Chapter 15

Ocean Water and Ocean Life

15.1 The Composition of Seawater

Salinity

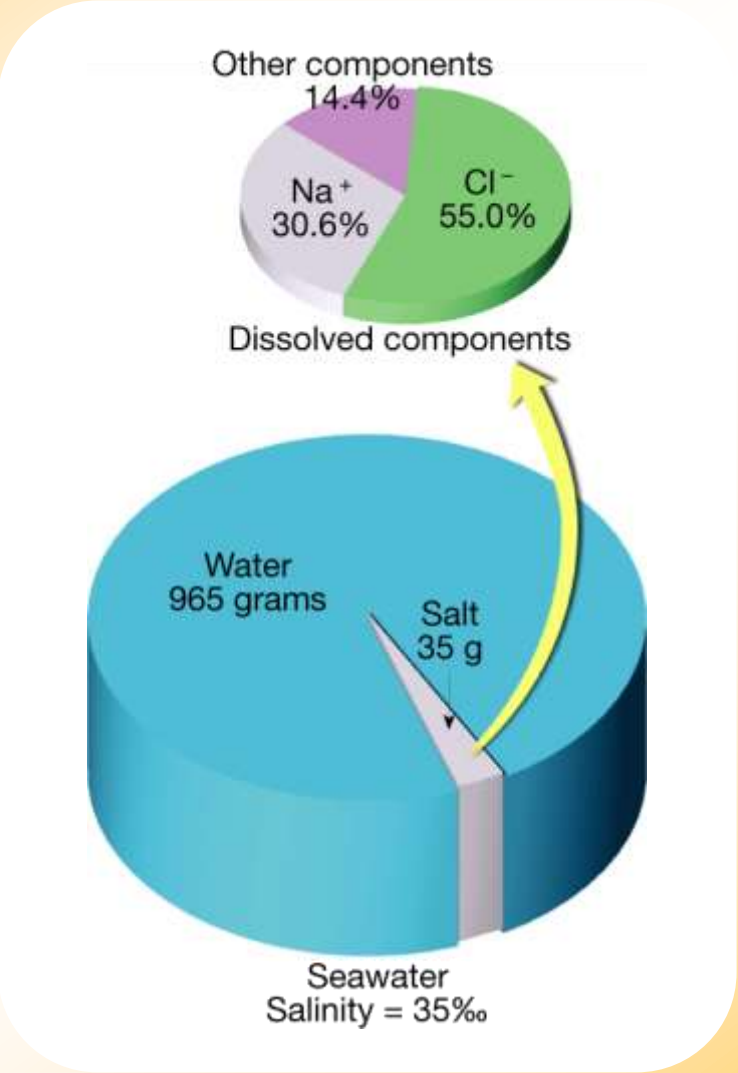
- **Salinity** is the total amount of solid material dissolved in water.
- Because the proportion of dissolved substances in seawater is such a small number, oceanographers typically express salinity in parts per thousands.
- Most of the salt in seawater is sodium chloride, common table salt.

15.1 The Composition of Seawater

Salinity

- Sources of Sea Salt
  - Chemical weathering of rocks on the continents is one source of elements found in seawater.
  - The second major source of elements found in seawater is from Earth's interior.

Salts in Seawater



15.1 The Composition of Seawater

Salinity

- Processes Affecting Salinity
  - Processes that decrease salinity:
    - Precipitation
    - Sea ice melting
    - Icebergs melting
    - Runoff from land
  - Processes that increase salinity:
    - Evaporation
    - Formation of sea ice

