TEACHER'S RESOURCE PAGE
Harmful Algal Blooms answer key

This activity provides real time hands on data for students to locate and disseminate. Computer skills, graph and table analysis, and research for these activities can be done in groups or as an individual assignment.

National Science Education Standards addressed:
- ✓ Life Science-Content Standard C
- ✓ Science in Personal and Social Perspectives-Content Standard F

Benchmarks for Science Literacy addressed:
- ✓ The Living Environment-5_A, 5_C, 5_D
- ✓ Common Themes-11_C, 11_D

Activity #1:

1. Go to NOAA's Gulf of Mexico Harmful Algal Bloom Forcasting System website (current web address: http://www.csc.noaa.gov/crs/habf/). This service provides alerts for HABs in the Gulf of Mexico to minimize possible human impacts.

What are the current conditions off Florida?

Will vary depending on time of year

2. Click on the "HAB bulletins" link. This page shows all of the Bulletins that have been issued concerning possible HABs in the Gulf of Mexico since 2000.

Blooms of *K. Brevis* can be transported by wind and also by currents. Using these bulletins, we can observe the movement of a *K. Brevis* bloom. In November and December 2004, there was a well-defined bloom off of southwest Florida. Read through the HAB bulletins for 11/22/04 through 12/06/04. Each bulletin shows the movement of the bloom and the associated wind speed and direction. Does the bloom appear to move based on the prevailing winds? Explain and provide examples.

The analysis on each bulletin describes the winds and the movement of the bloom. The bloom does move based on prevailing winds. The bloom tends to move in the direction of the winds and slightly to the right. For example, if there are northerly winds (from the North), the bloom will move to the south and slightly offshore. If there are southerly winds, the bloom will move to the north and onshore. For example, between 12/02/04 and 12/06/04 northerly winds had transported the bloom to the south and slightly offshore. (**The movement slightly to the right is caused by the Coriolis Effect – an effect related to Earth's rotation. Depending on the level of your class, you might use this as an opportunity to address this concept**).

What was the overall distance the bloom was transported in the 14 days?

The location of the center of the bloom on 11/22/06 was 25°27' N and 81°51'W. By 12/06/04, the bloom was located at 25°18' N and 81°49'W. Using a latitude/longitude distance calculator (such as the one provided by NOAA at http://www.nhc.noaa.gov/gccalc.shtml), the distance can be calculated as 9 nm or 17 km.

3. If there is a bloom in the Gulf of Mexico today, which direction would the winds need to blow in order for the bloom to be blown to shore? (If no bloom is present today, which direction would the winds have had to blow on December 6th 2004 in order for the bloom to be picked up by the Loop Current / Gulf Stream?)

On December 6th 2004 - to reach the shore, the bloom would have to be blown to the east so westerly and/or southerly winds would be needed

4. Go to NOAA's National Data Buoy Center (current web address: http://www.ndbc.noaa.gov/). This website provides current data of atmospheric and water conditions from buoys throughout the world. Choose the region including the area of the current HAB. Then choose the buoy closest to the current HAB. Are the winds blowing the correct direction to move the bloom to shore?

Yes / No

Wind direction: Will vary

Wind speed: Will vary

5. If the bloom were able to enter the Loop Current / Gulf Stream, estimate how long it would

take for the bloom to be transported from its current location in Florida to North Carolina? (Assume an average speed of 35-85 km/d for the loop current and the Gulf Stream and an average distance of approximately 100 km for each degree of latitude and longitude)

The distance is ~ 1700 km.

1700 km / 35 km/day = 48.6 days

1700 km / 85 km/day = 20 days

Somewhere between 20 and 50 days.

6. Go to APL's Ocean Remote Sensing webpage (current web address: http://fermi.jhuapl.edu/avhrr/). This website provides current and historical satellite images of the Gulf of Mexico / Gulf Stream region. The images are maps of sea surface temperature (SST). Warmer colors are shown in red and cooler colors are shown in purple. Because the Gulf Stream carries warm water northwards, it can be seen as a red "river" flowing within the ocean. View a current 7-day composite of the Gulf Stream and of the Southern Gulf Stream (which shows the North Carolina region with higher resolution). Sketch the current path of the Gulf Stream.

