9th-12th Grade Whale Watching Adventure Packet

Teacher Information:

This packet is designed for ninth grade through the twelfth grade and is based on the content standards adopted by the California State Board of Education. You will gain information about whales and other marine mammals as well as some fun facts. This packet's curriculum focuses on the physical and chemical components of the ocean and how it affects the population dynamics of gray whales and other marine mammals. The main concept of this packet is how marine ecosystems are connected on more than one level and how human interference can have a drastic affect on them.

Marine Mammal Background:

Whales, dolphins, seals and sea lions are marine mammals. Whales and dolphins spend their entire life in the ocean while seals and sea lions spend a lot of time out of the water on land or on buoys catching some sun to warm up. These animals are mammals, which means they breathe air with lungs, have hair or fur, and give live birth to their young that they nurse with milk produced by the mother. They are also warm blooded which means they can maintain their body temperature no matter what the temperature is of the environment. This is unlike a cold blooded animal like a snake, lizard or fish that's body temperature is the same as the environment they live in and need to seek a warmer area to warm their body up or a colder area to cool down.

Physical and Chemical Components of the Ocean

The surface of the Earth is comprised by 71% salt water and the average depth of the world's oceans is nearly 4,000 km. There are characteristics of the ocean that help to establish such complex ecosystems. Some of these are physical characteristics like light and temperature and others are chemical like salinity and oxygen. The currents that run along the coast bring many chemical nutrients to the coast by circulation. The California Current runs south along the coast of California and brings colder nutrient rich water from Alaska towards Mexico. During the summer and fall this current starts to swirl

inland toward Southern California and creates the Southern California Countercurrent. This current will cause a swirling current with warmer water and brings different fish and organisms to the Southern California coast. Upwelling is also a pattern that occurs where cold water from deep in the ocean will swirl upward towards the surface and replace warmer water, bringing nutrients to the surface. When these nutrients from the deep reach the surface, plankton that live there will grow rapidly. These currents and ocean patterns create a lot of opportunity for a complex food web off our coast.

Sea water is rich in a variety of dissolved substances and gases. The amount of dissolved substances in salt water is referred to as the salinity. Typically sea water has 96.5% water and 3.5% dissolved substances. This works out to be 35 grams for every 1000 grams of sea water and an average salinity of 35 psu (0/00). The dissolved substances include inorganic salts, organic material, and dissolved gases. The majority of the dissolved substances is in the form of inorganic salts including chloride, sodium, sulfur (sulfate), magnesium, calcium, and potassium.

The two most crucial inorganic nutrients for marine organisms is phosphate and nitrate which are required for plant growth and photosynthesis. These two nutrients can sometimes be limited in surface waters but can also be over abundant near areas of agricultural runoff, often causing algal blooms that can be hazardous to marine life.

The physical components like temperature are affected by the currents but also by climate patterns like El Nino and La Nina. The El Nino and La Nina patterns are semi-periodic weather patterns. In southern California the El Nino affect causes an increase in rain and a more tropical weather pattern while La Nina patterns cause the opposite conditions with drier and colder conditions. El Nino patterns typically occur every 5 years but have been occurring more frequently over the last several decades. These temperature changes have an affect on the ecosystems off of our coast and around the world.

Nutrient Cycling in the Ocean

There are three nutrients that cycle through the oceans that have the most significance; carbon, nitrogen, and phosphorus. In all of these cycles there is a reservoir or pool of the element where it is continually being cycled in and out and usually a sink where the element is not getting recycled back in the normal processes.

In the carbon cycle, carbon is pooled in the form of carbon dioxide and fixed into compounds by photosynthetic organisms. This is then transferred to animals by herbivory, absorption and predation and then recycles back into the reservoir by respiration and bacteria. Carbon is lost in the cycle when carbonate materials like shells are deposited into deep oceans as sediment.

Nitrogen cycles in the environment through the use of nitrogen gas in the air by bacteria and algae. Nitrogen gas can not be utilized by many organisms and must be converted into a compound first. Sometimes this is accomplished by volcanic activity. The nitrogen can then be used in the form of nitrates or nitrites which is one of the inorganic nutrients needed for photosynthesis.

Phosphorus has a major reservoir in phosphate rock. As the rock is eroded it travels into the ocean and is used by animals and plants and is cycled back through decay and excretion. Phosphorus is lost to skeletal material that sinks to the bottom and is accumulated in deep sediments.

