Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

Lesson Plan

Whale Jenga: A Food Web Game

Grade Level

4-8

Timeframe

30-45 Minutes

Materials

- Game Contents – 1 set of Jenga blocks
- 21 green blocks (Phytoplankton)
- 12 blue blocks (Zooplankton)
- 12 red blocks (Krill and small fish)
- 1 purple block (this is 4 smaller blocks glued together (Whales)
- 1 stack of playing cards Informational whale cards

Activity Summary

Students will use the game Jenga to learn about the marine food web and how small changes in the food web can have large effects on other organisms.

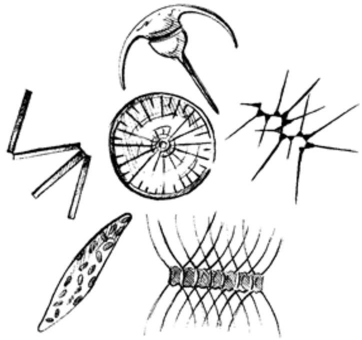
Learning Objectives

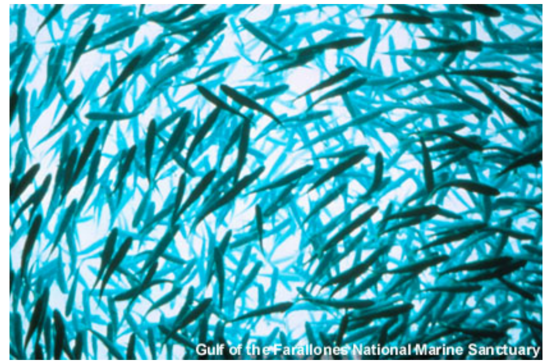
Students will learn how organisms are connected through the marine food web

Students will learn how small changes in the food web may have large scale effects

Background Information

Baleen whales feed on crustaceans such as amphipods, copepods, and krill, as well as small fish. With changes in ocean temperature, upwelling, acidification and other urban influences, whales can be impacted through the food web. This game demonstrates the relationship between the trophic levels of a food web in the ocean and the potential impact of humans on that food web. Everything is connected. If the balance on one level is disturbed too much by climate change, the other levels will be affected as well.





At the base of the marine food web are phytoplankton. Phytoplankton are microscopic algae. Phytoplankton are the lowest trophic level, using the sun to photosynthesize and produce their own energy. They are ingested by zooplankton (animal plankton) and other planktivores (such as anchovies, sardines, filter feeding invertebrates, jellies, baleen whales, and filter feeding sharks such as whale sharks and basking sharks). Zooplankton are animals that are not capable of swimming against the current. Most zooplankton are microscopic, although some larger organisms such as sea jellies are also considered zooplankton. Some zooplankton spend their whole life in the planktonic state (holoplankton). Others are zooplankton during their larval form, then leave the plankton when morphing into their adult stage (these are called meroplankton). Examples of these organisms are sea stars, barnacles, and crabs.

Ocean acidification is a process in which carbon dioxide is absorbed by the ocean. Burning of fossil fuels such as coal and gas by humans produce rampant amounts of carbon dioxide. Twenty-five percent of the carbon dioxide created by the burning of fossil fuels is absorbed by the ocean. When carbon dioxide and water combine the reaction forms carbonic acid and hydrogen ions. The carbonic acid decreases the pH of the ocean which makes it more acidic. In turn the hydrogen ions react with calcium carbonate depleting the amount of calcium carbonate available in the oceans. Many organisms, such as molluscs, crustaceans, and corals, utilize calcium carbonate to produce their shells. Acidity eats away at materials such as calcium carbonate shells. As the ocean continues to absorb carbon dioxide the water will become more acidic, breaking down existing calcium carbonate shells, and the reduction of available calcium carbonate will inhibit organisms' shell production. Both processes may have significant negative impacts on these organisms.

By reducing our burning of fossil fuels for energy and shifting toward renewable energy resources, we can reduce the amount of carbon dioxide going into the atmosphere and the ocean.

