organisms are not affected by their physical environment.* Students often learn about food chains/webs gaining an understanding that one species feeds on another, and therefore that interaction affects population density. Students often do not take into consideration how the physical environment or abiotic factors affect population densities and dynamics. The major focus of this activity is oceanographic processes and food webs, including biotic and abiotic factors.

### Learning Objectives

Students will be able to:

- **describe** the function and operation of different types of oceanographic research equipment.
- **analyze** and **interpret** data (collected from the research equipment) in order to **draw conclusions** on how bird and mammal numbers are impacted by their physical environment (bathymetry, weather, and water profile) in the research area.
- **report** that many factors must be taken into consideration when analyzing populations of organisms and how they interact.

## Background Information

The National Oceanic Atmospheric Administration (NOAA) Teacher At Sea (TAS) program's mission is to provide classroom teachers from kindergarten through the college level the opportunity to gain a clearer insight into our ocean planet, greater understanding of maritime work and studies, and increase environmental literacy. This is all done aboard NOAA research and survey ships under the tutelage of NOAA scientists and crew. I participated in the program during the 2008 field season, and had the opportunity to sail aboard the NOAA ship McArthur II from April 7<sup>th</sup> through the 14<sup>th</sup>. During this time researchers were investigating the distribution and abundance of marine birds, mammals and zooplankton relative to the physical oceanography of the Gulf of Farallones and the Cordell Bank. Scientists had two primary objectives during the cruise:

- Test the hypothesis that timing, intensity, and duration of upwelling influences the distribution, abundance, growth and reproductive dynamics of euphausiids (or krill), thus affecting the distribution and abundance of krill predators in the region.
- Test the hypothesis that distribution and abundance of marine birds, mammals, and zooplankton in the Gulf of the Farallones and Cordell Bank is determined by bathymetric and hydrographic features and predictable in space and time.

Due to the abundance of marine life and unique ecosystems, there are three contiguous National Marine Sanctuaries (NMS) outside the Golden Gate of San Francisco: Monterey Bay, Gulf of the Farallones, and Cordell Bank NMS. These areas were recognized as vital to supporting the complex marine food web and sustainable economic activities. National Marine Sanctuaries have environmental protections and regulations to help

protect the habitats in addition to supporting research and education programs to learn about these areas and engage communities in helping to protect them.

With this lesson plan students will conduct internet research to learn more about oceanic research equipment, analyze data from research cruises and gain insight into oceanographic processes.

If you are a classroom teacher and interested in embarking on your own TAS voyage, go to the following web page for more information:

<http://teacheratsea.noaa.gov/index.html>

## Teacher Preparation

- Review information on Cordell Bank National Marine Sanctuary and Gulf of Farallones National Marine Sanctuary websites [www.cordellbank.noaa.gov](http://www.cordellbank.noaa.gov) and [www.farallones.noaa.gov](http://www.farallones.noaa.gov)
- Review ACCESS website <http://accessoceans.org/>
- Review research project description
- [http://sanctuarysimon.org/cordell/sections/oceanography/project\\_info.php?projectID=90&sec=0](http://sanctuarysimon.org/cordell/sections/oceanography/project_info.php?projectID=90&sec=0)



Scientists deploy a "CTD" Credit: ONMS/PRBO

## Vocabulary

Density Dependent Limiting Factor: reduce population growth with an impact that depends on current population size

Density Independent Limiting Factor: environmental factors affecting a population regardless of size

Bathymetry: is the study of underwater depth of lake or ocean floors.

Population Dynamics: short- and long-term changes in the size and age composition of populations, and the biological and environmental processes influencing those changes.

Abiotic / Biotic Factor: non-living/ living component of an ecosystem

Hoop net: a type of net used to collect zooplankton samples

Tucker Trawl: three nets in one, using a system to allow water collection at a variety of depths

CTD logger: an instrument that measures conductivity, temperature, and depth

Upwelling: movement of dense, cooler, and usually nutrient-rich water towards the ocean surface

Zooplankton: plankton that does not use sunlight to make food and instead eats organic material

Phytoplankton: microscopic organisms that utilize the sun and upwelled nutrients in the surface waters to generate energy

Euphausiids: krill, shrimp-like marine crustaceans

Cassin's Auklet: a small, cavity nesting, nocturnal, wing-propelled diving seabird found in the Northern Pacific.

