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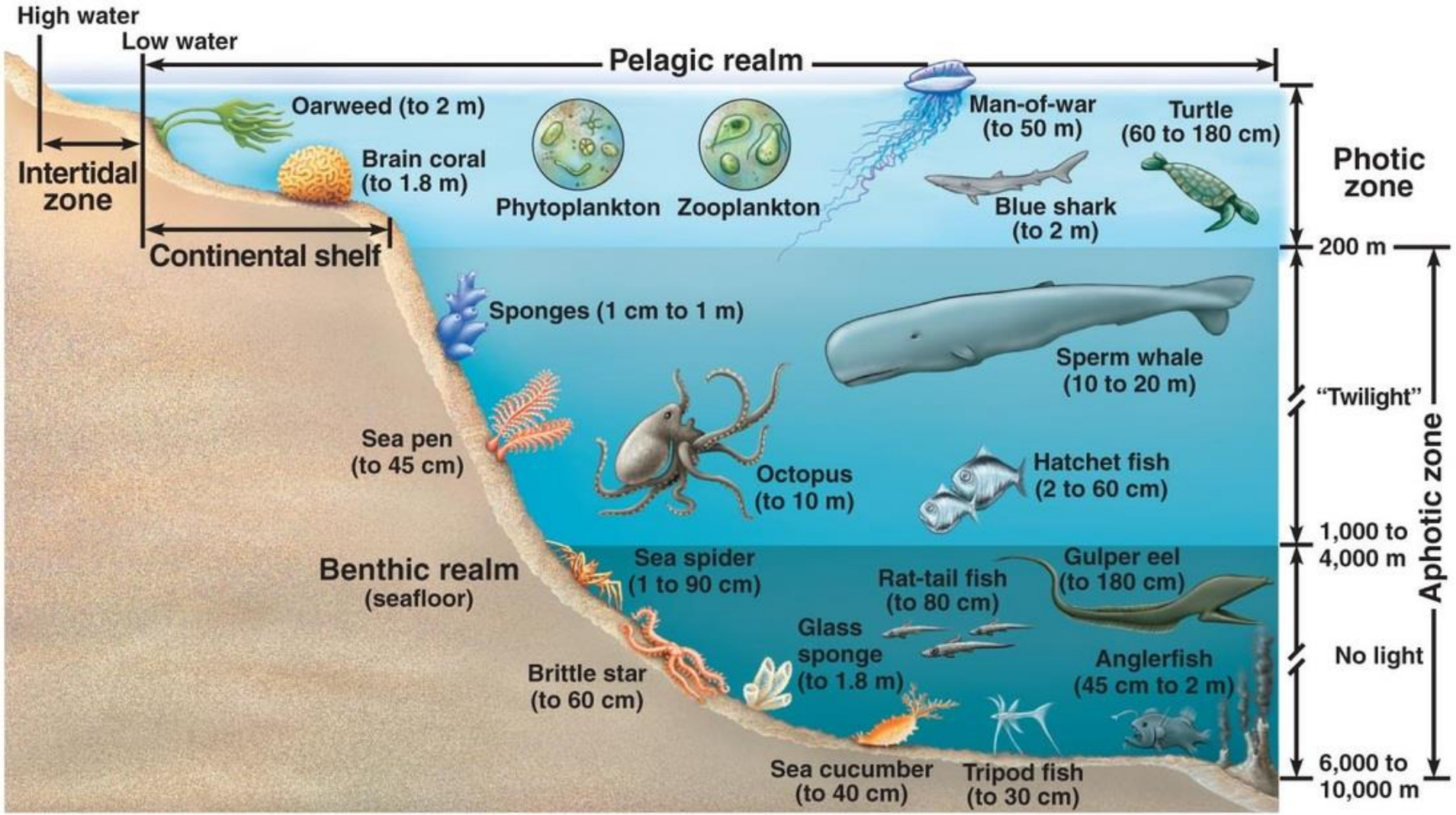
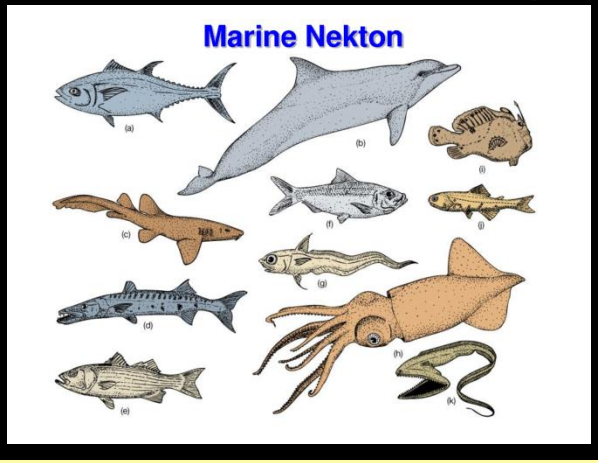
The Open Ocean

Regions of the Open Sea



Life in the Open Sea

- Two groups of organisms inhabit the oceanic zone: plankton and nekton.



GLOSSARY

The *plankton* are a diverse group of organisms that live in the water column of large bodies of water and that cannot swim against a current. They provide a crucial source of food to many large aquatic organisms, such as fish and whales.

The *nekton* are species with ability to swim strongly against ocean currents, they are restricted to the large, muscular, streamlined, higher consumers among the animals, such as tuna and other pelagic fishes and whales.