Vocabulary

adaptation/adaptacíon – a modification to fit a changed environment
baleen/ballena – a flexible substance hanging in plates from the upper jaw of baleen whales
climate change/ cambio de clima – long-term change in the earth's climate
crustaceans/crustáceos – a chiefly aquatic arthropod
endangered species/especie en peligro – a species at risk of extinction
filter-feeder/conductor de alimentacíon – an aquatic animal that feeds on microscopic particles by straining them out of the water
food web/ web de alimento – a series of organisms related by predator-prey and consumer-resource interactions
invasive species – an organism that is not native to an environment and has a negative effect
krill – small, pelagic, shrimplike crustaceans
migrate/migrar – to move from one place to another
plankton/plankton – organisms that drift and cannot swim against the current
plankton bloom – a large number of plankton in a concentrated area
pollution/contaminacion – introducing harmful substances to the environment
salinity/salinidad – the measurement of dissolved salt content of water
upwelling/corriente ascendente – warm, less dense surface water is drawn offshore by currents and replaced by cold, denser water
urban runoff/agua contaminada urbana – storm water from streets and other developed areas

Preparation

Game Contents – 1 set of Jenga
21 green blocks (Phytoplankton)
12 blue blocks (Zooplankton)
12 red blocks (Krill and small fish)
1 purple block – 4 blocks glued or taped together (Whales)
1 stack of playing cards
Informational whale cards

Directions Preparing the game:

1. Color the ends of Jenga blocks as specified above.
2. Glue images of the organisms on the sides of the blocks to match.
3. Print out playing cards and informational whale cards.
4. Print whale food web card.

Game set up:

1. Place three green blocks side by side with pictures facing out. Place three more green blocks on top of the first layer cross-ways. Continue to stack green blocks this way until all are used up.
2. Stack blue followed by red blocks on
3. Place the purple block on the very top. The stacked up blocks represent the food web for Baleen whales in the ocean.
4. Shuffle the playing cards and stack them upside down.

Procedure

Focus Questions:

If the ocean is so large, why do small changes make a difference?

How can something as large as a whale be impacted by changes in the ocean?

Explain to the students that this game is a representation of how seemingly small changes can impact the stability of a whole system. Prior to the game introduce vocabulary to ensure understanding of terminology used on cards.

Playing the game:

1. The first player picks a card, reads it aloud and follows the instructions written on the card. Only the block being removed or returned may be touched. (You are not allowed to hold the rest of the stack together while removing the blocks.)
2. Put the used cards into a discard pile.
3. Place removed wood blocks into a discard pile off to the side.
4. Continue to take turns adding or removing blocks (depending on the card instructions) until the tower falls and the food web collapses or all cards are used up.
5. Reset to play again using the directions above.

Review questions:

1. What surprised you in playing this game?
2. What did you discover about human influences on the environment?
3. What questions would you like to investigate further?

Extension:

1. Create additional cards for the game
2. Look for local impacts on the ocean that could influence the food web and find solutions you can facilitate.
3. Students will write an explanation of what happened while they were playing the game and how that correlates to what is going on in the ocean.

Additional Extensions:

Use some of the resources listed below (SOARCE videos and www.cisanctuary.org/ocean-acidification/ presentations give information on ocean acidification; urchin lab show how ocean acidification effects zooplankton, Marine Osteoporosis lesson and powerpoint presentations from www.cisanctuary.org/ocean-acidification/ show how ocean acidification effects other organisms) introduce students to the topic of ocean acidification (one of the scenarios in the game). Have students discuss the idea of ocean acidification as it pertains to the food web they just learned about in the game. How will ocean acidification effect baleen whale food sources such as phytoplankton and zooplankton? How will crustaceans such as amphipods, copepods, and krill (main food sources for baleen whales) be affected by ocean acidification?

