Copepod Conundrum

How are trends in plankton diversity and biomass used to indicate ocean conditions?

Overview

The Northern California Ecosystem off Oregon and Washington supports juvenile salmon and other commercially valuable fish species that feed on copepods and other zooplankton. Fluctuations in ocean conditions lead to variations in the types and numbers of copepods occurring off the Oregon coast. Because researchers have been regularly sampling copepods off the coast of Oregon for many decades, detectable patterns in the data can help characterize ecosystem health and forecast future ocean conditions. In this lesson, students examine long term copepod data to reveal patterns and make predictions.

Learning Goals

Students will learn the following:

- *Scientists collect and utilize data and models to predict populations.*
- *Fluctuations in copepod diversity and biomass are indicators of ocean conditions.*
- *Observed patterns in data can inform future predictions.*

Introduction

Juvenile salmon entering the ocean for the first time experience ocean conditions that may be favorable or unfavorable to their survival. Scientists have been collecting data on physical, chemical, and biological ocean parameters off the Oregon coast, and over many years have uncovered patterns showing how ocean conditions and climate variability relate to salmon survival. Patterns in the data not only reveal complex ecological connections, but can also help researchers forecast future conditions and salmon survival rates.

One important ocean indicator is zooplankton; in particular, the tiny crustaceans called copepods. A major food source for fish, birds, and whales, copepods make up an important trophic level in ocean food webs.

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Grade Level

9-12

Anchoring Phenomenon

Copepod Conundrum

Driving Question

How are trends in plankton diversity and biomass used to indicate ocean conditions?

Standards

Next Generation Science Standards

LS2A –Interdependent Relationships in Ecosystems

LS2.C – Ecosystem Dynamics, Functioning and Resilience

A group of copepods in a July plankton sample - Image: NOAA Fisheries

Learning Objectives

Students will be able to:

1. *Describe relationships between copepod species richness and copepod biomass in the Northern California Current,*
2. *Identify multiple ocean conditions that tend to be favorable for salmon survival, and*
3. *Describe long term patterns in ocean conditions that could affect future salmon survival.*

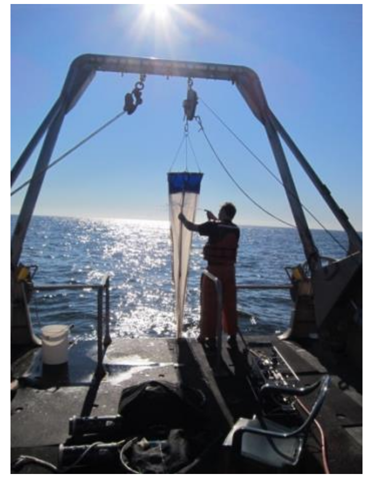
The anchoring phenomenon of this lesson revolves around how researchers use observed fluctuations in plankton diversity and biomass to study ocean conditions and make predictions about impacts to other marine species. Every two to four weeks, researchers from NOAA and Oregon State University sample plankton along the Newport Hydrographic Line, measuring copepod species richness and biomass. Copepod species richness, measured by the number of copepod species present in a sample, has fluctuated during the last two decades of sampling. Periods of low species richness (fewer numbers of species) are correlated with the presence of northern copepods, which are brought in by cold, sub-Arctic coastal currents. The higher fat content of these northern copepods supports a productive food web that translates to higher rates of salmon survival. In contrast, the smaller and leaner southern copepods that come in with warmer, subtropical waters, comprise a greater variety of species, but often correspond with lower rates of salmon survival.

At the same time that they sample plankton, the researchers collect other physical, chemical, and biological data along the Newport Line. Together, the long-term data form patterns that can help scientists identify new changes related to the climate crisis, as well as inform future ocean conditions.