Classification of plankton

- The two most familiar kinds of plankton are phytoplankton and zooplankton. Phytoplankton are primary producers. Zooplankton are the heterotrophic eukaryotic microbes and those animals that are so small or are such weak swimmers that their distribution in the sea is determined by ocean currents.

Seston are particles, living or dead, suspended in seawater.

Tripton are particles of dead organic matter suspended in seawater; largely synonymous with detritus and POM (particulate organic matter).

Holoplankton are organisms that are planktonic throughout their life cycles.

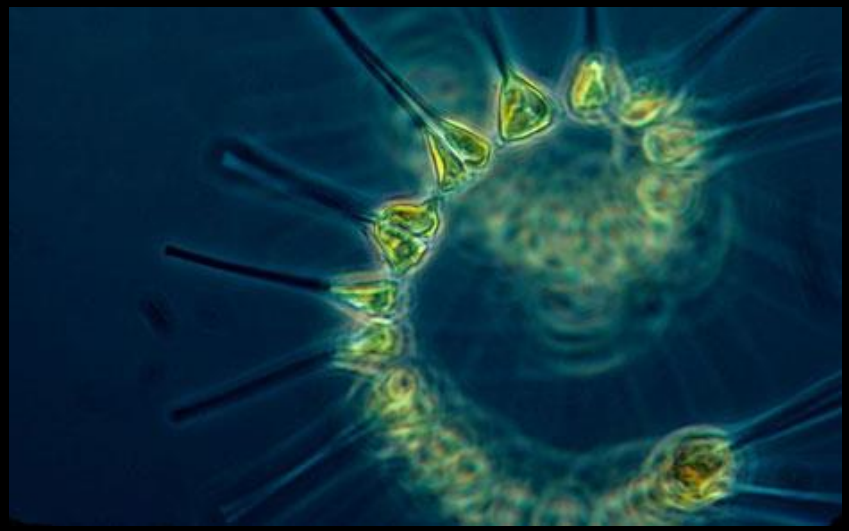
Meroplankton are planktonic stages of an organism that is benthic or nektonic at other stages in its life history.

Neuston are plankton that live at or near the surface of the ocean.

GLOSSARY

Size of plankton

- *Macroplankton* were those organisms that were visible to the naked eye and generally exceeded 1 millimeter.
- *Microplankton* were small plankton that could be caught with standard plankton



Life History of Plankton

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GLOSSARY

Plankton Migration

- Many open-ocean zooplankton make daily migrations from the surface of the sea to depths of nearly 1600 m.
- Some marine biologists believe that these movements take advantage of the benefits of feeding on the phytoplankton that live only in the photic zone and reduce to some extent the threat of predation by plankton-eating fishes, which are also more abundant in the epipelagic zone.

Cnidarian Zooplankton

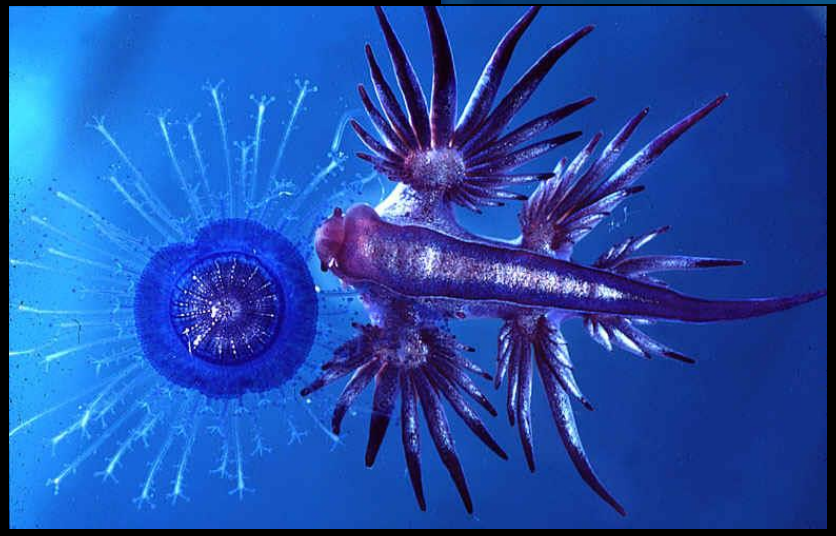
- The largest members of the plankton are jellyfish. One of the most common is the moon jellyfish. The largest is the Lion's Mane jellyfish.

Moon jellyfish

Lion's mane jellyfish

Pelagia noctiluca

Molluscan Zooplankton



Nekton

- Nekton are the actively swimming organisms whose movements are not governed by currents or tides. Included in this group of animals are some larger invertebrates, fishes, reptiles, birds, and mammals.
- The invertebrates that reign supreme in the open sea are the squids.