CA Current: Eastern Boundary Current in the Pacific Ocean, highly productive food web, characterized by lots of upwelling

## Learning Procedure

**Assign or have student select one of the following expert groups based upon interest:**

(groups should contain the same number of individuals)

- Bathymetrists
- Bird and Mammal Investigators
- Zooplankton Investigators
- Physical Oceanographers

### Opening:

Brain Dump – In expert groups each student should be given a stack of post-it notes. Timing 2-3 minutes (or more) students should go around from one individual to the next each stating a word that comes to mind when they hear the question (*What influences a marine food web?*) Students should write down their words on post-it notes. Students should not repeat words already stated by group members and must continue until time is up.

Once time is up instruct expert groups to somehow organize all of the post-its onto the poster board or chart paper with the essential question written at the top. Connections should be made on the posterboard or chart paper indicating how students organized the post-its (like a web.) Allow students 2-3 minutes (or more if needed) to complete this portion of the activity.

Go around to each group and have them present what they came up with and how they organized it.

This activity will provide the instructor the opportunity to assess students' prior knowledge and misconceptions about what influences a marine ecosystem.

Instructors could have students revisit the poster boards/chart paper to make changes after the activity is completed.

Background Information – It is strongly recommended that students read my first log submitted while at sea to gain some information about the research project. This log is dated 4/7/08 and can be found at the following location <http://teacheratsea.noaa.gov/2008/lancaster/index.html>

### Activity 1: (~45 minutes)

Students will work in their expert groups to gather information about the pieces of research equipment they would use on an oceanographic research vessel, and how the equipment works using the internet. Students will complete data collection sheets with guiding questions to ensure that lesson goals and objectives are met.

The following websites correspond to the data

collection sheets for each group. TIP: You may want to consider placing links on your class or school website(s) to assist students as they gather information.

### **Bathymetrists**

Animals in Curriculum Based Ecosystem Studies (ACES) -

[http://www.bigelow.org/virtual/bath\\_sub1.html](http://www.bigelow.org/virtual/bath_sub1.html)

Cordell Bank National Marine Sanctuary -

<http://cordellbank.noaa.gov/about/welcome.html>

Gulf of the Farallones National Marine Sanctuary

- <http://farallones.noaa.gov/welcome.html>

National Geophysical Data Center -

<http://maps.ngdc.noaa.gov/viewers/bathymetry/>

### **Bird and Mammal Investigators**

Video: Applied California Current Ecosystem Studies (ACCESS) Bird and Mammal Observer Video -

<http://cordellbank.noaa.gov/library/videogallery.html>

Sanctuary Integrated Monitoring Network (SiMoN) - <http://sanctuariesimon.org/index.php>

PRBO Interactive Abundance of Bird, Mammal and other Vertebrates at the Farralon Islands – and surrounding waters

<http://data.prbo.org/cadc/tools/multimap/aocean.php>

### **Zooplankton Investigators**

Video: Applied California Current Ecosystem Studies (ACCESS) Hoopnet and Tucker Trawl <http://cordellbank.noaa.gov/library/videogallery.html>

Information: SiMoN Euphausiids in the Gulf of Farallones

[http://sanctuariesimon.org/cordell/sections/marineMammals/project\\_info.php?projectID=90&sec=mm](http://sanctuariesimon.org/cordell/sections/marineMammals/project_info.php?projectID=90&sec=mm)

Applied California Current Ecosystem Studies (ACCESS) Research and Monitoring -

<http://accessoceans.org/index.php?page=research->

[monitoring-and-management](#)

### **Physical Oceanographers**

Video: Applied California Current Ecosystem Studies (ACCESS) CTD

<http://cordellbank.noaa.gov/library/videogallery.html>

Cordell Bank National Marine Sanctuary

Oceanographic Setting -

<http://cordellbank.noaa.gov/about/oceanographic.html>

### **Activity 2: (~45 mins)**

Students will now form new groups with one or two representative(s) from each expert group. Students will work together to synthesize collected information in order to draw conclusions regarding the influence of bathymetric and hydrographic features on the population dynamics of zooplankton, marine birds and mammals in the Cordell Bank and Gulf of Farallones areas. You may want to have students follow a protocol to share their information before they all dive into to synthesis of information. A worksheet is available



Krill Credit: ONMS/PRBO

## Education Standards

<b>National Education Standards</b>	<p>Content Standard A: Science as Inquiry Formulate and revise scientific explanations and models using logic and evidence. Recognize and analyze alternative explanations and models. Communicate and defend a scientific argument.</p> <p>Content Standard C: Life Science The interdependence of organisms Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers. Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms. Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.</p>
<b>California Education Standards</b>	<p>Investigation and Experimentation - Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will: Formulate explanations by using logic and evidence. Ecology - Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept: Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size. Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.</p>
<b>Ocean Literacy Principles</b>	<ul style="list-style-type: none"> <li>• 5. The ocean supports a great diversity of life and ecosystems</li> <li>• 6. The ocean and humans are inextricably</li> <li>• 7. The ocean is largely unexplored</li> </ul>

to assist with this.