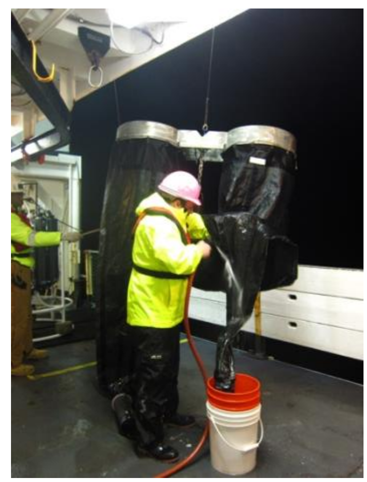
Essential Questions:

- *What methods do researchers use for long-term environmental monitoring in marine environments?*
- *What benefits do long-term data collection provide?*
- *What kind of copepod biomass and diversity findings correspond with "good" conditions for juvenile salmon?*

Image: NOAA Fisheries



Deploying the plankton net
Image: NOAA Fisheries



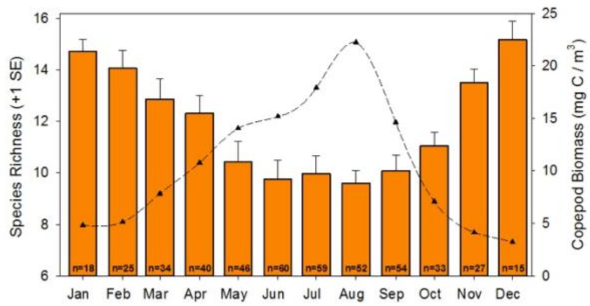
Emptying the plankton net contents
Image: NOAA Fisheries

Image: NOAA Fisheries

Lesson Procedure

ENGAGE

To begin the lesson, share data with students without much explanation. First, show students the video *How to do a plankton tow*, and then examine a graph of copepod biomass and species richness:



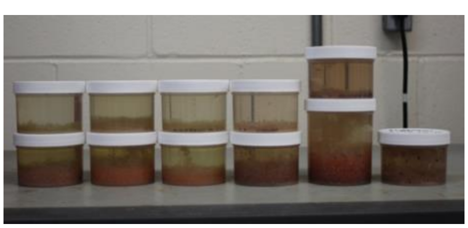
Without context, encourage students to develop theories and ideas as to what the data describe, in addition to why the data are important to the coastal community. After watching the plankton tow video, invite a plankton researcher to come talk to the class to explain methods of plankton data collection. The intent is that the researcher will *not* tell them why the data is significant.

EXPLORE

Students will have obtained background knowledge in the ideas of species richness, diversity, biomass, and food webs during earlier units of the class. By this point in the lesson, they will have seen the data being collected in real time as well as had an explanation of methods from a video and conversation with a researcher.

Activity: The Newport Hydrographic Line

Students will follow *Guided Notes* to fill a *Graphic Organizer* as they explore indicated webpages. Beginning with the story *Towing the Line*, they learn about how and why the Newport Hydrographic Line was established. Then, on the NOAA Fisheries' *Newportal Blog** students can access published data as well as the more complex information provided on the *Ocean Ecosystem Indicators* webpages.



Plankton samples - Image: NOAA Fisheries

LESSON RESOURCES

Video:

- [How to do a plankton tow]

Reach Out to a Plankton Researcher

- Samantha Zeman
- OSU CIMRS / NWFSC

Samantha Zeman - Image: NOAA Fisheries

Newport Hydrographic Line

- Towing the Line *story map*
- Newportal Blog
- Ocean Ecosystem Indicators
- Guided Notes #1 worksheet
- Graphic Organizer worksheet

Where is the line?

"On a map of Oregon, find the coastal town of Newport. Draw a straight line directly west, perfectly perpendicular to the coast, out into the mighty Pacific 200 nautical miles from the blinking beacon of the Yaquina Head lighthouse. You've just sketched the Newport Hydrographic Line."

