INTRODUCTION:

This curriculum unit is designed for a one to two week study of harmful algal blooms, their cause, their effect on the marine food chain, and identification of the organisms in an algal bloom. The unit is designed to address Life Science Standards at the Middle School level. The unit is broken down into sections that allow teachers quick access to the different lessons and extensions.

BACKGROUND INFORMATION: This is also included as a handout to use with your students.

Harmful Algal Blooms

Marine algae are single-celled plantlike organisms that are present throughout the world’s oceans. They are also called phytoplankton or “drifters”. When conditions are right (adequate nutrients, light, and temperature), the algal cells can rapidly multiply and create what are called “algal blooms”. Some algal species produce toxins that can be harmful to other members of the marine food web. For example, filter feeding fish like anchovies eat toxic algae and then pass the toxins to their predators, like sea lions and pelicans. These predators can become sick and in some cases die as a result of the toxins. Humans can also become sick when the toxins are passed through seafood. Fortunately, several seafood safety programs are in place to prevent people from eating toxic seafood.

When a bloom of toxic algae occurs, it is called a Harmful Algal Bloom (HAB).

It is not clear exactly what causes algae to bloom or to produce toxins. Scientists do know that temperature, nutrients, light and water quality are factors that influence when and where algal blooms occur. In general, warmer water temperatures are more favorable for blooms. This causes concern because ocean temperatures have been steadily increasing as a result of global climate change. Scientists are concerned that this will cause the number of blooms and the geographic range of blooms to increase.

MATERIALS:

- The video, Zombie Sea Lions, is 27 minutes and 27 seconds long.
- The video, Plankton Tow, is 6 minutes and 22 seconds long.
- Notebook of lessons and extensions
- Sets of prepared phytoplankton slides or laminated picture cards
- Sets of identification cards
- Food web cards
- Readings
- Handouts
- Checklist for assessment purposes

TEACHER PREPARATION: View the video yourself and then decide how to present to your classes.

- Choose pausing points for clarification, questions, and discussion
- Students will view in its entirety to maintain the urgency and suspense of solving a scientific puzzle
- View with attention to the scientific process
- Have students construct a note-taking graphic for recording interesting facts and questions to ask
PRE-LESSONS: Any of the material below can be used to prepare your classes for this unit.

A. This video contains some graphic footage of postmortem exams, anatomy, some blood, and ailing marine animals that may cause distress in your students. You may need to prepare your students for this and inform them of the reason why scientists conduct postmortem exams.

B. Have some National Geographic magazines available if your students are not familiar with the organization. The clip provided is a segment of a larger program produced by National Geographic.

The video contains interviews, dramatizations and technical vocabulary you may want to review with your students beforehand or prepare word cards for further discussion after viewing the video.

C. Below is a list of vocabulary frequently used throughout the video. Definitions obtained from http://www.wordcentral.com/home.html and http://www.britannica.com/.

- **Seizure**: a sudden attack (as of disease); especially: the physical signs (as extreme twitching of muscles) of an episode of abnormal brain activity (as in epilepsy).
- **Toxin**: noun, a substance made by a living organism (as a bacterium) that is very poisonous to other organisms
- **Toxic**: adjective, of, relating to, or caused by a poison or toxin
- **Hippocampus**: region of the brain that is associated primarily with memory
- **Algae** (in the video the word is pronounced with both the hard and soft g): any plant or plantlike organism (such as a seaweed) that includes forms mostly growing in water
- **Dramatization**: to make into a drama, to reenact
- **Postmortem**: done or occurring after death

D. Show the class a map of the region discussed in the video, from British Columbia to the Baja Peninsula. Students can mark the places discussed in the video on the classroom map or on individual maps.

E. People and their careers:

- **Veterinary Scientist** Dr. Frances Gulland Marine Mammal Center in Sausalito, California
- **International Bird Rescue response team member** Mark Russell
- **Pathologists** were sent brain tissues to examine for neurological causes
- **Oceanographer** Chris Scholin Monterey Bay Aquarium Research Institute
- **Research Biologist** Kathi Lefebvre National Oceanic and Atmospheric Administration (NOAA) Fisheries

F. Noteworthy questions to either have the entire class find the answers to while viewing the video, assign different groups to answer specific questions or to use as talking points throughout the video. These questions can also serve for debriefing your class.