Fish in the Open Ocean-Sailfish

Tuna

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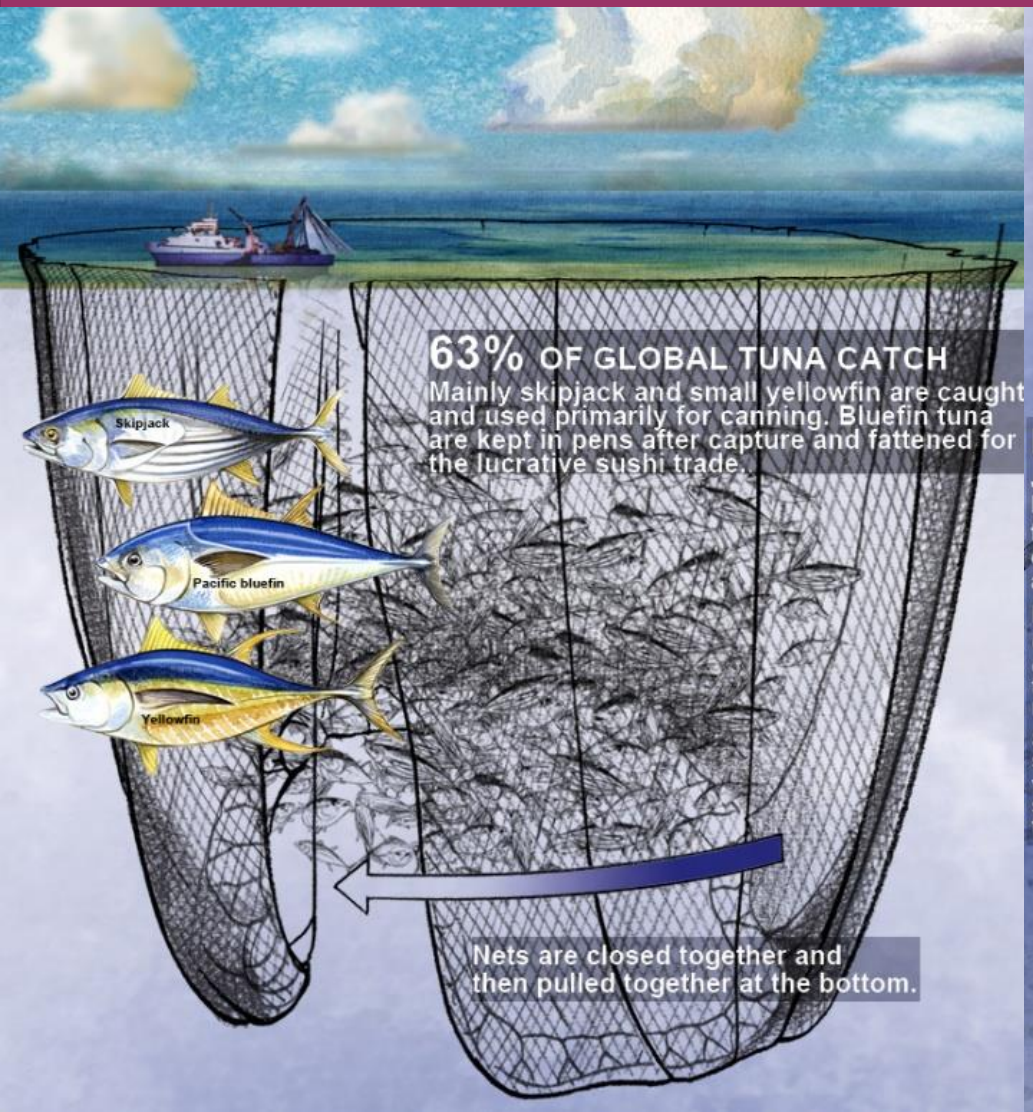
Tuna

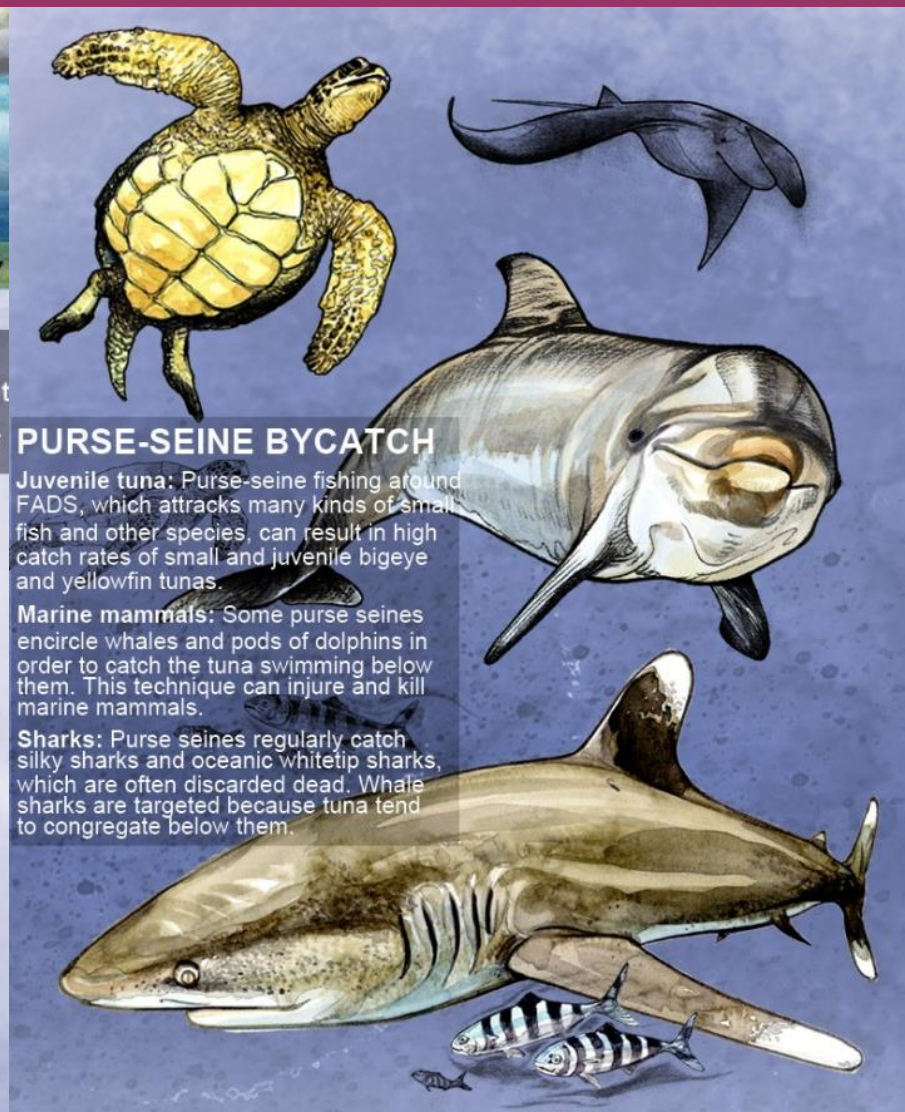
- Tunas must swim constantly (some cruising at 27 kilometers, or 16 miles, per hour) or they will sink for lack of a swim bladder.
- This level of activity requires a large amount of energy and a good supply of oxygen. To supply the needed oxygen, these animals must swim fast and move large volumes of water past their gills.
- One adaptation for fast swimming in some tuna species is a body temperature 8 to 10° C higher than the surrounding water.