Re-examine the Focus Questions:

- *If the ocean is so large, why do small changes make a difference*
- *How can something as large as a whale be impacted by changes in the ocean?*

Evaluation:

Have students write informational text about ocean acidification and its effects on various marine organisms and the food web.

Have students navigate the Stanford Virtual Urchin Lab experiment http://virtualurchin.stanford.edu/AcidOcean/AcidOcean.htm

Share portions of archived SOARCE (Sharing Ocean Acidification Resources for Communicators and Educators) Ocean Acidification webinars with students. http://oceanacidification.noaa.gov/AreasofFocus/EducationOutreach/SOARCEWebinarSeries.aspx

Students will read Earth's Acid Test published in Nature March 10, 2011 and answer questions about the text.

Students will explore the www.cisanctuary.org/ocean-acidification/ website (with supervision of teacher) to learn more about ocean acidification. Investigate what other types of organisms may be the first to be effected by ocean acidification and why.

Utilize the International Student Carbon Footprint Challenge website (http://footprint.stanford.edu/calculate.html). Students will investigate how to calculate their own carbon footprint and develop and present ideas on how they individually, as a family, and as a school community can lower their carbon footprint and help decrease the amount of CO_2 (produced by the burning of fossil fuels) being absorbed by the world's oceans. Have students present and compare their solutions to reduction of carbon footprint and have them use individual plans to come up with the best overall plan. For middle and high school students have students devise a way to evaluate the effectiveness of their solution(s).

Students will explore ways they can effect change in the use of fossil fuels beyond their home and school communities

Resources:

http://www.cisanctuary.org/ocean-acidification/

http://oceanacidification.noaa.gov/

http://oceanacidification.noaa.gov/AreasofFocus/EducationOutreach/SOARCEWebinarSeries.aspx

American Cetacean Society Whale Pages:

- Blue Whale: http://www.acsonline.org/factpack/bluewhl.htm
- Fin Whale: http://www.acsonline.org/factpack/finwhl.htm
- Gray Whale: http://www.acsonline.org/factpack/graywhl.htm
- Humpback Whale: http://www.acsonline.org/factpack/humpback.htm Image of baleen whale food web

Acknowledgements: This lesson is one in a series exploring ocean acidification. This lesson was developed by Cabrillo Marine Aquarium and adapted by NOAA Channel Islands National Marine Sanctuary. Correlations to Common Core and Next Generation Science Standards by Maria Petueli. When reproducing this lesson, please cite Cabrillo Marine Aquarium and NOAA National Marine Sanctuaries as the sources and provide the following website: http://sanctuaries.noaa.gov/education.
If you have any further questions or need additional information, email sanctuary.education@noaa.gov.

Education Standards

Common Core ELA Standards	Reading: Informational Text Grades 4-8: 1 – Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text 4 – Determine the meaning of general academic and domain-specific words or phrases in a text 7 – Interpret information presented visually, orally, or quantitatively and explain how the information contributes to an understanding of the text in which it appears. **Writing Standards Grades 4-8:** 1 – Write opinion pieces on topics or texts, supporting a point of view with resons and information 2 – Write informative/explanatory texts to examine a topic and convey ideas and information clearly 4 – Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience
Common Core Math Standards	Mathematical Practices: Reason abstractly and quantitatively Construct viable arguments
Next Generation Science Standards	4 Structure, Function, and Information Processing 4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction Science and Engineering Practices: Engaging in Argument from Evidence Crosscutting Concepts: Cause and Effect Systems and System Models 3-5 Engineering Design 3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. Science and Engineering Practices: Constructing Explanations and Designing Solutions Crosscutting Concepts: Influence of Science, Engineering, and Technology on Society and the Natural World MS Human Impacts MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment Science and Engineering Practices: Constructing Explanations and Designing Solutions Crosscutting Concepts: Cause and Effect Influence of Science, Engineering, and Technology on Society and the Natural World
Ocean Literacy Principles	5 The ocean supports a great diversity of life and ecosystems 6 The ocean and humans are inextricably interconnected
Climate Literacy Principles	3 Life on Earth depends on, is shaped by, and affects climate A,C,E 6 Human activities are impacting the climate system C,D,E