- **What is wrong with the sea lions?** The sea lions are having seizures, are confused and have brain damage.
- **What other animals are affected?** Sea birds such as pelicans also show seizures and confusion.
- **What is the name of the toxin responsible for the illness?** Domoic Acid.
- **Where does the toxin come from (i.e. what organism produces it)?** The toxin is produced by single-celled microalgae, phytoplankton, called *Pseudo-nitzschia.*
• How did scientists solve the mystery? Or Take note of the scientific process undertaken by Dr. Lefebvre. A team of scientists unraveled the mystery by identifying the toxic algae in the water (Pseudo-nitzschia), finding the toxin (domoic acid) in fish that the sea lions were eating and in the feces of the sick animals, and finding damage in the brains of sea lions.
• Draw a simple food chain showing the route of exposure to the toxin sea lions and/or the pelicans.
• Algae → Fish → Sea Lions or Algae → Fish → Sea Birds
• Name the organism at the beginning of the food chain. Pseudo-nitzschia, single-celled microalgae and phytoplankton are all acceptable answers
• Volunteers were mentioned in several parts of the video. Have you volunteered your time? What roles did the volunteers serve? Why were volunteers used in these roles?

LESSONS:

TIMELINE: a minimum of 5 lessons, not including preparation work, with various delivery suggestions and extensions.

LESSON 1: View the Video (27 minutes and 12 seconds long).

LEARNING GOAL: How do scientists approach a problem?

We will watch a video about zombie sea lions. Are zombies real or fictional? Why would a video made by National Geographic choose the title Zombie Sea Lions? At the time these animals were discovered, scientists did not know what was making them behave this way. The term zombie fit at the time.

Allow time for comments, questions, replaying of key parts for clarification. See Teacher Preparation section for suggestions. You can also employ the use of ExitTickets where students record a response to the video. An example is provided.

Name 2 reasons why the video was named Zombie Sea Lions.
LESSON 2: Debriefing the video: any of these suggestions can be used to check for student understanding.

Materials: group whiteboards with dry erase markers and erasers, or light colored butcher block paper with markers.

A. Group your students with a large piece of butcher block paper to summarize the important aspects of the video, such as: commenting on how the mystery was solved, how scientists worked as a team to piece together the evidence and share their expertise, and/or how the scientists revised their understanding of what was happening from one year to the next. The students can record three questions. For differentiation purposes, direct students to record what was important about the video. Allow time for the groups to present their work to the rest of the class. If time is short, have A/B groups present to each other. Use the provided checklist for students to practice their presentation skills. You can change the directions while keeping the presentation portion intact.

B. For differentiation purposes, direct students to record what was important about the video. Encourage the groups to not summarize key points but to go beyond and look for the importance of the work involved.

C. Give each group of students in your class a set of questions to answer from the Noteworthy questions section. They can use butcher block paper to record their answers and use it to present their work to the rest of the class.

D. The above two options can be individualized into science notebook reflection pieces, exit tickets, or homework assignments.

E. Answer the question from the Learning Goal.

F. Collapse Day 1 and 2 together.

EXTENSIONS:

- Collect the questions from the debriefing session, review ones that are testable and research questions. Assign students to find the answers.
- Students can make PowerPoints of the research or as a portfolio for the unit.

ADVANCED PREPARATION: Students can make their tables for the slide lesson on this day.
LESSON 3: Short video clip on collecting plankton (6 minutes and 22 seconds). Use microscopes to view prepared slides of phytoplankton

LEARNING GOAL: Using a microscope, what characteristics do we use to identify phytoplankton from prepared slides?

VOCABULARY TO CONSIDER: http://www.merriam-webster.com/

- plankton: the passively floating or weakly swimming usually minute animal and plant life of a body of water. Greek for wandering or drifting.
- zooplankton: plankton that is composed of animals
- phytoplankton: planktonic plant life

Scientists collect plankton from the water with a plankton tow. It is a device that captures the microorganisms while allowing the water to pass through. The plankton in the collection cup are pipetted onto a slide. This lesson may take more scaffolding if your students have not practiced using a microscope.

We will watch a short video and then use the microscopes to view a set of prepared slides of phytoplankton collected using a plankton tow. Using your notebook drawings and identification cards, we will work together to identify the different species.