Tuna Fisheries

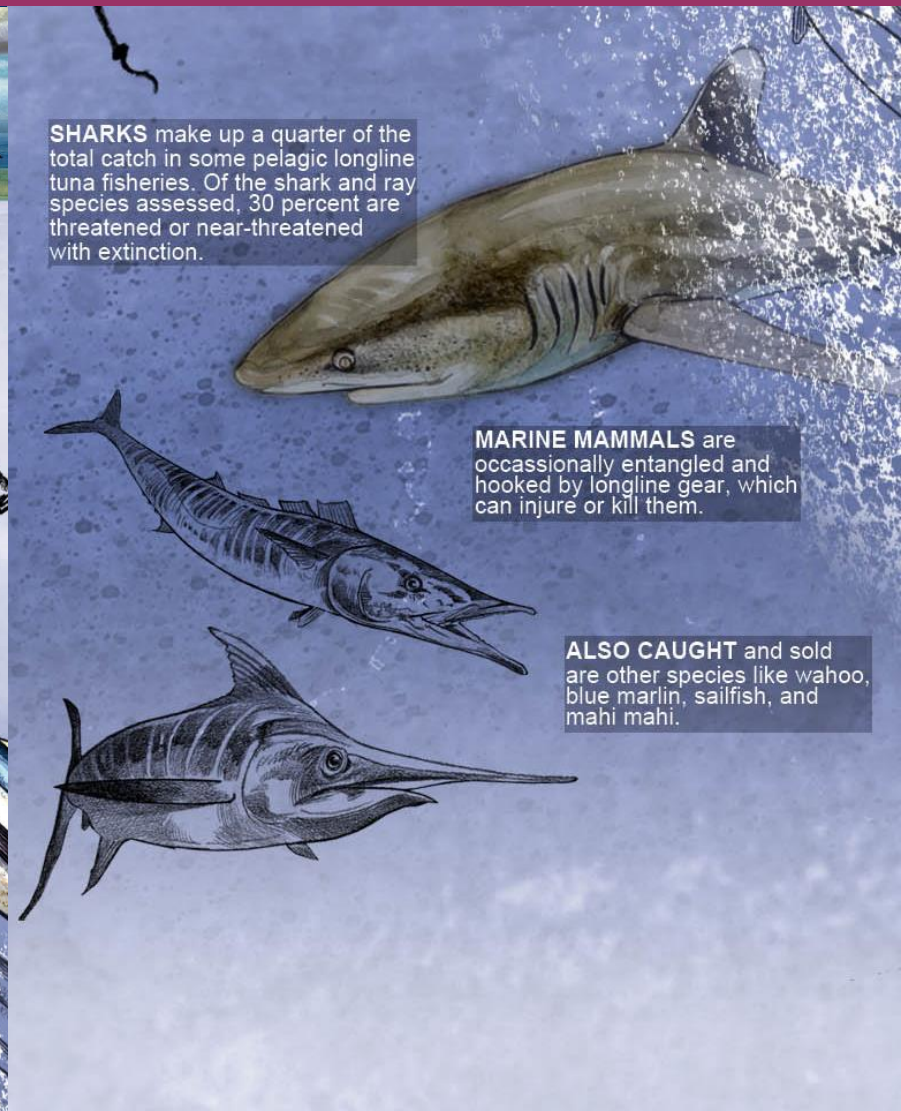
- Tuna species are found throughout the world's oceans. Atlantic, Pacific, and southern bluefin tuna are prized for the sushi and sashimi market. Skipjack, yellowfin, and bigeye tunas are found mainly in the tropics, while albacore, like bluefin, are also found in temperate waters. These species are used for a mixture of canned and fresh products.