Bacteria decomposing algae following a bloom pull oxygen from ocean water. Remove 1 blue and 1 red block.	Changes in ocean currents, disperses phytoplankton. Remove 2 green blocks.
Increase in atmospheric carbon dioxide (CO_2) leads to increased ocean acidification. Remove 2 red blocks.	Successful beach clean-up reduces near shore blooms. Put back 1 blue block.
Sunlight reaching ocean increases. Put back 1 green block.	Pollution through storm drains increased with storms. Remove 1 green and 1 blue block.

Chemical spill in watershed. Remove 1 green, 1 blue and 1 red block.	Layer of smog reduces sun reaching ocean. Remove 1 green block.

Oil spill in harbor. Remove 1 green, 1 blue and 1 red block.	Increase in ocean temperature leads to smaller phytoplankton, unsuitable as food for zooplankton. Remove 1 blue and 1 red block.
Whales leave the area. Put back 1 red block.	Blue whales remain in area longer than usual. Remove 1 red block.
Changes in ocean currents decrease upwelling. Remove 1 blue block.	Rise in ocean temperature. Remove 1 green, 1 blue and 1 red block.

Rainwater influx into ocean reduces the concentration of phytoplankton. Remove 2 green blocks.	Introduction of invasive zooplankton reduces the number of phytoplankton. Remove 1 green block and put back 1 blue block.

Commercial fishing pressure is reduced. Replace 1 red block.	A Marine Protected Area prevents the removal of fish and krill by fishermen. Replace 1 red block.
Treatment of local sewage waste water is improved prior to release into the ocean. Replace 1 green and 1 blue block.	Increased use of renewable energy resources reduces the production of CO_2 from fossil fuels and slows climate change. Replace 1 green block.
Ecotourism and whale watching encourages locals to protect the ocean by reducing water pollution. Replace 1 green and 1 blue block.	Scientists monitoring the ocean notice and remove a non-native predatory fish species before it reproduces. Replace 1 red block.

Handout on Earth's Acid Test by Quirin Schiermeier

What happened to the urchin larvae in the initial experiment?

Name some factors that could affect the severity in which organisms are affected by a more acidic environment?

Hypothesize what affect each of these variables may have on the pH of the ocean.

How much carbon dioxide does the ocean absorb every year?

What evidence is there from a rise in ocean acidity 55 million years ago that may shed light on what could happen in our near future?