### Closing:

Have students revisit their answers to the essential question (What factors influence a marine ecosystem?) Have them write a one-page response to the question using the key vocabulary and data from the lesson.

### Suggested Student Assessment

- Have student groups present their conclusions on what influences a marine ecosystem. Students could create a brief Power Point to capture summary points and supporting evidence.
- Have student groups write a proposal on what protections the National Marine Sanctuaries should have in place based upon the information they gathered from the

investigation.

- Have students write a response to the following hypothetical scenario: If you were managing the sanctuary and an oil spill occurred in the area, what resources would you be most concerned about? What would you want to protect? How could you advise the oil spill response team to minimize the impact of the oil spill?
  - Utilize the pre/post test to assess students' prior knowledge and gains from the lesson. Pre/post test is available.

### Related Links

McArthur II - <http://www.moc.noaa.gov/mt/>

Ship Tracker  
<http://shiptracker.noaa.gov/default.aspx>

Cordell Bank National Marine Sanctuary -

<http://cordellbank.noaa.gov>

<http://cordellbank.noaa.gov/>

Gulf of Farallones National Marine Sanctuary  
<http://farallones.noaa.gov/welcome.html>

Sanctuary Integrated Monitoring Network  
(SIMoN) - <http://sanctuariesimon.org/index.php>

PRBO Conservation Science -  
<http://www.prbo.org/cms/index.php>

SiMoN Euphausiids in the Gulf of Farallones  
[http://sanctuariesimon.org/cordell/sections/marineMammals/project\\_info.php?projectID=90&sec=mm](http://sanctuariesimon.org/cordell/sections/marineMammals/project_info.php?projectID=90&sec=mm)

Animals in Curriculum Based Ecosystem  
Studies (ACES) -  
<http://www.signalsofspring.net/aces/index.cfm?page>

[hl=home](#)

PRBO/ACCESS mapping tool

<http://data.prbo.org/cadc/tools/multimap/aoccean.php>

Applied California Current Ecosystem Studies  
(ACCESS) - <http://accessoceans.org/>

Oikonos - <http://www.oikonos.org/whatsnew.htm>

Marine Career Resources -  
<http://www.marinecareers.net/careerfields.html>

Encyclopedia of the Sanctuary -  
<http://www8.nos.noaa.gov/onms/park/>

National Geophysical Data Center -  
<http://maps.ngdc.noaa.gov/viewers/bathymetry>

## Acknowledgements

**Author:** Beth A. Lancaster, Naugatuck High School, 543 Rubber Avenue, Naugatuck,

Connecticut 06770, [lancastb@naugy.net](mailto:lancastb@naugy.net)

**Creation date:** 2009

**Completion date:** 2011

I would like to thank the following individuals and organizations for this unique experience and assistance in creating this lesson: Dr. Jamie Jahncke, PRBO and Dr. Lisa Etherington, NOAA for allowing me to participate as a Teacher at Sea during the April 2008 survey, and sharing their wealth of knowledge and resources. Jennifer Stock, Education and Outreach Coordinator of Cordell Bank National Marine Sanctuary for her many suggestions and edits that led to this final lesson plan. Lastly, the Teacher At Sea program for providing unique experiences for teachers and their students.

## For More Information

Education and Outreach Coordinator  
Cordell Bank National Marine Sanctuary  
PO Box 159 Olema, CA 94950  
416 663 0314  
[cordellbank@noaa.gov](mailto:cordellbank@noaa.gov)

This lesson is in the public domain and cannot be used for commercial purposes. Permission is hereby granted for the reproduction, without alteration, of this lesson on the condition its source is acknowledged. When reproducing this lesson, please cite NOAA's Cordell Bank National Marine Sanctuary as the source, and provide the following URL for further information: <http://cordellbank.noaa.gov> If you have any further questions or need additional information, email [cordellbank@noaa.gov](mailto:cordellbank@noaa.gov)