Purse-Seine Fishing



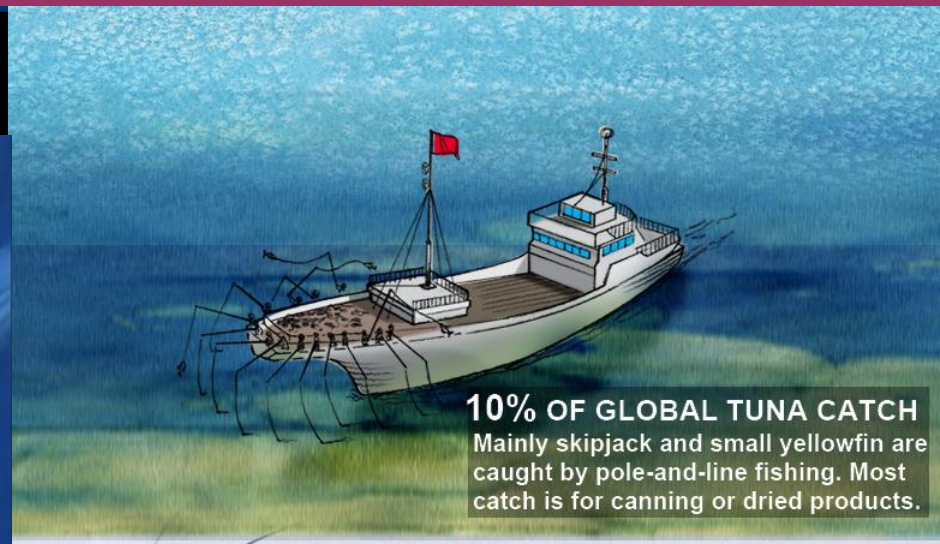


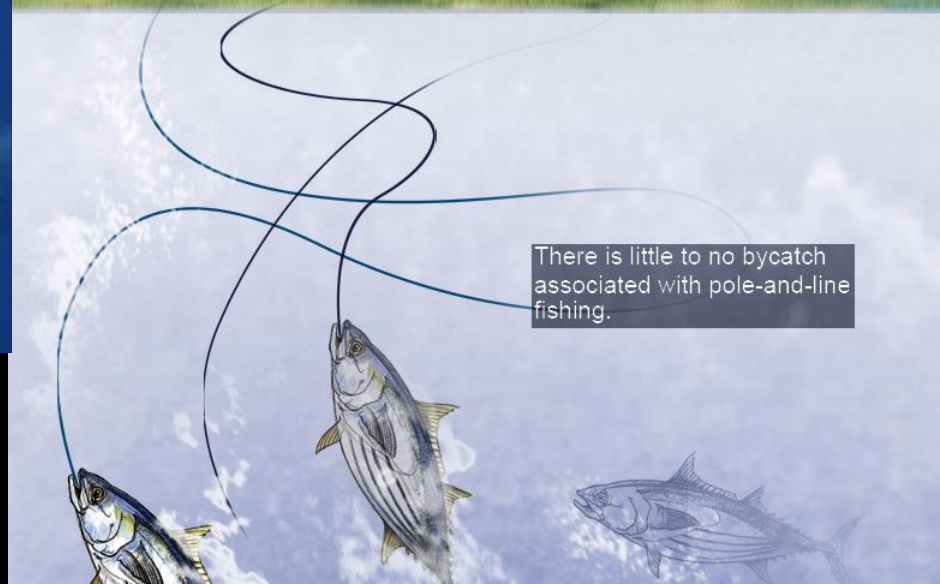
Longline Fishing



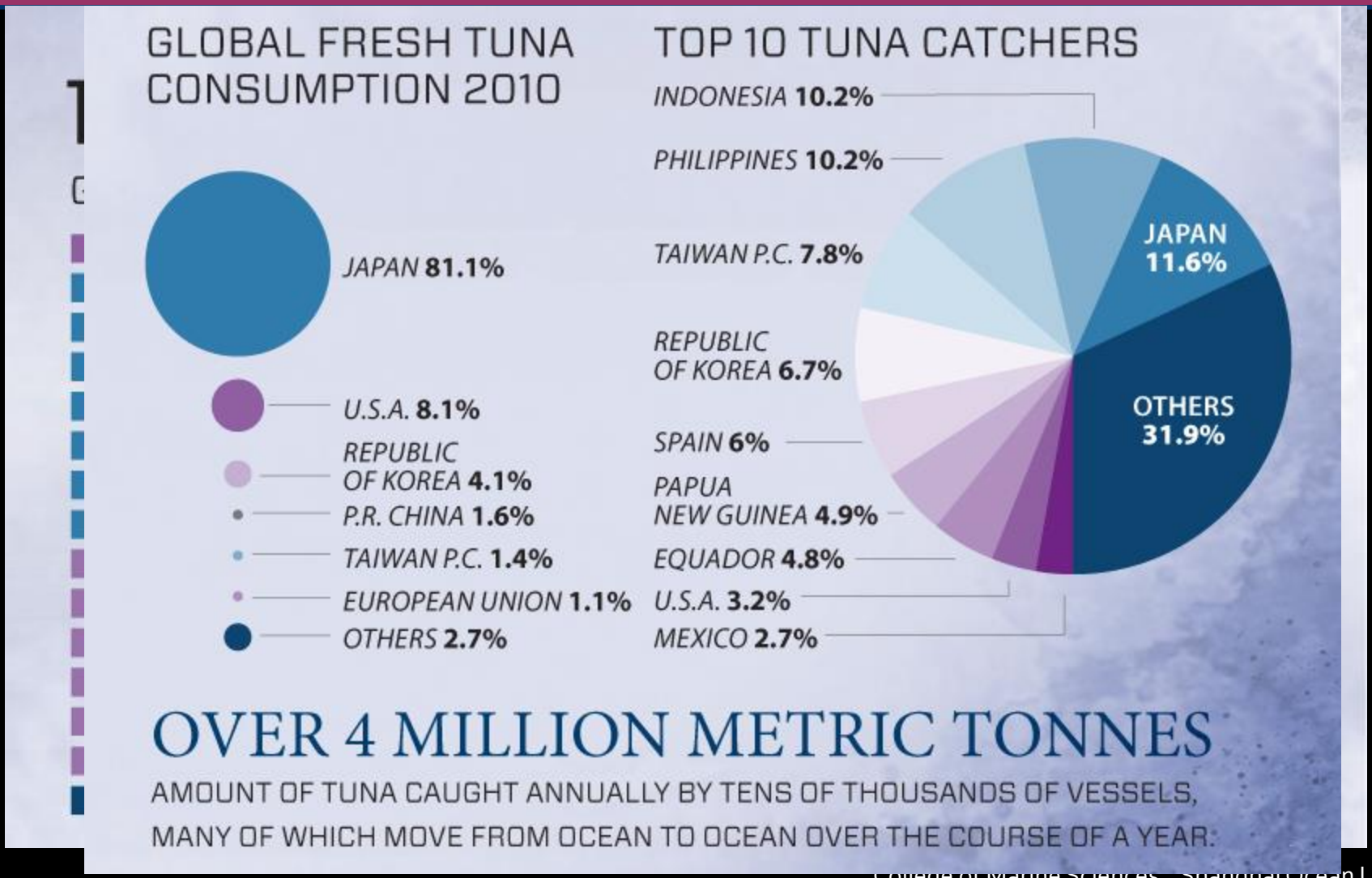
Longline Fishing

Pole-and-Line





Tuna Consumption Globally



Ecology of the Open Sea

- The open sea represents a pelagic ecosystem, one in which the inhabitants live in the water column. In a pelagic ecosystem, the basis of food chains is the many species of small phytoplankton.
- These organisms derive the nutrients that they need from the seawater that surrounds them. The smaller the organism, the greater the relative surface area that is exposed for the absorption of nutrients and sunlight and the lesser the amount of nutrients needed to sustain the body.
- The major herbivores in the open ocean are zooplankton, and these supply food for the nekton.

Productivity

- Although surface waters of the open ocean receive large amounts of sunlight, they do not receive any of the nutrients that wash to sea from the land. This results in low levels of nutrients, such as nitrogen and phosphorus, that are necessary to support the life of phytoplankton.
- The low level of nutrients in the open ocean is most pronounced in tropical waters.
- Phytoplankton production in the central South Pacific Ocean is only about half as much as the productivity off the California coast and only about one sixth as much as in some coastal areas off Saudi Arabia or western Africa, where coastal upwelling brings nutrients to the surface.

