Patchy Plankton

What factors contribute to spatial variability in plankton abundance?

Overview
Plankton are the foundation of most marine food webs, but plankton abundance varies through time and space. Studying variability in plankton abundance may help us understand changes in populations of fish, marine mammals, and other organisms that depend on plankton. In these lessons, students will use plankton abundance data collected off Oregon and California to learn about ecological sampling; plankton diversity; dichotomous keys and identification; food webs; summarizing, plotting, and interpreting ecological data; and how information from ecological research can be applied to address environmental issues.

Essential Questions
- *What tools and methods do researchers use to study plankton?*
- *What roles do plankton serve in the food web?*
- *How can ecological data be plotted to explore trends?*
- *How can scientific research be used to address environmental issues?*

Learning Goals
Students will learn the following:
- *Plankton are important to ecosystems and people.*
- *Researchers use sampling transects and dichotomous keys to quantify and identify plankton.*
- *Data can be collected, summarized, and plotted to help us understand ecological communities.*
- *Environmental conditions, like upwelling and food availability, influence plankton abundance.*

Learning Objectives
Students will be able to:
- *explain what plankton are, why they are important, and how they are studied.*
- *demonstrate how a dichotomous key is used to identify plankton.*
- *describe the steps of data collection.*
- *summarize data using averages and plot these averages for visual comparison.*

Authors
Carrie Averill
Tillamook Jr High School
Kim Norberg
Tillamook Jr High School
Luke Bobay
Oregon State University

Grade Level
7-8

Anchoring Phenomenon
Patchy Plankton

Driving Question
What factors contribute to spatial variability in plankton abundance?

Standards
Next Generation Science Standards
LS2.A – Interdependent Relationships in Ecosystems
ETS1.A – Defining and Delimiting Engineering Problems

Common Core Math Standards
7.SP.A.1
7.SP.B.3
7.SP.B.4


Rockfish larva

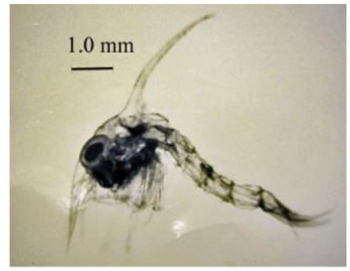
- *make predictions and explain whether data support or refute their predictions.*
- *explain why larger sample sizes result in more reliable results, and how science benefits from collaboration.*
- *make environmental management recommendations based on results of scientific investigations.*
- *define key vocabulary applicable to ecology and marine science and understand some of the responsibilities of scientists, marine ecologists, teachers, and oceanographers.*

Introduction

Plankton are small aquatic organisms whose movements are largely dictated by currents. Many physical and biological factors, like nutrient and food availability, can influence the abundance and distribution of plankton. In this middle school unit, students will use real plankton abundance data to explore these factors while learning about how ecological data are collected and analyzed. Explorations are driven by the question, “What factors contribute to spatial variability in plankton abundance?” because of the implications of this spatial variability for organisms that depend on plankton as food.

MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System) and plankton imaging systems like the OSU Plankton Ecology Lab’s ISIIS (*In Situ* Ichthyoplankton Imaging System), are especially well-suited to studying spatial variability in plankton abundance. These sampling technologies collect plankton abundance data at finer spatial resolutions than many other sampling devices, allowing scientists to study spatial patterns in plankton abundance. MOCNESS collects plankton from depths controlled by the user, who opens and closes each net while the MOCNESS is towed through the water. ISIIS captures continuous images of plankton in the water while simultaneously recording environmental data, allowing the positions of plankton in the water column to be related to environmental factors.

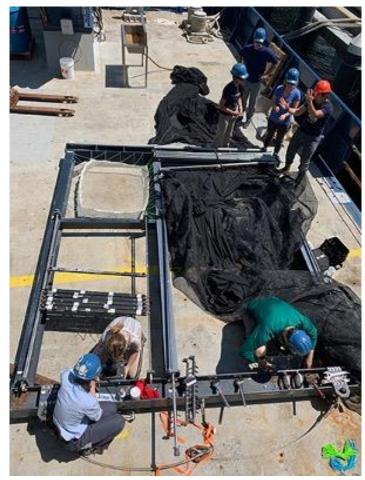
Using the data in this unit collected with MOCNESS and ISIIS, students will learn about ecological sampling, food webs, the scientific method, data analysis. Students will also have additional hands-on opportunities to collect their own plankton samples, identify plankton from samples under a microscope, and conduct an experiment in the classroom.

