Teacher's Background Information

Program 1: The Who? What? Where? How? and Why's? of Plankton

During this program we will present an overview of the plankton community and the types of research being conducted. **Student activities** include diagrams of the ocean environments and a who' s who plankton matching game. "On air" we will describe and contrast three marine communities (planktonic, nektonic, and benthic). Teachers may want students to complete accompanying Student Worksheets: Marine Communities, Can You Recognize Me, and Zonation 1.

WHAT are plankton?

Just beneath the surface waters of the ocean is a breathtaking, miniature world of unique and beautiful wander-ers, the plankton (Greek: *planktos* "to wander"). Plankton are defined by their movements and their size. Although they are capable of swimming vertically in the water, they have little ability to swim horizontally and thus are carried about by currents. They are usually small in size generally microscopic (*microns*, 1/1000th of a mm). Plankton are the most abundant form of life in the ocean. In fact, all other marine life is dependent upon plankton. The plant forms and many protozoans are known as *phytoplankton*. The abundance of ALL marine life is directly related to the supply of phytoplankton in the ocean. The animals in the plankton community are known as *zooplankton*. Zooplankton are important as a stable food source for fish and other animals. It is these small drifting plants and animals of the global ocean that comprise the marine plankton community. The survival of plankton is intrinsic to the survival of all other marine life from bacteria to whales!

Plankton can range in size from microns to meters. The smallest plants living in the ocean are the phytoplankton, which vary in size from about 5 microns to 50 millimeters. Single-celled plants called *diatoms*, constitute more than half of the phytoplankton in the ocean. These plants, together with the rest of the phytoplankton, are often referred to as "the grass of the ocean". By means of photosynthesis they convert chemical nutrients into their food. Phytoplankton absorb nutrients such as phosphates, nitrates, and minerals directly from the ocean waters. The animal portion of the plankton, the zooplankton, can range in size from a few millimeters to over a meter in size. The phytoplankton are consumed by the zooplankton and by some of the larger animals. Then the larger animals, such as fish, lobsters and crabs, feed on the zooplankton. The chemical nutrients are replaced in the ocean by the excretion of animals and bacterial action in the decomposition of dead plants and animals. Thus, the ocean's food cycle is continuous, from chemical nutrient to phytoplankton to zooplankton to strong swimming animals to bacteria, who recycle the organic matter from dead animals and sloppy eating back into chemical nutrients used as food by phytoplankton.

WHERE do the plankton live in the ocean?

Phytoplankton need water, carbon dioxide, sunlight and chemical nutrients to grow. Sunlight in sufficient strength to permit photosynthesis penetrates only to a maximum depth of about 500 to 600 feet (100-200 meters). This upper layer of the ocean's water is called the *euphotic* or *photic* zone. Within this zone, photosynthesis is limited by the supply of chemical nutrients. Under favorable conditions, phytoplankton may increase by as much as 300 percent in a single day. On a highly productive day, a cubic foot of ocean water may contain 20,000 plants! The biological process of creating high-energy organic material is called primary production. The marine environment produces approximately 200-250 billion tons of plant material each year. For comparison, the entire human population of the earth requires about 3 billion tons of food annually.

In shallow water, the chemical nutrients on the bottom (in the sediments) are stirred up by the motion of the water and carried into the photic zone. These shallow, nutrient-rich areas are often good fishing ground. In polar regions the chemical nutrients are relatively abundant. In these regions nutrients are brought to the surface by convective currents, when cold surface water sinks because of it's density and is replaced by the warmer water rising from the bottom. In the tropics, on the other hand, the water is relatively stable (that is, no surplus of nutrients), and so the chemical nutrients have a tendency to sink below the photic zone. Even though the clear, blue water has the deepest photic zone (reaching 200 meters in places), photosynthesis proceeds at a slower rate. For this reason, blue water is sometimes called the "desert regions of the ocean".

Phytoplankton are found in areas where many environmental factors are present, not just nutrients. Environmental factors influencing rates of primary production are light intensity and quality, availability of nutrients, seasonal variations of water temperature, and grazing pressure by predators. When these environmental conditions are favorable there is a phytoplankton bloom (a rapid increase in the population). Blooms are common seasonally in temperate and cold environments and in areas of upwelling (see activities section for details).