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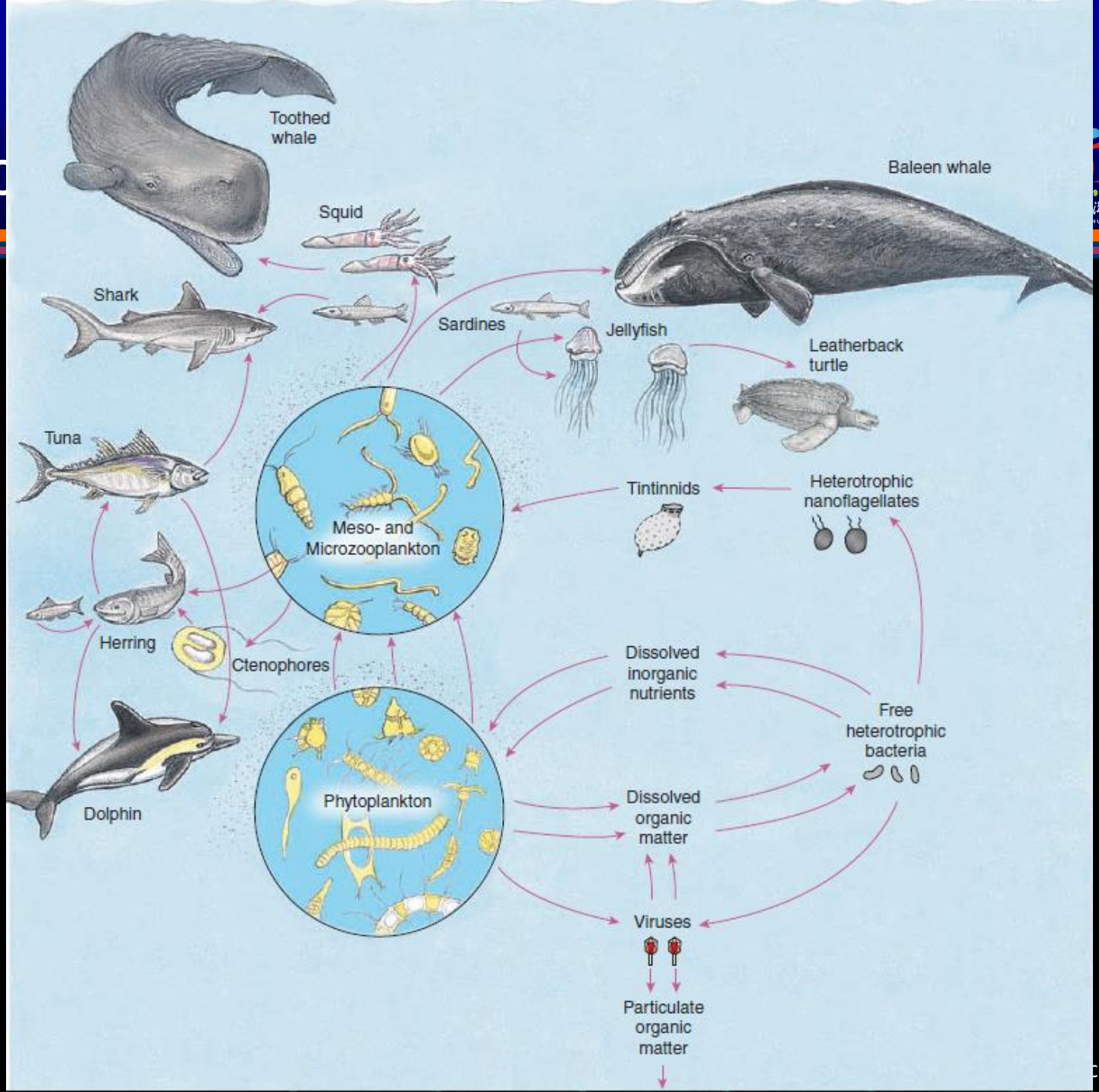