The video shows how plankton are collected and they will use the microscopes to see a very small sample of what is collected in a plankton tow. Students will draw what they observe then use their notebook entries to match their drawings with description cards. Have your students create a table for their notebook entry. If they have had a lot of exposure making tables, ask them what their tables should have. Otherwise lead them through the construction. Creating handouts is not recommended. Their tables should look something like this:

<table>
<thead>
<tr>
<th>Slide #</th>
<th>Drawing</th>
<th>Characteristics observed with the microscope</th>
<th>Species</th>
<th>Characteristics learned from the reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
</tbody>
</table>

MANAGEMENT: if you do not have enough microscopes for partners use the following suggestions.

- Create stations of microscopes and place one slide at each scope. Have students rotate around the room.
- Students not on microscopes have 3 different handouts to read and questions to answer for each

As you circulate, remind your students to draw what they see, using direct observations. Placing a circle in the drawing column may help students concentrate on their observations. Many times, students use inferences and draw what they think they see. You will know who is doing this because they are not referring back to the microscope for details.
The slide containing *Pseudo-nitzschia* is the organism responsible for the marine animals’ (sea lions and pelicans) illness and death. The last column is best utilized by students who quickly identify the organisms. Students should check with you to verify that they have correctly identified each one before completing this column. Instruct students to use the identification cards to record characteristics of the different organisms.

**EXTENSIONS:**

- students research phytoplankton
LESSON 4: Food Webs

LEARNING GOAL: How do toxins affect a food web?

It is important for students to understand how toxins affect the organisms within a food web. This day is devoted to students constructing a food web with the cards provided.

What is a food web and how is it different from a food chain? Students can answer this in their notebooks or make it the start of an exit ticket. They can add more after the lesson is complete.

A food chain is a simplified version of a food web which includes a single path. A food web shows many paths of nutrient flow. You will work in small groups to construct a food web with the organism cards. Work together to build consensus on the paths nutrients or energy takes from one organism to the next. Each organism card has a description on the back that will help you decide its role in a food web.

As you circulate, check to see that the groups understand how energy flows from organism to organism. Once the majority has demonstrated understanding of how a food web functions, ask them to relate how the toxin Domoic Acid entered the food web in the video Zombie Sea Lions. How did the toxin travel through the food web? Were the fish affected by the toxin? What other organisms not in the video could be affected by this toxin? What organisms in the constructed food webs are affected by the toxin?

Use the reading piece about Marine Algal Blooms to further students understanding. This can be partner read, read aloud by you, class read popcorn style, or as a homework note-taking assignment.

CLOSING SUGGESTIONS:

- When the class has completed their food webs, have the groups conduct a gallery walk to view each other’s work. Give students sticky-notes or scratch paper to leave comments and/or questions.

- Have each group present their food webs to each other. Use the checklist for students to practice their presentation skills before each group presents.

- Make extra copies for the picture cards so students can glue them on butcher block paper and display in the halls. Do provide each group with an uncut copy so they may use the reading parts found on the backside. Have the groups draw directional arrows to show how the flow of energy travels from prey to predator.

EXTENSIONS:

- Form a circle with your students. Once the circle is broken and the students are milling about, they will attempt to keep the same distance between themselves and two other people they have secretly chosen. It is important that the students not know who has chosen whom in this exercise. There will be a lot of movement but it will gradually decrease as the equilibrium has been established. This shows the students how, in a food web for example, organisms are interrelated and interdependent on each other. Assign someone to leave the group. How does this disrupt the group?
A VISUAL PRIMER ON THE DIFFERENCE BETWEEN A FOOD WEB AND A FOOD CHAIN:

Notice in this food chain how the path is in one direction, it shows who eats whom.

But in a food web, the arrows point to the direction of the energy flow. These arrows show how the nutrients travel from prey to predator. A food web also shows how organisms are interrelated.
LESSON 5: Closure

LEARNING GOAL: What have you learned about marine algal blooms?

SUGGESTIONS FOR CLOSURE:

A. Students can work together to create posters for peer presentations, reflect in their science notebooks, or answer in an assessment format, any of the following questions.

- What were the three most important things you learned in class this week and why were they important?
- If you could interview someone in the video, who would it be and what would you ask?
- How can marine algal blooms affect you?

B. Students can create informational posters to display in the halls for peers or for an upcoming family/community event.

C. You can use any of the lessons as Exit Tickets or written assessments.

EXTENSIONS: Play the Toxin Game, You are What you Eat: http://www.bigelow.org/edhab/pdf/you_are.pdfw