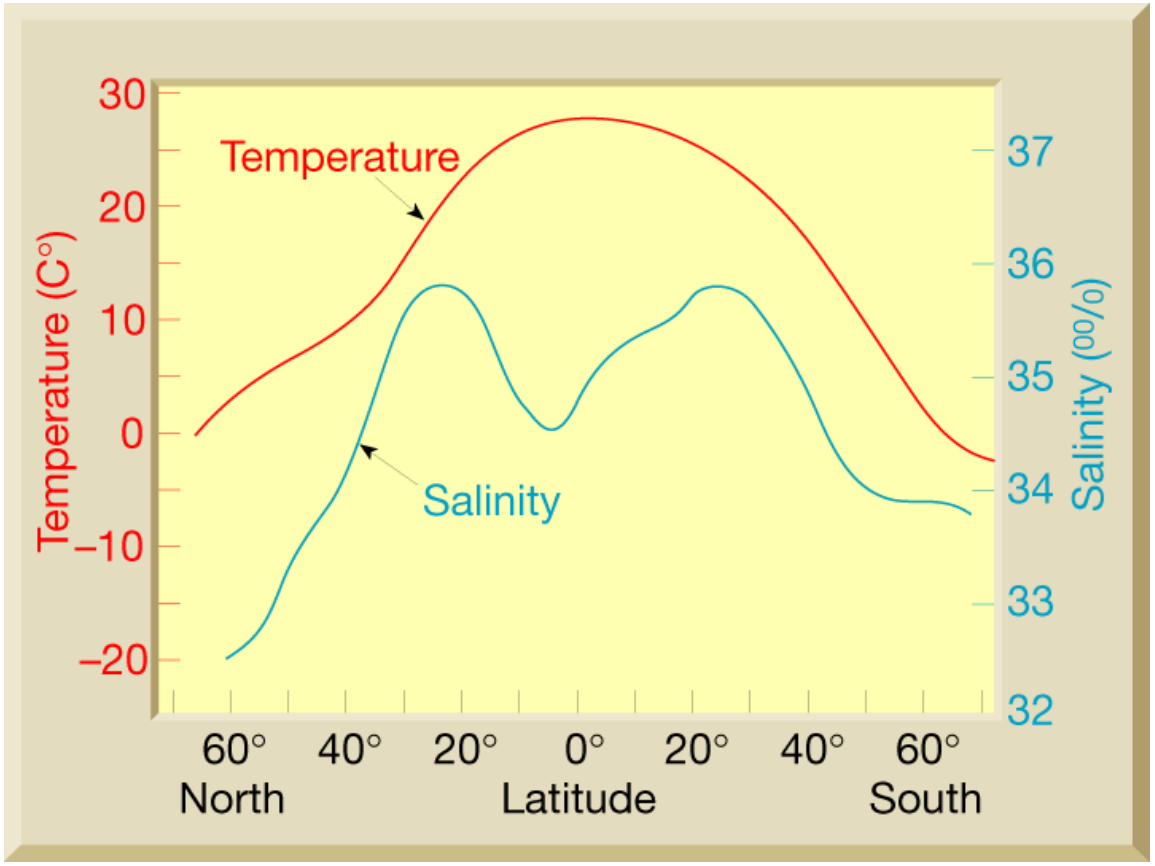
Natural Processes Affecting Salinity

15.1 The Composition of Seawater

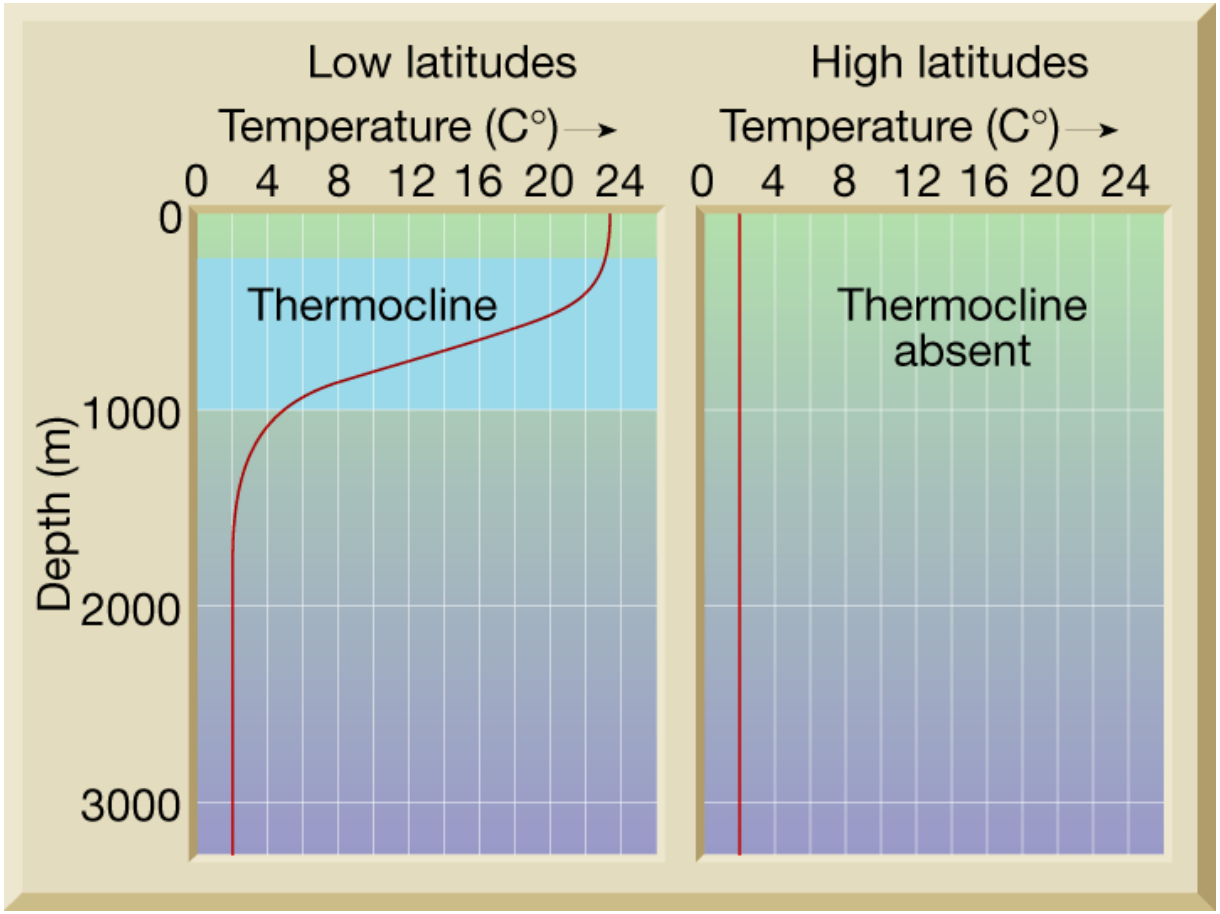
Ocean Temperature Variation

- The ocean's surface water temperature varies with the amount of solar radiation received, which is primarily a function of latitude.
- Temperature Variation with Depth
  - The **thermocline** is the layer of ocean water between about 300 meters and 1000 meters where there is a rapid change of temperature with depth.
  - The thermocline is a very important structure because it creates a barrier to marine life.