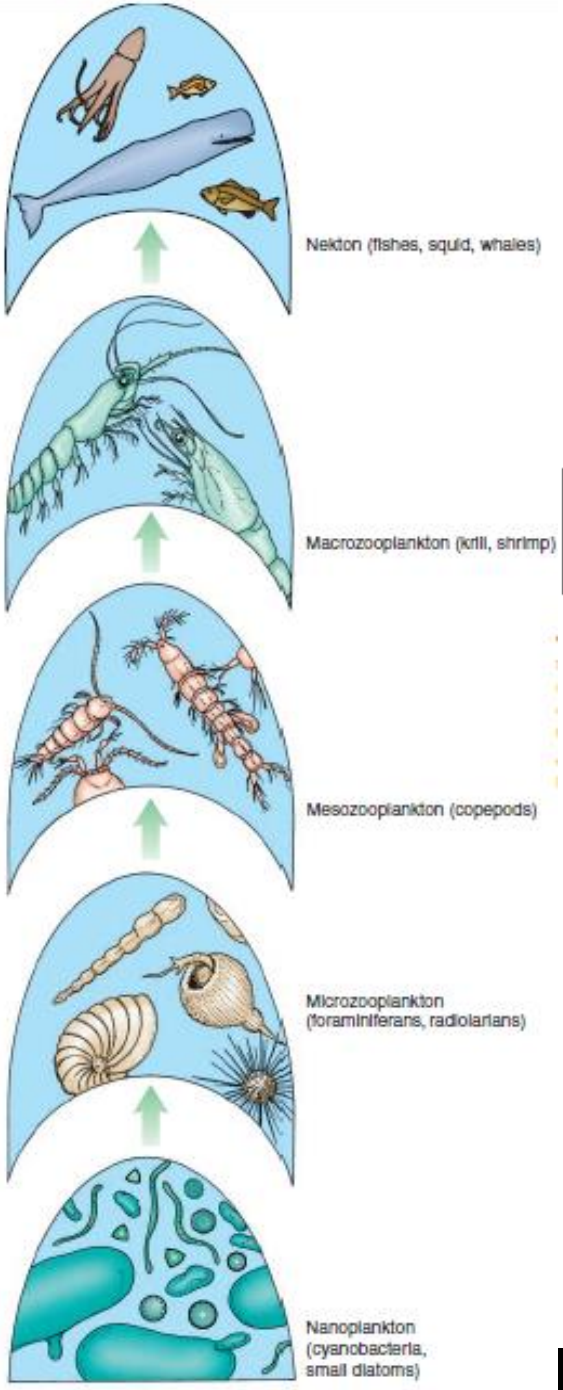
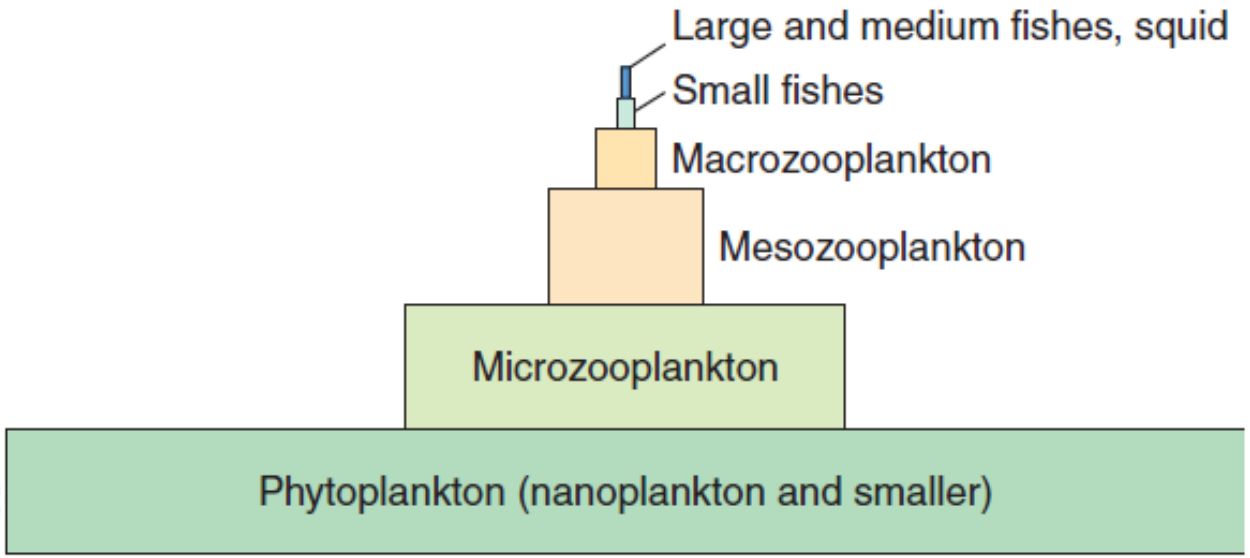