The zooplankton in the ocean are found where the phytoplankton is abundant! They are concentrated in areas of upwelling, over continental shelves and other shallow water areas, and elsewhere in or near the photic zone. Zooplankton are represented by a variety of permanent planktonic forms called *holoplankton*, and by temporarily planktonic larval stages called the *meroplankton*, which are a variety of shallow-water usually benthic invertebrates. The majority of the meroplankton remain in the photic zone for two to three weeks, although a few remain for three to six months. The abundance of meroplankton depends on the seasonal productivity of the phytoplankton community. In oceanic waters meroplankton rarely occur in significant numbers. The holoplankton are dominated by protozoans, chaetognaths, numerous crustacean arthropods, cnidarians, several mollusks, and ctenophores. The animal members of the plankton begin as eggs and hatch into larvae that live as zooplankton in the epipelagic zone of coastal and oceanic waters.

HOW do we study the plankton community?

- Plankton samples are collected from the ocean's waters using; plankton nets, Niskin bottles, opening-closing Tucker trawls, MOCNESS systems of nets, and submersibles.
- Plankton samples are studied to determine their distribution patterns, ecology (behavior, growth, reproduction), identification, indicator species to define major epipelagic habitats, and plankton's relationships to oceanic energetics, carbon cycling, nutrient cycling, and food webs.
- Plankton are also studied via remote sensing with satellites that are orbiting earth and continuously collecting information. Ocean currents and marine life are so interrelated that currents can sometimes be traced by their supply of plankton

WHY do we study the plankton community?

- human welfare: sea-air exchange impacts our living conditions (climate changes, atmospheric gases, air temperatures)
- global food supply: many human cultures depend on food from the sea, when phytoplankton populations decrease so too do a number of fisheries upon which humans depend
- removal of carbon dioxide from the atmosphere (global warming)
- marine food web and population dynamics
- economy: mariculture and aquaculture (plankton serves as food for cultured species)
- production of toxins (red tides, ciguatera)

WHO studies the plankton community?

How does a biological oceanographer relate to plankton?
Plankton biologists study the transfer of energy in the ocean, the distribution of the plants and animals, the reproduction, growth, physiology, and primary production rates. Biologists may also address the impacts of toxic phytoplankton on humans (e.g. red tide, ciguatera-fish poisoning). Scientists know more about the adult forms of animals than their larval forms, e.g. meroplankton.

How does a chemical oceanographer relate to plankton?
The ocean waters absorb more than two-thirds of the solar energy available for photosynthesis. Even though photosynthesis converts each year about a trillion tons of *carbon* into *organic compounds*, the total amount of earth's stored energy in the form of hydrocarbons is decreasing while the carbon dioxide in the atmosphere is increasing. Such changes are due to the huge amounts of energy that people consume. Marine chemist provide better understanding the chemistry underlying photosynthesis. Other chemists study the chemical components of seawater, such as the nutrients, salts, minerals and gases.

How does a physical oceanographer relate to plankton?
Ocean currents and marine life are so interrelated that currents can sometimes be traced by their supply of plankton. Pigment signatures produced by phytoplankton are used in studying ocean color.

How does a geological oceanographer relate to plankton?
Several marine sediments are described by the plankton species buried within. For example, some areas of the deep oceans are comprised of radiolarian ooze formed from sinking radiolarians whose silica skeleton does not dissolve under pressure. Other oozes are formed from foraminiferans and coccolithophores. Buried carbon reserves form fossil fuels and minerals.

Some Plankton Facts to Ponder:

- Plankton are important in both marine and fresh waters as a vital part of all food webs
- Phytoplankton are the world's number one source of oxygen
- Phytoplankton produce about 90% of all photosynthetic processes that take place on earth
- Phytoplankton's key ecological role: primary production of biomass and oxygen
- Primary production is the growth and reproduction of phytoplankton cells
- Most abundant member of the phytoplankton community is the diatom
- Phytoplankton can absorb marine pollutants (pesticides, mercury) that are carried up the food chain and accumulate to lethal levels in larger animals
- Phytoplankton are increasingly important moving from nearshore to offshore environments
- Phytoplankton are the only plants in the sunlit zone of the open ocean and are thus the major primary producer in the oceanic food web
- Phytoplankton is easily digested and has a high nutritional value per unit weight
- Zooplankton are important nearshore, because 80% of the recreationally and commercially important species (fish, crabs, oysters, and shrimp) have a planktonic larval stage
- The abundance of zooplankton is related to their food supply
- Zooplankton community serves as a "nursery" for many larval animals
- Zooplankton are a stable food source for larger marine animals
- Most abundant member of the zooplankton community is the copepod