Will vary – note that the 7-day composite images average the data from the last week and are likely to remove the effects of clouds. If there has been a very long cloudy spell, however, it might be necessary to look at older images

7. Look in the archives for other images of the southern Gulf Stream. Can you find instances where the Gulf Stream came closer to the NC shore?

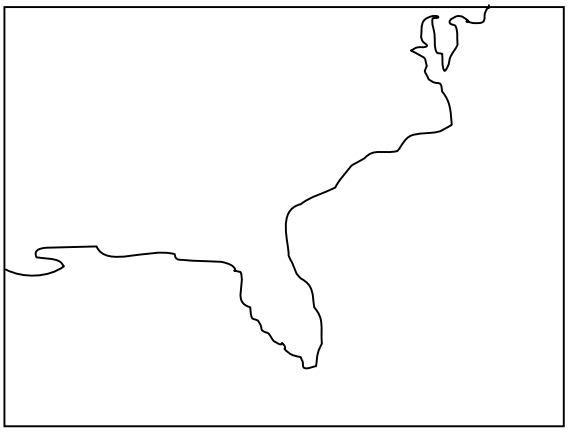
For example, June 14, 2002 the Gulf Stream was quite close to shore

Further from the NC shore?

June 14, 2003 it was much further away

Based on these images, do you think it likely that the Gulf Stream could transport *K. brevis* to the coast based on today's location of the Gulf Stream?

Will vary – If the Gulf Stream is close to the coast, it is likely that *K. brevis* could be transported to the coast.



8. Go back to NOAA's National Data Buoy Center (current web address: http://www.ndbc.noaa.gov/). Choose the region including North Carolina. What is the current water temperature at station 41025, a station off the North Carolina Coast?

Current temperature: Will vary – note you can choose "metric" units to switch to °C

K. brevis lives best at temperatures between 18 and 30 °C. Based on temperature, could K. brevis be present in NC waters today?

Will vary – yes or no

9. What other factors may also be important in influencing whether or not a bloom of K. brevis occurs?

The other factors listed in the introduction, the amount of nutrients, sunlight, viruses, movement of the water, all influence if a bloom occurs.

Questions:

1. Why do you think that only one bloom of *K. brevis* has occurred off the coast of North Carolina?

There are many factors that must come together just right in order for a bloom to occur. It is not often that all of the conditions are ideal (for example, there may be no seed population in the Gulf of Mexico, the winds may not be blowing the correct direction, the Gulf Stream may not be close to shore in North Carolina, the temperature may be too cold for a bloom off North Carolina). Even if all of these factors were perfect, a bloom may STILL not occur

unless there were also sufficient nutrients and no viruses present.

2. How could scientists monitor the waters off North Carolina to warn the citizens if a *K. brevis* bloom could potentially occur?

Note: There are several possible responses to this question. In addition, students may be creative and think of monitoring schemes that go beyond the answers presented here.

Scientists could monitor some of the environmental factors that were just investigated – presence of blooms in the Gulf of Mexico, movement of the Gulf Stream, water temp etc… - so they could warn citizens when all of the factors were optimal for a bloom.

Scientists could use satellites to monitor the chlorophyll concentration in the water off North Carolina. Chlorophyll concentration reflects the amount of phytoplankton in the water (as all phytoplankton have chlorophyll just like all plants on land have chlorophyll). If there is a high concentration of chlorophyll, therefore, there may be a bloom of phytoplankton.

When the bloom did occur in 1987 off of North Carolina, people first noticed the change in water color, difficulty breathing, and eye irritation. A repeat of these symptoms would certainly indicate the possibility of another bloom, so scientists could monitor the health of fishermen and boaters that are commonly out on the water.

Activity #2:

The answers to this activity will vary depending on what species bloom each year. In addition, all articles may not address every question.

If no articles can be easily obtained, a well-documented bloom of *Alexandrium fundyense* occurred in the Gulf of Maine in summer 2005. The following documents describe that bloom:

M. Carlowicz, "Red tide – gone for now, but back next year?" *Oceanus*. 2005. Can be accessed at the following website:
http://www.whoi.edu/oceanus/viewArticle.do?id=5618&archives=true

"New England Red Tide Outbreak 2005". Can be accessed at the following website:
http://www.whoi.edu/sbl/liteSite.do?litesiteid=3230&articleId=12650