Lesson 2: Changing of the Tides in a South Carolina Estuary

Focus Question:
How do tides affect sea level in coastal estuaries?

Objectives:
- To identify how tides change over a 24 hour period
- To plot tidal changes based on data from a tide chart
- To determine tidal ranges

S.C. Curriculum Standards:

5-3.4	Explain how waves, currents, tides, and storms affect the geologic features of the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).
5-3.5	Compare the movement of water by waves, currents, and tides.
5-1.3	Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
5-3.2	Analyze patterns and functions with words, tables, and graphs.
7-3.2	Analyze tables and graphs to describe the rate of change between and among quantities.
8-3.5	Classify relationships between two variables in graphs, tables, and/or equations as either linear or nonlinear.

Purpose: This is a graphing and prediction activity in which students plot high and low tidal data points using a tide chart. Students will make predictions from their graph.

Time Duration: 1-2 hours

Materials:
With Class:
- Photographs of high tide and low tide (Appendix 1)
- Guide for converting to Military Time and Standard Time (Appendix 2)

Each student:
- Graph Paper (Appendix 3)
- Student Worksheet (Appendix 4)
- Copy of the tide data from South Carolina location. Various locations available from http://tidesonline.nos.noaa.gov/geographic.html.

Vocabulary:

Mean Sea Level – measure of the average height of the ocean's surface
High Tide – (flood tide) the highest sea level rises in a tidal cycle. High tide waters cover the intertidal zone.
Low Tide – (ebb tide) the lowest sea level in a tidal cycle. The intertidal zone is exposed.
Semi-diurnal tide cycle – The southeast Atlantic shoreline experiences a tidal pattern in which there are generally two high tides and two low tides in a 24 hour period.

Hooking Students on Tides

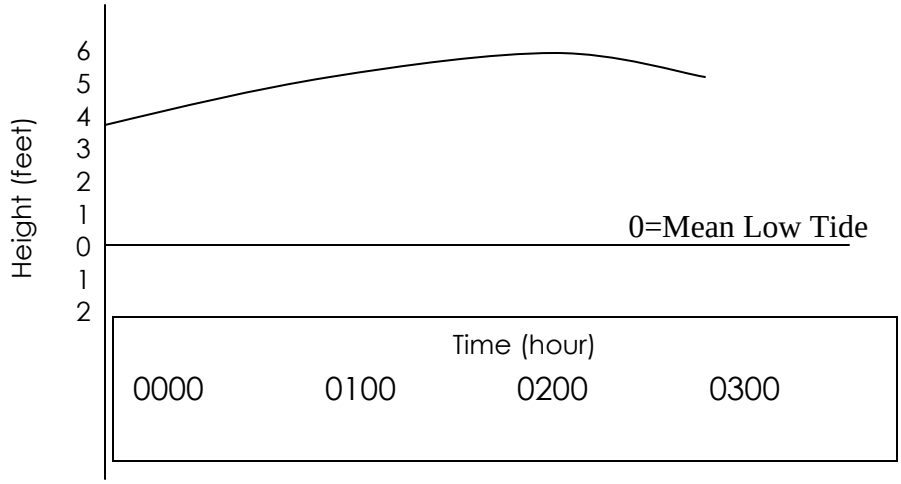
1. Guide students to observe and list the differences between each pair of images of a coastal scene (Appendix 1). Ask questions such as, "Which picture represents high tide and which low tide?" What is the evidence do you see for low tide prediction?
2. Ask students what they know about the cause of tides. If students experience difficulty in recalling forces from Earth and Moon, visit the NOAA Education website http://oceanservice.noaa.gov/education/kits/tides/media/supp_tide03.html

Student Engagement:

Distribute a Charleston Tide Table and graph paper to each student (you can get tide tables for any coastal area online).

1. Learn to read a tide table. "How many high tides occur in a 24 hour period?" What does each column of data represent? (**Station**- Location of tide recording instruments; **Date**- The day for tide data; **Time-**the time during the 24 hour day for high and low tides NOTE: Some tide tables use military time and if needed, discuss the differences between the two; **Height-**the height of sea level measured in feet, above or below "mean low tide."
2. Make your own Tide Graph to illustrate the cycle.
   Label the line graph example where the X axis is **TIME** with **HOURS** as the unit of measurement and the Y axis is **HEIGHT** with **FEET** as the units of measurement. Review how to set up the vertical units on the graph so that positive and negative tide values can be recorded. (0 ft) is mean low tide. Some tides can be lower and are a negative height.
   Use 24 hours of data to construct a graph with dots. Then connect the points with a smooth curved line.