Gray Whale Life History

Gray whales have one of the longest migrations, starting in Alaska and ending in the warm lagoons of Baja California (10,000-14,000 miles). They feed in the Bering Sea and Chukchi Sea on tiny shrimp like amphipods and ghost shrimp that live in the sediments. Gray whales are unique from other baleen whales because they are the only ones that scoop their prey out of the sediment. They roll onto their side, and disrupt the sea floor with their head scaring up the amphipods into the water where they take large mouthfuls of water and sediment and sieve out the amphipods with their baleen. They will feed all summer in Alaska when the long daylight hours provide high productivity for the amphipods. They start their migration towards Baja California when the ice starts to form and the daylight shortens. They arrive off the coast of Southern California during this migration in December and January. Once they arrive in Baja California they congregate in warm shallow lagoons to mate and give birth to their young. With a gestation period of 12-13 months they will give birth the following year when they return to the lagoons. Once the babies are born they will remain in the lagoons for a couple of months until the calf is strong enough to swim the migration and has enough blubber to stay warm. The mother and calf will then travel back north around March-May, hugging the coast to stay safe from predators like white sharks and orcas. During this

migration the gray whales will eat sporadically on their way south but survive entirely off of their reserves of fat for the summer and the trip back north.

Historically there were three populations of Gray whales, a north Atlantic population, a Korean or western north Pacific population and the eastern north Pacific population. Due to whaling in the 1800's and early 1900's the north Atlantic population is now extinct, the western north pacific is highly depleted and the eastern north pacific is the largest surviving population. The gray whales were hunted to near extinction because they were hunted in the calving lagoons where they could not flee to deep water with their calves. The International Whaling Commission listed them as partially protected in 1937 and fully protected in 1947. The eastern north pacific population was listed as an endangered species until 1996 where it was moved to a lower risk category and the western north pacific population is still listed as critically endangered. Although hunting of gray whales is now illegal there are other factors the still have an affect on their population.

Human activity affects on gray whale population ecology

When discussing the population ecology of gray whales there are some terms and concepts to establish for better understanding.

- **A population is a group of individuals of a single species living in an area with natural or human-imposed boundaries.**
- **The physical environment limits the geographic distribution of a species.**
- **In the presence of abundant resources, populations can grow and as resources are depleted population growth slows and eventually stops.**
- **Disturbance increases nutrient loss from ecosystems and human activity can have large scale affects on nutrient cycling and potentially global climate patterns.**

So what does this all mean for gray whales? Gray whales are a species that have been separated into three different populations one of which is now extinct. The three populations were originally threatened due to whaling in the 1800's-1900's however even though the original threat is out of existence the species is still threatened by other forms of human activity.

One threat to the eastern northern pacific population is the human activity within the lagoons. Some lagoons have become unsuitable due to boat traffic and salt extraction. Another threat to migratory populations is noise pollution caused by oil and gas exploration and offshore mining and dredging. This is thought to interfere with the whales along their migration making them avoid certain areas that may have historically served as feeding or breeding grounds. The noise pollution may also have an effect on the increase in boat strikes off of our course during the whale's migration.

One of the most significant issues facing whales in the current times is the abundance of plastic trash and especially abandoned fishing lines and nets. Whales can become entrapped in abandoned nets and drown or the line can get caught in their baleen affecting their eating habits. They can also consume plastic trash which can lead to malnutrition.

Another threat to not just whales but the entire marine food web is the presence of chemical pollution. One chemical present off the Southern California coast is DDT a pesticide once widely used in all over the country. DDT was responsible for the near extinction of many bird species including the bald eagle, California condor, and the California brown pelican. Unfortunately DDT is a heavy molecule so once in the environment it sinks into the sediment and exists there for decades or longer. Gray whales being a filter feeder that sieve through the sediment could be prone to DDT poisoning but there is little evidence yet to to support this. However the eating habits of the gray whale do put it at a position to be susceptible to chemical pollution or other heavy metals in the sediments. Fertilizers and agricultural runoff are also a problem for marine life because it can cause harmful algal blooms and a disease called Domoic Acid Poisoning. This disease has a devastating affect on seals, sea lions, dolphins and sea birds. Domoic Acid is a neurotoxin produced naturally as a byproduct of a phytoplankton reproduction. The chemical is ingested by filter feeders which are eaten by fish and eventually eaten by tertiary consumers. The toxin accumulates in each trophic level of the food chain and the toxicity magnifies the higher up the food chain. This is called biomagnification and is common with chemical pollution and toxins.

With the two remaining populations of gray whales they face many obstacles for survival and if those populations become threatened it has the potential for extinction. Even though the western northern pacific population is in good numbers the eastern northern pacific population is dwindling and if it is lost it will be a distant memory to that location and

the entire food web it surrounds. When a population is lost it is not just one species that is affected nut the entire food web that it exists in. If the food web is altered the entire ecosystem can become out of balance and can experience a devastating loss in biodiversity.

What is biodiversity? Marine biodiversity is the variety of organisms living in a marine environment. Here in Southern California we have a vast amount of organisms living in and around our coast. Even us as humans can be considered part of the diversity considering that we fish and eat some of the species living in our coastal waters. Biodiversity is defined as being a measure of the health of an ecosystem by the variety of organisms living in it.