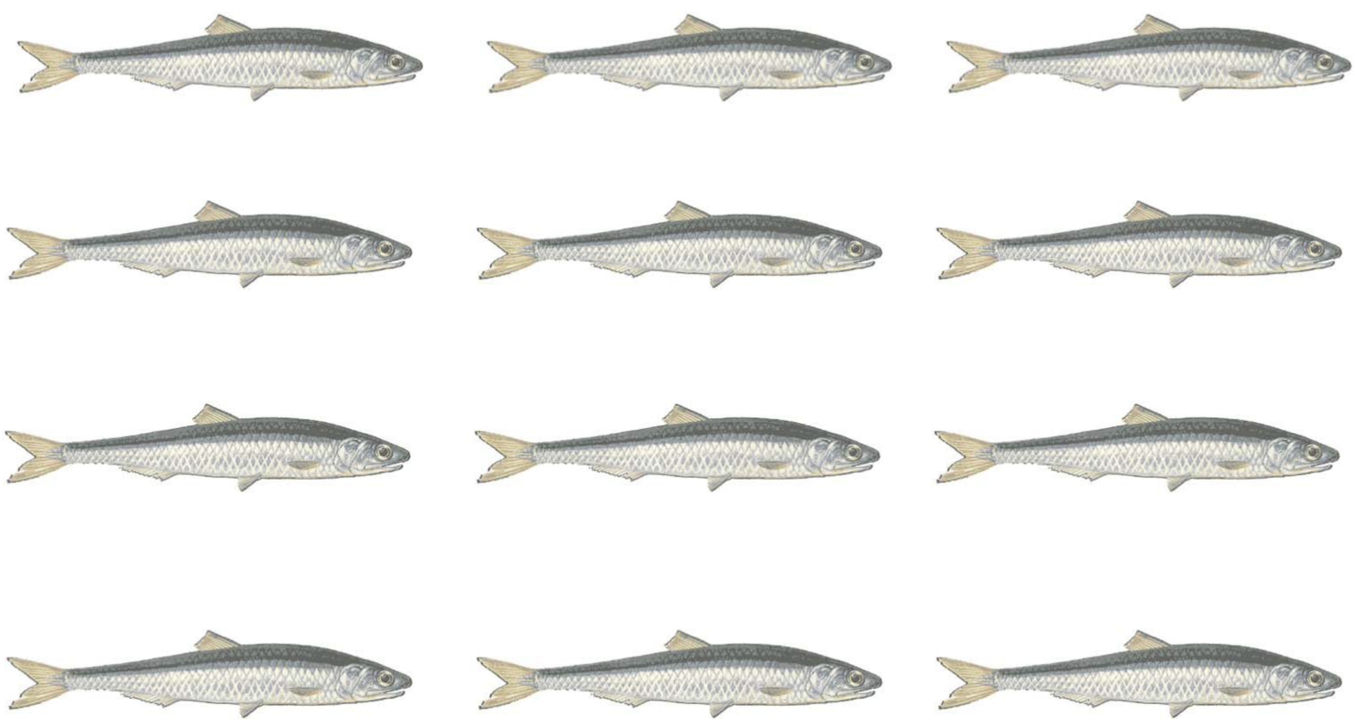
Where do scientists believe the effects of ocean acidification will be seen first and why?

