



**Cabrillo
Marine
Aquarium**

Cabrillo Marine Aquarium Lesson Plan

Grade Level: Eighth Grade

Title: *Silversides & the Solar System: A Lesson on Earth's Tides & the Grunion*

Objective: Students will learn how the moon affects ocean tides and also will create and interpret graphs from NOAA's regional tide data website. Students will also investigate the Grunion fish & its fascinating connection with Earth's lunar cycle.

California Science Standards: 8th: 2g, 4e, 9a-g

Time to Complete: 60- 90 minutes

Materials Provided by CMA: *Reading Handout: Introduction to Grunion Biology*, (the following items only provided with CMA's Ocean Discovery Kit: *Photo*, Fish Specimens, Eyewitness Books & DVD's, Grunion Life Cycle Magnets and Poster)

Materials Provided by Teacher: Photocopies, two safety pins, two 16-inch pieces of string, labels or name tags for the "*Earth, Moon, Sun, and Gravity*"; access to the Internet for current tide information, overhead projector, transparency of graph paper, graph paper, colored pencils

Vocabulary: Diurnal tide, high tide, low tide, neap tide, spring tide

Background Information: The Earth's ocean **tides** are a result of variations in gravitational attractions between the Earth, the moon, and the sun. The moon is the primary factor controlling the rhythm and height of the tides. The moon produces two tidal bulges on the Earth. Due to strong gravitational attraction, the sea is drawn towards the moon at the location on the Earth closest to the moon. Another tidal bulge occurs simultaneously on the opposite side of the Earth, pulling away from the moon (by centrifugal force). The Earth's rotation and the revolution of the moon thus play a large part in the timing of tidal events. The Earth completes one rotation every 24 hours, while the moon takes 27 days to revolve around the Earth. As a result, each tidal period is 24 hours and 50 minutes long.

During each tidal period, most of the Earth's surface experiences two **tidal crests** (high tides) and two **tidal troughs** (low tides). However, due to the unevenness of the sea floor, along with the fact that the moon orbits at an angle around the Earth rather than directly around the equator, some areas of the Earth experience only one high and one low tide (called **diurnal tides**) each day.



The sun also influences the Earth's tides. When the moon, the Earth, and the sun are in alignment, the pull of the sun and the moon act together to create higher high tides and lower low tides, called **spring tides**. These tides occur every 14–15 days, during full and new moons. When the moon, the Earth, and the sun are at right angles to each other, **neap tides** are formed. Neap tides occur during the first and last quarter of the moon, and consist of lower than normal high tides and higher than normal low tides.

Lesson Outline:

- **Activity 1: Sun, Moon & Tides Demonstration**
- **Activity 2: Tides Online: NOAA Website**
- **Activity 3: The Grunion Connection: A Fish that Know the 'Tide' Tables!**

Lesson Procedures:

Activity 1: Sun, Moon & Tides Demonstration

- For an excellent animation of spring & neap tides visit:
http://www.csun.edu/~vceed002/geoscience/oceanography/graphics/gif_jpg/whytides.gif
- Demonstrate how the moon affects the tides by using students as models.
 - Teachers may want to make a large necklace or name tag to label your models.
 - Select one student to stand in the front of the room to symbolize the Earth.
 - To enhance student understanding, tape continents onto the "Earth's" body.
 - Select another student to stand up next to the "Earth" to represent the moon.
 - Select a third student to represent the sun
 - Two additional students represent the force of gravity.
 - Tie a piece of string to two separate safety pins and pin them to the front and back of the "Earth's" shirt.
 - The shirt will represent the Earth's oceans.
 - For "gravity," students will use the strings pinned on the shirt to demonstrate the force of gravity.
 - To demonstrate a neap tide, have the "sun" and the "moon" stand in a perpendicular formation to the "Earth" and have the "Earth" face the "moon."
 - Have the "gravity" students tug gently on the strings in the direction of the "moon" and directly opposite the "moon" to demonstrate how gravity creates tidal bulges.
 - As the models demonstrate, ask the rest of the class to identify where high and low tides would consequently occur on the "Earth."
 - After observing the model, have students try to draw and label the diagram on their worksheet to show neap tides.
 - You can use the same models or allow other students to get up to demonstrate spring tides. This time, have the "moon" stand between the "sun" and the "Earth."