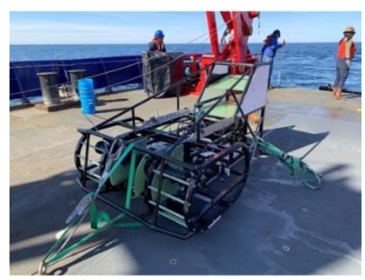


Crab larva

Key Terms and Definitions

- *[What are plankton?]*
- *Vocabulary ([pdf])([doc])*


MOCNESS


ISIIS

**TIP: Start a culture of brine shrimp in your classroom early in the unit so that students can conduct experiments with them later in the EVALUATE section of this lesson.*

Lesson Procedure

ENGAGE

Presentation: Patchy Plankton Hook

To begin the unit, use the *Patchy Plankton presentation* to Introduce students to the importance of plankton, plankton research, and plankton collection methods used by the *Plankton Ecology Lab* at Oregon State University. This presentation created by researcher Luke Bobay (*see bio*) includes Four Videos, each of which could also be shown separately.

****Pause** the presentation at the prompt to use the hands on *Matching Cards* described below, and then continue the presentation to follow up with the answers and discussion prompts.

Activity: Temporary Plankton Matching

The presentation concludes with an activity designed to get students thinking about how plankton are important to ecosystems and people. Also, they discover how some plankton become organisms they have probably seen before. Using the *Matching Cards*, students attempt to match examples of temporary plankton with images of their adult forms. The *Teacher notes* includes solutions and guided questions.

EXPLORE

Activity: Sampling Transects

Briefly use the *Sampling Transects presentation* to introduce students to sampling transects and illustrate how they are used. Using a *Sampling Transects activity* worksheet, students will simulate plankton sampling methods and explore spatial variability in plankton abundance. Graphs generated from this activity will give students an opportunity to begin thinking about factors that influence plankton distributions. The *Teacher notes* for this activity includes datasets, detailed instructions, and guided discussion questions.

Activity: Dichotomous Keys

Tell students about the diversity of plankton and introduce them to dichotomous keys using the *Plankton Identification presentation*. Using a *Dichotomous Key activity* worksheet, students learn to use a dichotomous key to explore the diversity of plankton taxa in samples or on slides under the microscope.

Optional: Specimens for the dichotomous key activity can be collected by students in the field if a body of water is accessible nearby. See the *Plankton Field Collection Activity* for guidance on how to collect plankton samples using household materials. Direct

LESSON RESOURCES

Patchy Plankton Hook

- *Presentation (ppt)(pdf)*
- *Video: Hook video*
- *Video: Deploying MOCNESS*
- *Video: Deploying ISIIS*
- *Video: ISIIS images*

OSU Plankton Ecology Lab

- *PEL website*
- *Marine plankton*

Career Connection

- *Researcher bio: Luke Bobay (pdf)*

Temporary Plankton Matching Activity

- *Matching Cards (pdf)*
- *Teacher notes (pdf)*

Print and cut out temporary plankton cards and match them with adult cards

Sampling Transects Activity

- *Presentation (ppt)(pdf)*
- *Student sampling transects worksheet (pdf)(doc)*
- *Teacher notes (pdf)*

Dichotomous Keys

- *Presentation (ppt)(pdf)*
- *Optional plankton collection activity (pdf)*
- *Student dichotomous key activity (pdf)*
- *Teacher notes (pdf)*

sampling can help students visualize how plankton are collected from the environment and giving them an opportunity to view live organisms that are found locally. Alternatively, specimens for the dichotomous key activity may be borrowed from a university research group, who often have old unusable samples that can be used for outreach, or found on prepared microscope slides that can be purchased from a biological supply company. The *Teacher notes* contain additional considerations about the dichotomous key activity.

EXPLAIN

Activity: Food Webs

Use the *Food Webs presentation* to introduce students to major food web concepts. Then, students will reconstruct the marine food web in the *Food Webs activity* worksheet, explaining how plankton fit into the food web and which other animals depend on them. This will also give students some of the background knowledge necessary to explain how trophic relationships among marine organisms contribute to spatial variability in plankton abundance, like that observed in the sampling transects activity. Answers to the guided discussion questions for the food webs activity are found in the *Teacher notes*.