LINE GRAPH EXAMPLE (using only 3 hours of data) :



Student Reflection:

1. Use your graph to identify the time for the highest tide and the lowest tide.
2. Why is a tidal chart and/or graph important to scientists or fishermen?
3. Do you prefer a tidal chart or graph to understand and plan your coastal or beach experiences?

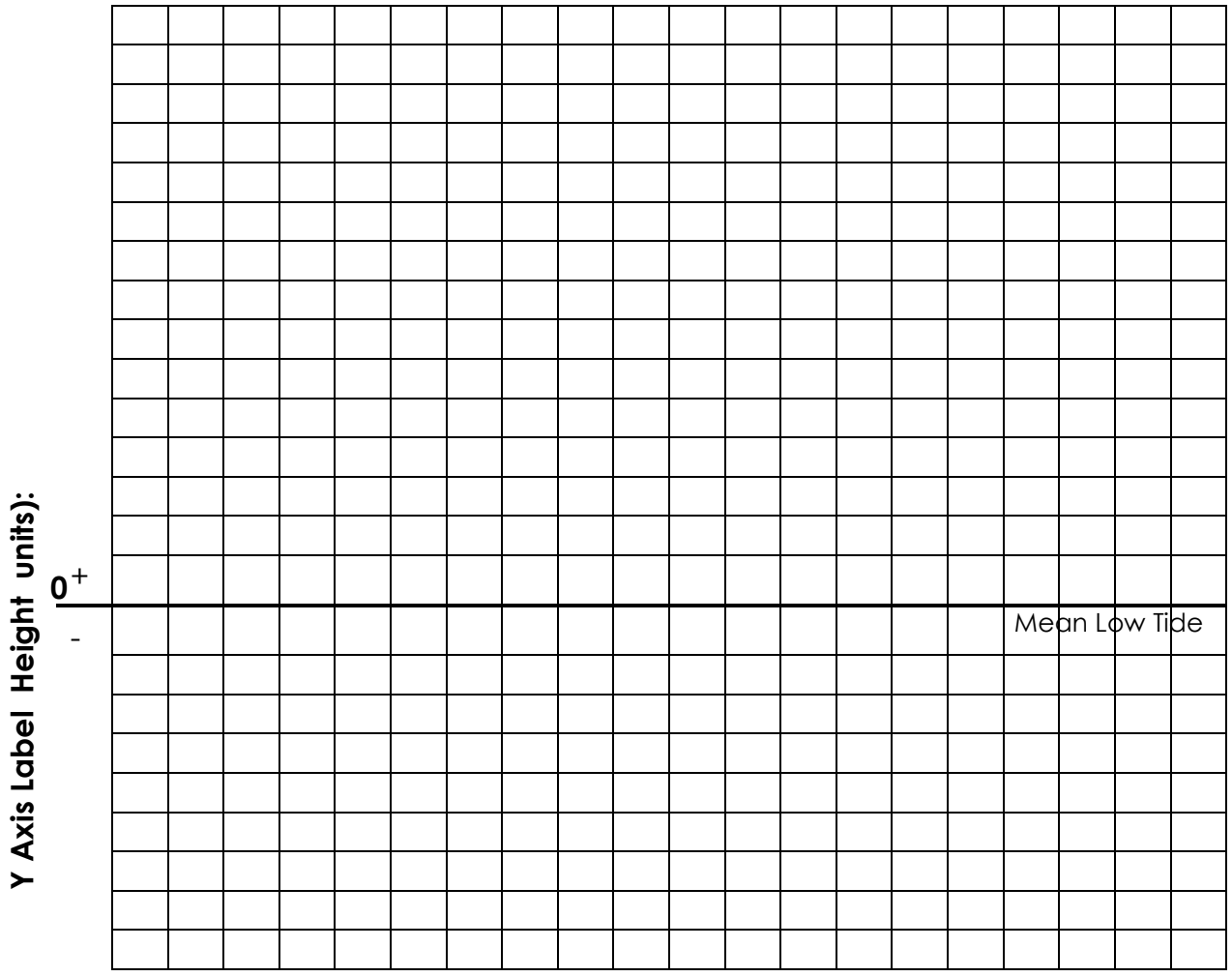
Appendix 1: Photographs of high and low tides in Charleston, SC.

Appendix 2: Guide to Converting Military and Standard Time

STANDARD	24-HOUR
12 MIDNIGHT	0000
12:01 AM	0001
12:15 AM	0015
12:30 AM	0030
12:45 AM	0045
1 AM	0100
2 AM	0200
3 AM	0300
4 AM	0400
5 AM	0500
6 AM	0600
7 AM	0700
8 AM	0800
9 AM	0900
10 AM	1000
11 AM	1100

STANDARD	24-HOUR
12 NOON	1200
12:01 PM	1201
12:15 PM	1215
12:30 PM	1230
12:45 PM	1245
1 PM	1300
2 PM	1400
3 PM	1500
4 PM	1600
5 PM	1700
6 PM	1800
7 PM	1900
8 PM	2000
9 PM	2100
10 PM	2200
11 PM	2300

Appendix 3: Graph Paper for Plotting the Tidal Changes. Label Units on X and Y axes.