Variations in Ocean Surface Temperature



Variations in Ocean Water Temperature



15.1 The Composition of Seawater

Ocean Density Variation

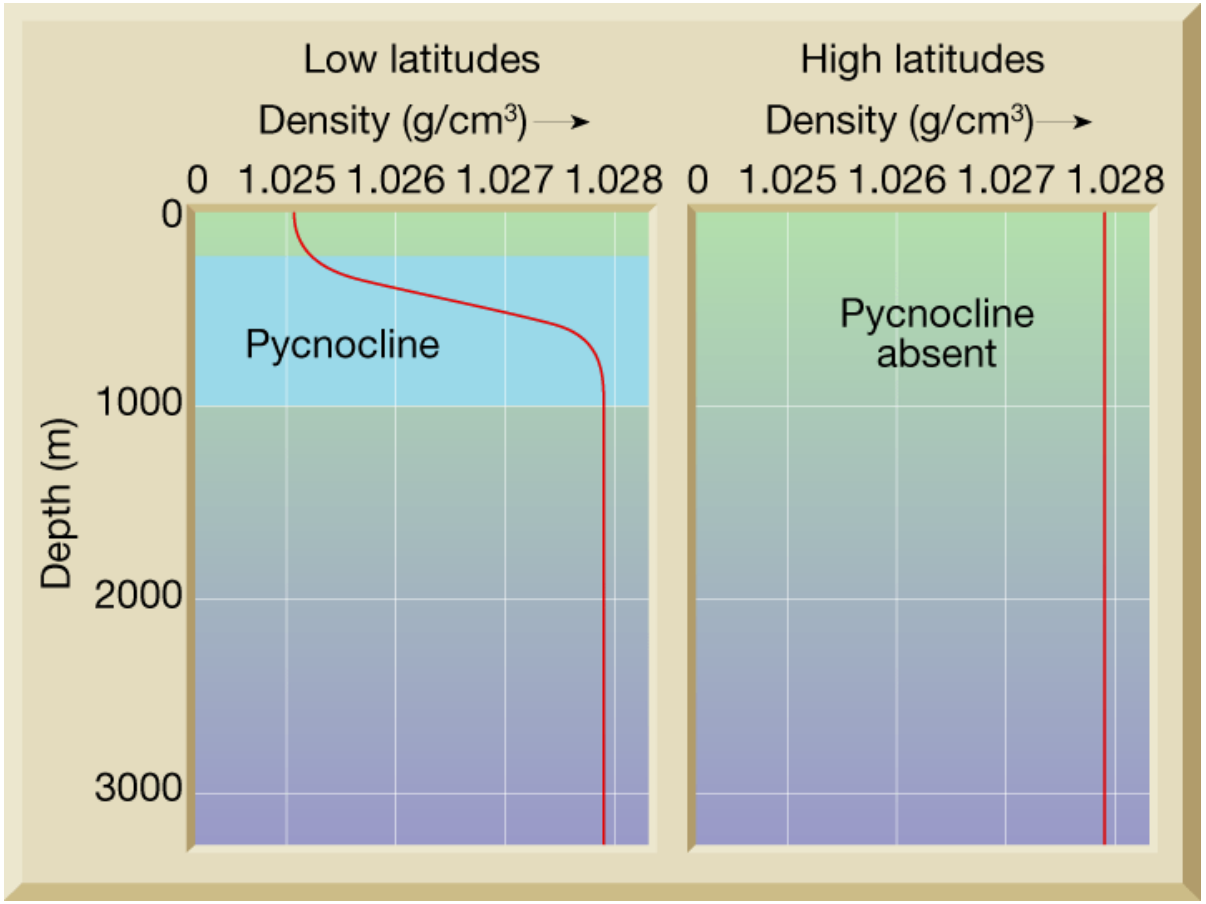
- Density is defined as mass per unit volume. It can be thought of as a measure of how heavy something is for its size.
- Factors Affecting Seawater Density
  - Seawater density is influenced by two main factors: salinity and temperature.

15.1 The Composition of Seawater

Ocean Density Variation

- Density Variation with Depth
  - The **pycnocline** is the layer of ocean water between about 300 meters and 1000 meters where there is a rapid change of density with depth.

Variations in Ocean Water Density



15.1 The Composition of Seawater

Ocean Layering

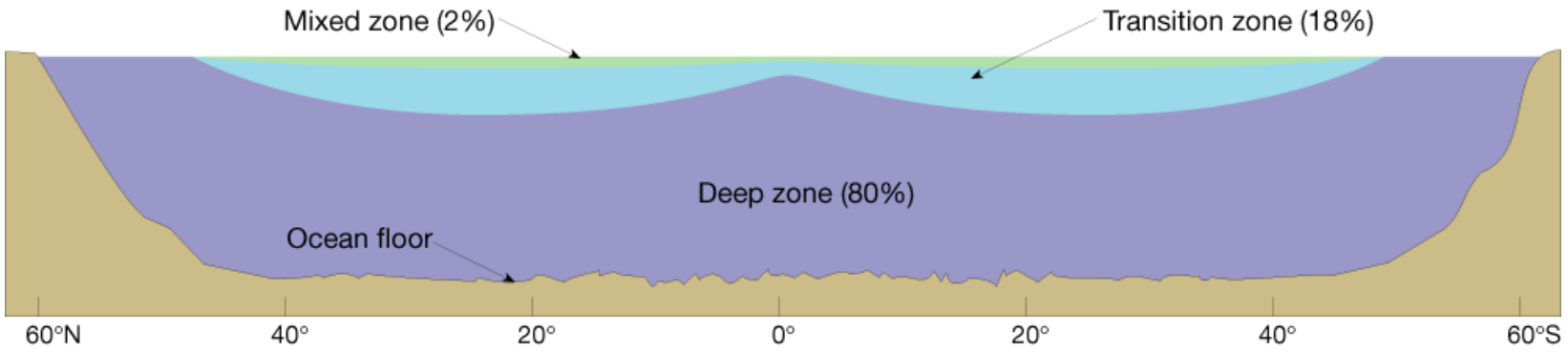
- Oceanographers generally recognize a three-layered structure in most parts of the open ocean: a shallow surface mixed zone, a transition zone, and a deep zone.
- Surface Zone
  - Shallow (300 to 450 meters)
  - Zone of mixing
  - Sun-warmed zone