- Have "gravity" tug gently on the strings in the directions towards and away from the moon.
- Again ask students to identify where the high and low tides would be on the Earth.
- Have students complete the remainder of their worksheets.
- Discuss their responses.

Activity 2: Tides Online: NOAA Website

- In a computer lab or with a projector in your classroom, log onto the *NOAA website* <http://tidesonline.nos.noaa.gov/> and navigate to find the section titled *Tides Online*.
- Select a region in *Los Angeles, CA* to access relevant tide data, then view graphs and tables displaying tidal information for various time periods.
- Note that some graphs include predictions for future high and low tides.
- Read through a month's worth of data with your students, determining together the high and the low tides, along with spring and neap tides.
- Using an overhead projector and a transparency of graph paper, demonstrate how to set up graph paper to create a graph showing tidal data.
- Label the Y axis (tide height in feet) and the X axis (6 hour time periods).
- Demonstrate on the overhead projector how to plot the tide level points for your chosen region, using tide data from the NOAA website.
- Pass out graph paper and have students graph a Tidal Chart.
- Click *Cabrillo Beach #9410650*
<http://tidesandcurrents.noaa.gov/noaatidepredictions/viewDailyPredictions.jsp?bmon=01&bday=23&byear=2013&timelength=daily&timeZone=2&dataUnits=1&datum=MLLW&timeUnits=2&interval=highlow&format=Submit&Stationid=9410650>
- Have students label the tidal crests and troughs (highest and lowest tidal points).
- Ask students to make tidal predictions, complete the chart with their predictions, and then graph any additional information.
- Discuss their responses.

Activity 3: The Grunion Connection: A Fish that Knows the 'Tide' Tables!

Grunion Background Information:

California grunions are small silvery fish found on the coast of southern California and northern Baja California. They have bluish-green backs with the rest of the body a shiny-silver color. Their average length is between five and six inches. This fish belongs to the family Atherinidae, commonly known as "*Silversides*."

Along southern California's sandy beaches, from March through September, one of the most remarkable life cycles in the ocean is completed; the California grunion comes ashore to spawn. The curious fact is that 1 to 3 hours after the high tide, female grunion and their male suitors wash up on the shore en masse. The females wriggle tail first into the sand laying some 300 to 3,000 eggs while the males encircle them, depositing milt along their bodies and fertilizing the eggs below the sand surface. In this protected pod, the eggs

develop for some 10 days until the next high tide agitates and triggers the baby grunion to hatch. They will mature in approximately one year and will complete the cycle. Grunion live for three to four years and females may spawn four to eight times per season.

- Have students read & discuss an *Reading Handout: Introduction to Grunion Biology* by Karen Martin, Ph.D .
- Refer to the Grunion Magnets and Life Cycle Poster.

Lesson Extensions: Grunion Documentary

- Watch this short 25 minute short documentary, "*Surf, Sand, and Silversides: the California Grunion*"
<http://grunion.pepperdine.edu/>

Further Student Exploration: Technology in the Classroom

- Allow students to build on their knowledge of the tides by reading more informational content from some of these suggested websites:
 - <http://www.mbgnet.net/salt/sandy/index.htm> - which explains how the tides are affected by the sun and the moon.
 - <http://co-ops.nos.noaa.gov/restles1.html> - a section of the NOAA website that provides users with in-depth information about tides and how they are affected by the moon and the sun.
- To integrate technology and increase students' knowledge of tidal charts, have students make their charts and graphs using a computer spreadsheet or a graphing program. A number of sites allow students to select the exact data they want presented and then modify the way in which the data are displayed on the screen.
 - <http://tbone.biol.sc.edu/tide/sitesel.html> - an excellent tide data website that allows students to select how they want data presented.
 - <http://tycho.usno.navy.mil/vphase.html> - the "Virtual Reality Moon Phases" from the tide service department of the U.S. Naval Observatory allows users to view the moon phase for any date, from the year 1800 to the year 2199.

References:

- A Modified Lesson from Oceans & Islands Alive!
http://www.sitalive.com/oil/private/03s/framesets/oil_index.html