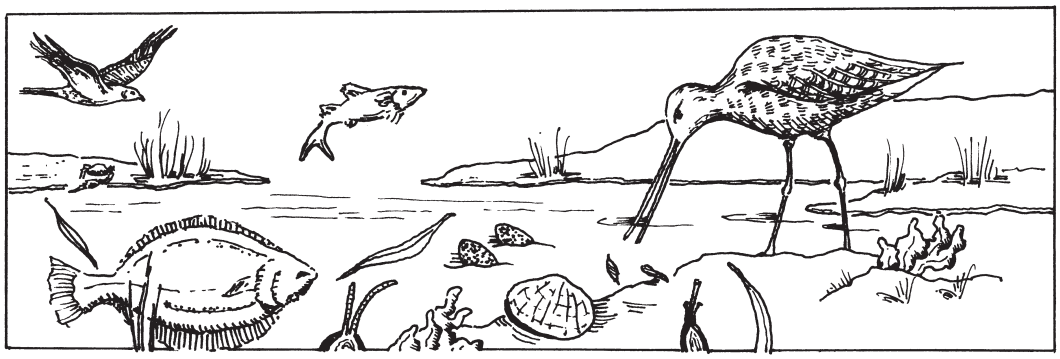

Activity #4: Primary Producers

Objectives:

To understand how carbon in the ocean is fixed by phytoplankton.

Time:

Varies according to activity selected

Background:

The ocean, like the land, requires plant life to harness the energy of the sun. However, global ocean productivity is based not on the large seaweed and sea grasses found along the shore but on the microscopic members of the plant kingdom floating at the surface of all the world's oceans. To understand ocean life and marine food webs, one must understand the primary productivity of the oceans. Primary productivity is a measure of the carbon fixed by these microscopic plants during photosynthesis. As with land plants, marine plants require water, carbon dioxide, sunlight, and nutrients. Water, of course, is abundant in the ocean, as is sunlight near the surface of the ocean. Carbon dioxide diffuses into surface waters from the atmosphere. The factor that can limit the amount of primary productivity, then, is nutrients. Areas of the ocean that have more nutrients (upwelling and coastal areas) have higher rates of primary productivity than areas with lower available nutrients (open ocean areas).

Procedure:

There are several ways of measuring primary productivity. One common way is to use the light bottle/dark bottle method. Dissolved oxygen is determined in a sample of water containing algae, and the sample is divided into two bottles. One bottle is covered with dark paper, the other is left uncovered. Both bottles are left in a sunny location, or are placed under lights. After a period of time, the dissolved oxygen in both bottles is again measured. Increased DO in the light bottle is an indication that more oxygen has been produced during

photosynthesis than has been used during respiration, since oxygen is a waste product of photosynthesis. Stable or decreased DO indicates no photosynthesis has occurred, or it indicates that more oxygen has been used during respiration than has been produced during photosynthesis. The dark bottle is a measure of respiration only, and can therefore be used to assess exactly how much O2 was used up.

Another method commonly used by scientists is satellite imagery. Since marine algae contain chlorophyll and other photosynthetic pigments, the color of a body of water from a satellite image can be used to determine productivity.

Listed below are several websites that contain productivity lessons for students. The first one, Message in the Bottles, estimates primary productivity using the light/dark bottle method. It is a pdf file that contains a teacher guide and can be printed and used in the classroom. The next two are SeaWiFS projects from NASA that students complete online using satellite imagery. The last two are instructional modules using real-time data from the Atlantic - one off the coast of New Jersey and the other from the Gulf Stream.

Based on time constraints, available technology, and class size, select one or more of these lessons for your students.

1.http://oceanexplorer.noaa.gov/explorations/02arctic/background/education/media/arctic_message.pdf

Estimating primary productivity. Identify the three realms of the Arctic Ocean, and describe the relationships between these realms, explain the relationships between gross primary productivity, net primary productivity, and respiration and understand how oxygen production and consumption can be measured and used to estimate primary productivity in water bodies.

2. http://seawifs.gsfc.nasa.gov/SEAWIFS/LIVING_OCEAN/

SeaWiFS Project - Studying Ocean Color From Space - Teacher's Guide with Activities

3. http://seawifs.gsfc.nasa.gov/SEAWIFS/sanctuary_1.html

Monitoring the Earth from Space with SeaWiFS

4. http://www.coolclassroom.org/home.html

The COOL Classroom is a series of Internet-based instructional modules that link middle and high school classrooms with active research investigations at the Rutgers Marine & Coastal Sciences (RMCS) COOLroom, a collaboration of oceanographers studying the coastal ocean off the coast of New Jersey. Here you will find information about how to use the COOL projects and printable teachers guides.

5. http://k12science.ati.stevens tech.edu/curriculum/gulfstream2/teacherguide.shtml

The **Gulf Stream Voyage** is an online multidisciplinary project which utilizes both real time data and primary source materials to help guide students to discover the science and history of the Gulf Stream. Students will investigate the driving forces behind this great ocean current, how it affects the Atlantic Ocean and some of mankind's experiences dealing with it. This voyage includes activities for marine science, earth science, chemistry, physics, biology, math, history and language arts. All may be easily used in today's technology enhanced classroom.

After your students have completed these exercises, have them answer the following questions about the Tijuana Estuary:

1. Explain how primary producers would affect the oxygen level of the water in the Tijuana Estuary.

Primary producers use photosynthesis to produce their food, and a by-product of photosynthesis is oxygen. Therefore, the greater numbers of primary producers in the water, the higher the oxygen levels.

2. What are the three main things primary producers need to survive? Explain where these things come from in the Tijuana Estuary

Water from the ocean, rivers, and runoff; carbon dioxide from the atmosphere and from respiration of bacteria and animals; nutrients from the decomposition of detritus.

3. When Alex, from the ecology reading, dug into the deeper layers of the sediment, he found it was a deep black color, indicating very low levels of oxygen. What would cause these low oxygen levels?

Bacteria, worms and other animals living in the sediments use up the oxygen through respiration, and since sunlight cannot reach this deep into the sediments, there is no photosynthesis to add oxygen to these layers. Agitation of the surface layers of the sediment replenishes the oxygen there, but only during the very largest storms is the lower level of the sediments disturbed enough to mix in oxygen from the water.

4. Alex learned that tamarisk uses 300 gallons of water a day. Explain how that will affect the primary productivity of the estuary.

The primary producers in the water are floating plants such as diatoms and dinoflagellates. If the water level of the estuary drops and the land dries out, these primary producers will die. There will not only be less oxygen produced, but the base of the food chain will be depleted, causing a loss of food for all other organisms living in the estuary.