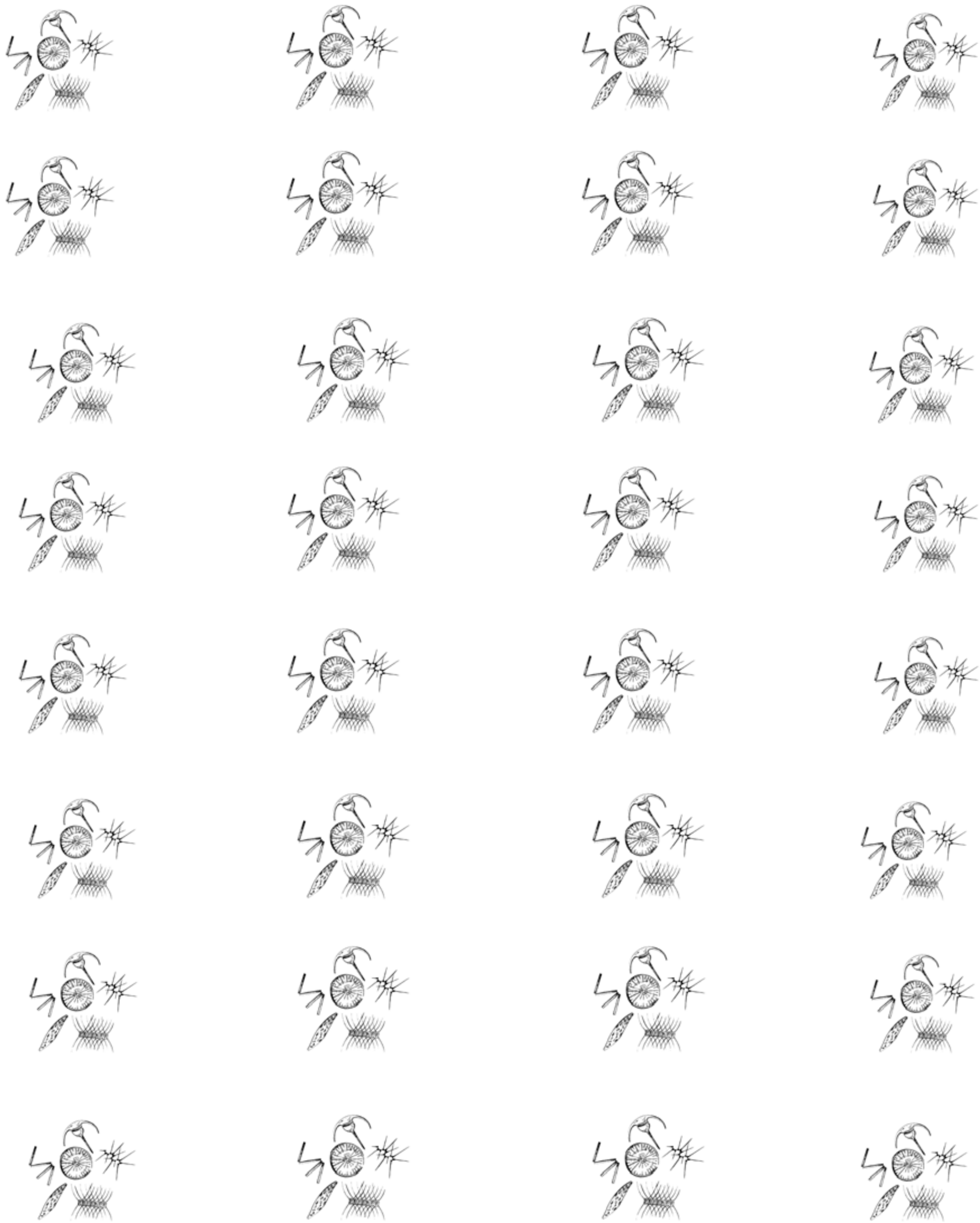
What are some other factors that are putting stress on the ocean environment?