– Towing the Line

Website under construction

**The NOAA Fisheries website is currently under construction and access to data is not yet fully functional. This lesson will be updated with new links when the webpage is complete.*

EXPLAIN

Activity: Graphing Data

Students will be in pairs or small groups and given different data sets to graph. The data can be obtained by the instructor in advance from the *Newportal Blog* or *Ocean Ecosystem Indicators* websites. Alternatively, use the dataset example provided in this lesson.

The students may need to use different graphing formats depending on the data they are given. They will be asked to compare the graphs they make and determine whether or not they believe their data is demonstrating any sort of trend or correlation. Students will be reminded that this is real data collected off of the Oregon coast. There will be a gallery walk so that all students can see the different graphs and will be taking notes of significant trends they see. Students will be asked to begin determining why they think this data is important.

ELABORATE

Activity: Stop Light Table

Students will use the *Guided Notes #2 worksheet* to explore the *Stop Light Table* provided by the researcher. In addition to determining if there are any patterns or trends that can be seen in the table, the students will identify overlaps in the data they used and graphed and the data presented in the Stop Light Table.

Activity: New Questions

Ask the students to develop a question around data that they have looked at over the course of this lesson. Encourage them to develop questions that are open ended and not easily answered. Students will then spend time researching their questions using the websites.

EVALUATE

Activity: Poster Presentation

Students will create a poster with a claim that addresses the questions: *What happens if copepod species richness increases or decreases in a local ecosystem? What happens if copepod biomass increases or decreases?* Their poster should include evidence from the dataset they graphed, as well as their reasoning as to why the data supports their claim. They will give feedback to each other and be provided with time to revise their posters. If students are able to use the data to support their claim it will show that students are able to address the essential questions. See the *Claim, Evidence, Reasoning* article for ideas about how to apply an assessment rubric.

Graphing Data
- *Example dataset*

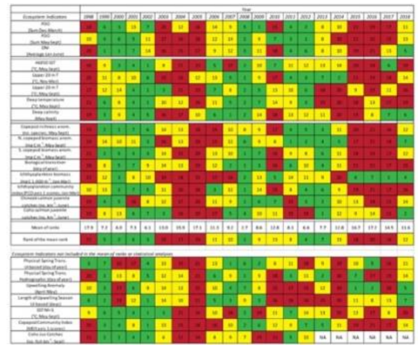


Image: Stop Light Table, NOAA Fisheries

Stop Light Table
- *Stop Light Table*
- *Guided Notes #2 worksheet*

Vocabulary
- *plankton*
- *copepod*
- *species richness*
- *diversity*
- *biomass*
- *invertebrate*
- *arthropod*
- *upwelling*
- *El Nino*
- *food web*
- *interdependence*
- *mean*
- *population*
- *trend*
- *inverse relationship*
- *trend lines*
- *slope*
- *bivariate data*

Poster Presentation
- ***Question:*** *What happens if copepod species richness (or biomass) increases or decreases in a local ecosystem?*
- ***Rubric:*** *Claim, Evidence, Reasoning*

If possible, give the students an opportunity to speak in person or virtually with a researcher at the end of the unit so that they can present their ideas and ask questions.

Next Generation Science Standards

Performance Expectations

HS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics
Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics
Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics
Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Science & Engineering Practices:

- Engaging in Argument from Evidence
- Constructing Explanations and Designing Solutions
- Using Mathematics and Computational Thinking
- Developing and using models

Disciplinary Core Ideas:

- Ecosystem Dynamics, Functioning, and Resilience
- Interdependent Relationships in Ecosystem

Crosscutting Concepts:

- Stability and Change
- Scale, Proportion, and Quantity
- Analyzing and Interpreting Data

Acknowledgments

The 2019-20 ORSEA materials are based upon work supported by Oregon Sea Grant and the Oregon Coast STEM Hub, as well as the National Science Foundation Regional Class Research Vessels under Cooperative Agreement No. 1333564 Award: OCE-1748726. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

See more lessons on the [ORSEA webpage]