15.1 The Composition of Seawater

Ocean Layering

- Transition Zone
  - Between surface layer and deep zone
  - Thermocline and pycnocline
- Deep Zone
  - Sunlight never reaches this zone.
  - Temperatures are just a few degrees above freezing.
  - Constant high-density water

Ocean Zones

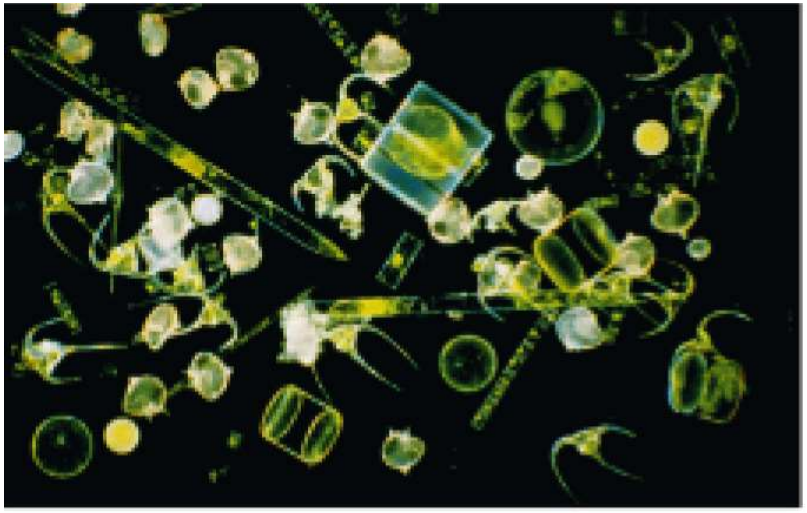

Mixed zone (2%)
Transition zone (18%)
Deep zone (80%)
Ocean floor
60°N
40°
20°
0°
20°
40°
60°S

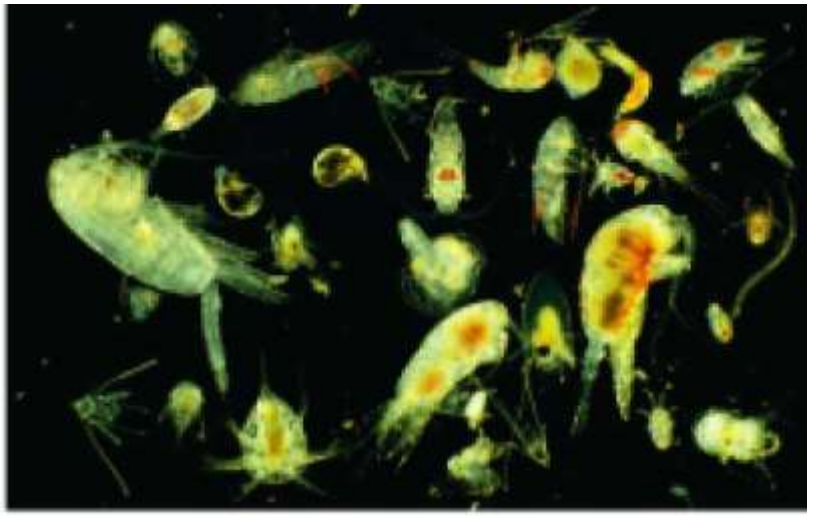
15.2 The Diversity of Ocean Life

Classification of Marine Organisms

- Marine organisms can be classified according to where they live and how they move.
- Plankton
  - **Plankton** include all organisms—algae, animals, and bacteria—that drift with ocean currents.
  - **Phytoplankton** are algal plankton, which are the most important community of primary producers in the ocean.
  - **Zooplankton** are animal plankton.

Plankton





15.2 The Diversity of Ocean Life

Classification of Marine Organisms

- Nekton
  - **Nekton** include all animals capable of moving independently of the ocean currents, by swimming or other means of propulsion.
- Benthos
  - **Benthos** describes organisms living on or in the ocean bottom.