Toothed whale
Baleen whale
Squid
Shark
Sardines
Jellyfish
Leatherback turtle
Tuna
Tintinnids
Heterotrophic nanoflagellates
Meso- and Microzooplankton
Herring
Ctenophores
Dissolved inorganic nutrients
Free heterotrophic bacteria
Dolphin
Phytoplankton
Dissolved organic matter
Viruses
Particulate organic matter

Food Webs in the Open Sea

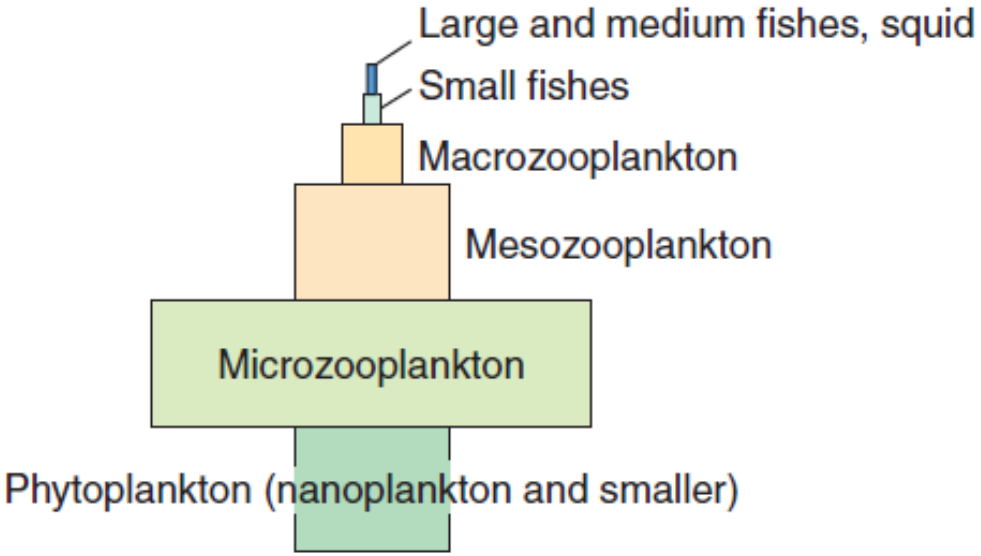
- The base of food webs in the open sea is formed by the phytoplankton and heterotrophic bacteria.
- Phytoplankton release some of their photosynthetic products into the surrounding seawater as dissolved organic matter (DOM). Bacteria can also metabolize some of the DOM and return it to the water in inorganic form, making the mineral nutrients again available to the phytoplankton.


Nekton (fishes, squid, whales)
Macrozooplankton (krill, shrimp)
Mesozooplankton (copepods)
Microzooplankton
(foraminiferans, radiolarians)
Nanoplankton
(cyanobacteria,
small diatoms)

(a)


Large and medium fishes, squid
Small fishes
Macrozooplankton
Mesozooplankton
Microzooplankton
Phytoplankton (nanoplankton and smaller)

(b)


Large and medium fishes, squid
Small fishes
Macrozooplankton
Mesozooplankton
Microzooplankton
Phytoplankton (nanoplankton and smaller)

(c)

Food Webs in the Open Sea

- The food webs in nutrient-poor open seas may have food chains with 5~6 links, leading to the nektonic top carnivores among the whales and sharks.
- The base of the food chain in plankton communities is formed by microbes with short life cycles, and 100% of each day's production may be grazed entirely by zooplankton.

A ***pyramid of production*** is a pyramid-shaped diagram that indicates the rate at which new biomass is produced at successive trophic levels.

A ***standing crop*** is the amount of biomass of organisms in a given area at a given time.

GLOSSARY

Summary

- The primary producers of the open sea are mainly phytoplankton. Even though the open sea receives large amounts of sunlight, it lacks the supply of nutrients that makes coastal seas so productive. The low level of nutrients is most pronounced in tropical oceans, where the water forms more or less permanent layers that are separated by thermoclines.
- Bacteria are important in the ability of the community to cycle nutrients efficiently. The open sea does not support many large animals because of limited primary production and food webs involving several energy-wasting steps between primary producers and final consumers.

Research in the Open Ocean

Key Concepts

- The open sea is a pelagic ecosystem, in which the living components are plankton and nekton.
- Plankton range widely in size, taxonomic diversity, and lifestyle.
- Phytoplankton are the primary producers in open-ocean food webs, and their productivity is limited by the scarcity of nutrients.
- Bacteria provide a second base to open-ocean food webs, and they allow the scarce nutrients to be efficiently recycled.

Key Concepts

- Limited primary production and food webs with several energy wasting steps limit the number of large animals the open ocean can support.
- Gelatinous plankton such as salps and ctenophores play significant roles in open-ocean ecosystems because of their efficient feeding mechanisms, reduction of nutritional quality, and provision as prey for specialist carnivores.
- Large zooplankton include jellyfish, gastropod molluscs, and colonial pelagic tunicates.
- Fish, squid, and mammals make up most of the nekton in the open sea.

Further Readings

- http://www.biosci.ohiou.edu/faculty/currie/ocean

  An academic site with many links to pelagic organisms and the scientists who study them.

- http://jellieszone.com/index.html

  Information on jellyfish and other gelatinous zooplankton.