Appendix 4: Student Worksheet (Teacher copy)

1. How many high tides and low tides does your location get in this 24 hour period?
   Twice daily.

2. How many hours separate the high tide and the subsequent low tide?
   Six hours separates the first high and low tide.

3. How many hours separate the first high tide from the next high tide?
   12 hours

4. What is the tidal range for South Carolina? (Tidal range is the difference of sea level height between the high tide and the low tide
   February 1 – Maximum: 6.19, Minimum: -1.38 = 7.57 feet

5. Will the tide on February 2nd be going out or coming in as the clock strikes midnight?
   The tide will getting low at midnight and will be coming in

Focus Question: How do tides affect sea level in coastal estuaries?

Appendix 4: Student Worksheet

1. How many high tides and low tides does your location get every day?

2. How many hours separate the high tide and the subsequent low tide?

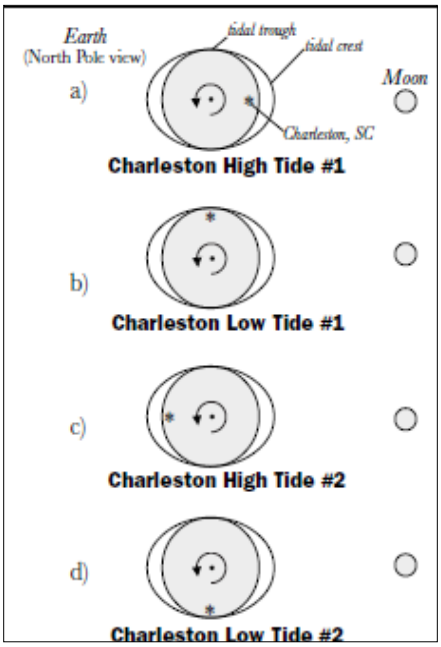
3. How many hours separate the first high tide from the next high tide?

4. What is the tidal range for South Carolina? (Tidal range is the difference of sea level height between the high tide and the low tide

5. Will the tide on February 2nd be going out or coming in as the clock strikes midnight?

Focus Question: How do tides affect sea level in coastal estuaries?

Background:
Excerpt from "Of Sand and Sea", pp. 26-29.



During the day, Charleston, South Carolina rotates on the earth's axis and passes through two tidal crests (high tides) and two tidal troughs (low tides). This occurrence is known as a semidiurnal tide.

Tides, or the periodic rise and fall of the ocean's Surface or sea level, are caused by the gravitational pull of the moon and the sun on the earth. The moon being closer to the earth than the sun, has a greater gravitational pull on the. The moon's gravitational attraction "pulls" the ocean covering the earth's surface toward the moon, creating a bulge of water at the point on the earth directly facing the moon ("tidal bulge"). There is a second tidal bulge on the opposite side of the earth that faces away from the moon, resulting from centripetal force created as the moon revolves around the earth. Thus, as the earth revolves around its axis, and the moon revolves around the earth, centripetal force causes water in the oceans to bulge on the side of the earth opposite the moon. The result of the gravitational pull and centripetal force is that there are always two tidal bulges on the earth, and they always align with the moon. As the earth rotates underneath the bulges, different locations revolve and experience rising and falling water that we call tides.

A tidal cycle is the complete cycling from one low tide to the next low tide. In the southeastern US, there are typical two highs and two low tides in a 24 hour period, which is called a semi-diurnal tide cycle.

Tidal range is the vertical distance in the height of the water between high and low tides. Tidal range varies with the alignment of the sun and moon. When the earth, moon, and sun are aligned linearly, tidal ranges are greater than average due to the combined gravitational pull of the moon and sun. These greater than average tidal ranges occur twice a month, during new and full moons, and are called "spring" tides. Conversely, when the moon is at a right angle to the sun and earth, the earth experiences "neap" tides, or smaller than average tidal ranges. During a neap tide, the moon is at a right angle to the sun. Neap tides also occur twice a month, during the first and third quarter moons.

Lastly, tidal range is influenced by the shape of the land. A curved shoreline or mouth of a river or bay produces greater tidal ranges. In the Florida Keys, the tidal range is less than a foot while in eastern Canada at the Bay of Fundy the tidal range is over 40 ft. In the Southeastern Atlantic, the greatest tidal range is near Savannah inside the points of the curve between Cape Hatteras, NC and Cape Canaveral, FL which have low tidal ranges.