Nekton

Benthos

15.2 The Diversity of Ocean Life

Marine Life Zones

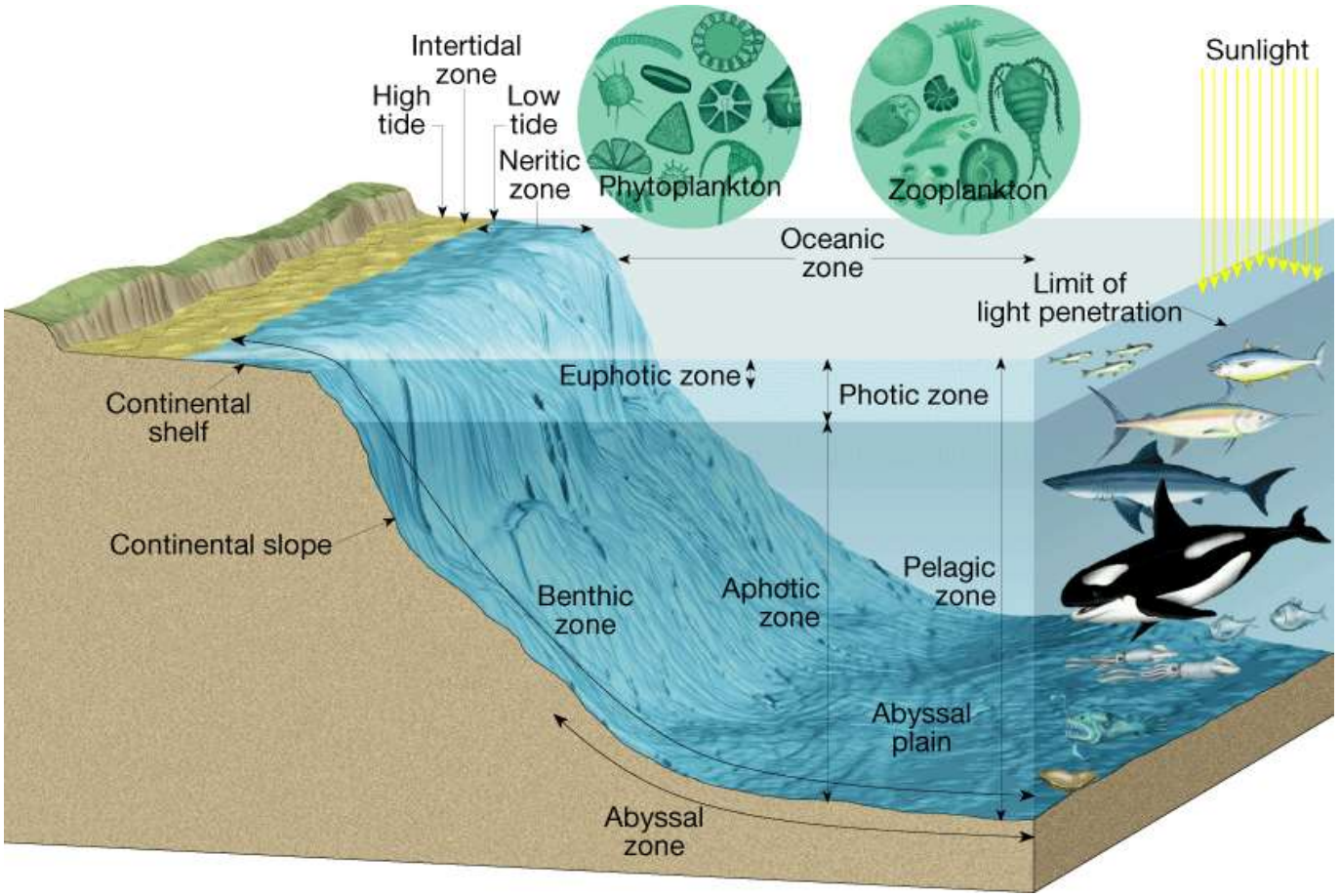
- Three factors are used to divide the ocean into distinct marine life zones: the availability of sunlight, the distance from shore, and the water depth.
- Availability of Sunlight
  - The **photic zone** is the upper part of the ocean into which sunlight penetrates.

15.2 The Diversity of Ocean Life

Marine Life Zones

- Distance from Shore
  - The **intertidal zone** is the strip of land where the land and ocean meet and overlap, or the zone between high and low tides.
  - The **neritic zone** is the marine-life zone that extends from the low-tide line out to the shelf break.
  - The **oceanic zone** is the marine-life zone beyond the continental shelf.