ELABORATE

Activity: ISIIS Imagery

Use the *ISIIS Imagery presentation* to get students thinking about the factors that influence plankton distribution and how ISIIS is used to determine plankton abundance. Following instructions on the *ISIIS Image activity* worksheet, students will collect data from ISIIS images and analyze and plot these abundance data against environmental factors that influence plankton distributions to support or refute their hypotheses about the relationships between these factors and plankton abundance. To get familiar with identifying zooplankton from ISIIS images, students first can explore the online Zooniverse *Plankton Portal* tool (click on 'Classify'). When ready to begin, students can start collecting data from the four provided ISIIS image sets (1)(2)(3)(4).

The *Teacher notes* provide guidance for this activity, and instructors are also provided with an *ISIIS Image key*. The full ISIIS image data set used to generate the line graphs in the ISIIS Imagery presentation is located in the *ISIIS Image spreadsheet*.

Tillamook students identify plankton

Food Webs

- *Presentation (ppt)(pdf)*
- *Student food webs activity (pdf)(doc)*
- *Teacher notes (pdf)*

ISIIS Imagery

- *Presentation (ppt)(pdf)*
- *Plankton Portal*
- *Student ISIIS image activity worksheet (pdf)(doc)*
- *ISIIS Image sets (1)(2)(3)(4)*
- *ISIIS Image key (pdf)*
- *ISIIS Image spreadsheet (xls)*
- *Teacher notes (pdf)*

Plankton researcher Luke Bobay and students match plankton

EVALUATE

Activity: Plankton Portal

Students can use their newfound understanding of plankton data collection and identification to participate in the Zooniverse *Plankton Portal* community science project. Students make a contribution to cutting-edge research as they explore real scientific data. The *Education guide* provides additional resources, and teachers may choose to have students create outreach and communication tools that both demonstrate understanding of plankton research and encourages others to participate in the Plankton Portal.

Activity: Brine Shrimp Feeding Experiment

Bring live plankton into the classroom to conduct classic science experiments. Using the *Brine Shrimp Feeding Experiment* worksheet, students evaluate how algae abundance can impact zooplankton abundance and apply what they learn to evaluate nutrient pollution management options. Guided discussion questions and answers for this activity can be found in the *Teacher notes*.

Next Generation Science Standards

Performance Expectations:

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-ETS1-3 - Analyzing and Interpreting Data: Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis *Analyze and interpret data to determine similarities and differences in findings.

Science & Engineering Practices:

Analyzing and interpreting data

Disciplinary Core Ideas:

LS2.A – Interdependent Relationships in Ecosystems
ETS1.A – Defining and Delimiting Engineering Problems

Crosscutting Concepts:

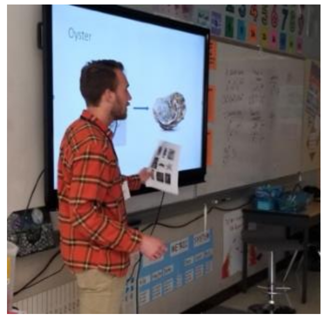
Cause and Effect

Plankton Portal Resources

- *Education guide*

Brine Shrimp Experiment

- *Student brine shrimp feeding experiment worksheet (pdf)(doc)*
- *Teacher notes (pdf)*



Plankton researcher Luke Bobay in the classroom

Common Core Math Standards

Math Standards:

5.G.A.1 - Graph points on the coordinate plane to solve real-world and mathematical problems.

6.SP.A.1 - Develop understanding of statistical variability.

7.SP.A.1 - Use random sampling to draw inferences about a population

7.SP.B.3 - Draw informal comparative inferences about two populations.

7.SP.B.4 - Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations

8.F.B.5 - Use functions to model relationships between quantities.

8.SP.A.1 - Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

Math Practices:

MP1 - Make sense of problems and persevere in solving them; explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends

MP 3 - analyze situations by breaking them into cases, and can recognize and use counterexamples.

MP 4 - Model with mathematics.

MP 5 - Use appropriate tools strategically.

Acknowledgments

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See more lessons on the ORSEA webpage: oregoncoaststem.oregonstate.edu/orsea