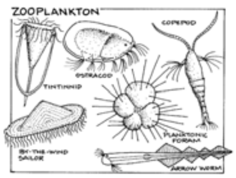
What were the new variables that the 2nd experiment tried to test for? How do these variables compare to the ocean variables mentioned at the beginning of the article? Can you think of any variables that they did not test for that could be added to the experiment?

Write a summary of the color graphics of the world's oceans.

What did the Baltic study on mussels show? Why might this be important?



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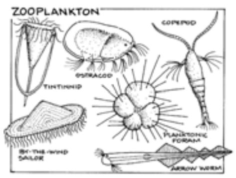
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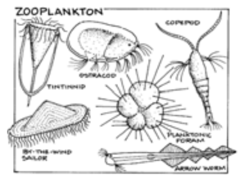
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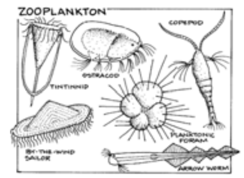
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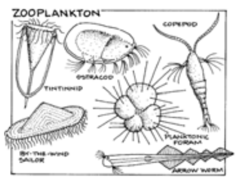
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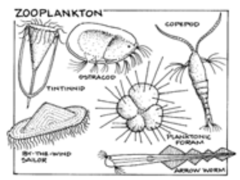
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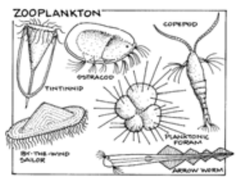
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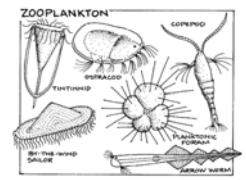
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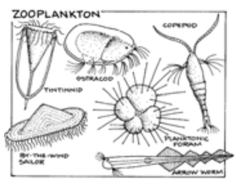
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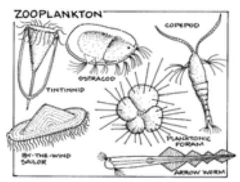
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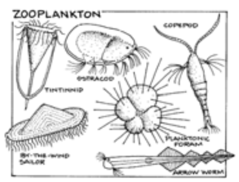
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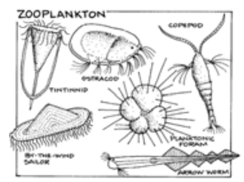
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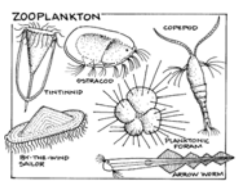
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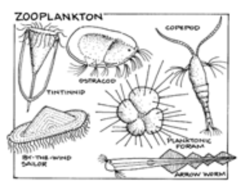
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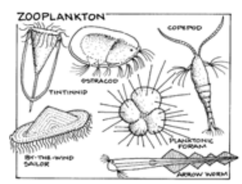
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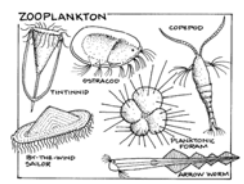
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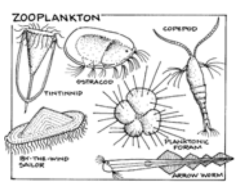
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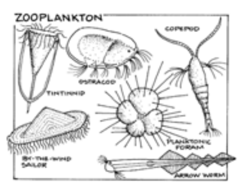
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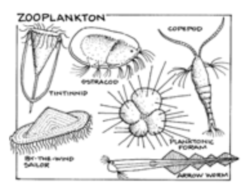
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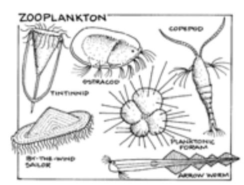
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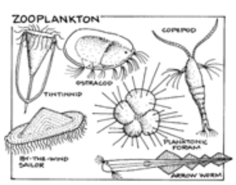
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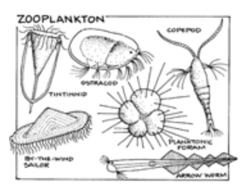
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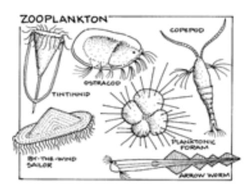
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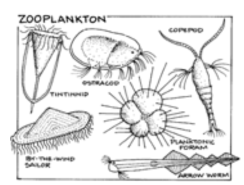
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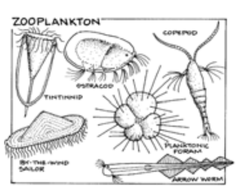
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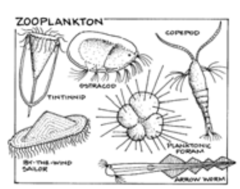
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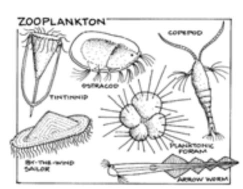
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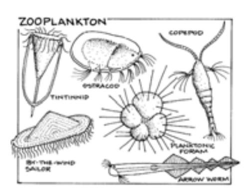
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HUMPBACK WHALE

Features

- About 50 feet long
- Knobs on head and flippers
- Long flippers

Food

- Small fish, krill
- Eats up to 1.5 tons a day

Fact

- Very acrobatic whale
- Produces long complex songs

GRAY WHALE

Features

- About 45 feet long
- Barnacles and lice on body
- No dorsal fin

Food

Amphipods, mysid shrimp, other crustaceans, and tube worms sucked from the muddy bottom

Fact

- Long annual migration form Arctic to Baja California (10,000 to 14,000 miles)

BLUE WHALE

Features

- About 80 feet long
- Small triangular dorsal fin towards end of back
- Tall blow (30 feet)

Food

- Krill, other crustaceans, small fish
- Can eat up to 4 tons a day (40 million krill!)

Fact

- Largest animal ever to live on Earth

FIN WHALE

Features

- About 78 feet long
- V-shaped head
- Asymmetrical coloration on
- Underside of jaws and baleen

Food

- Krill, small fish
- Eat up to 2 tons a day

Fact

- Second largest whale