Marine Life Zones



15.2 The Diversity of Ocean Life

Marine Life Zones

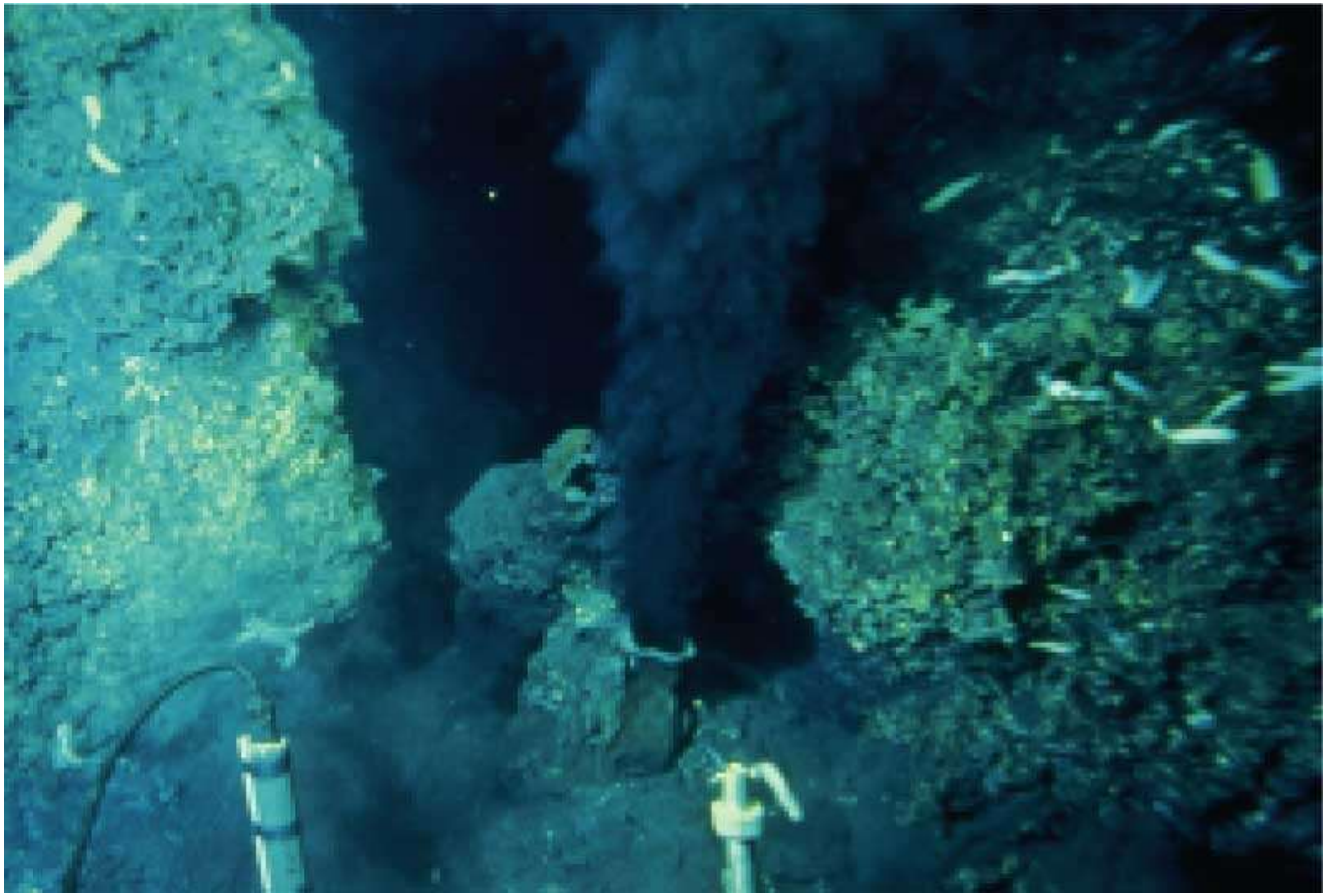
- Water Depth
  - The **pelagic zone** is open zone of any depth. Animals in this zone swim or float freely.
  - The **benthic zone** is the marine-life zone that includes any sea-bottom surface regardless of its distance from shore.
  - The **abyssal zone** is a subdivision of the benthic zone characterized by extremely high pressures, low temperatures, low oxygen, few nutrients, and no sunlight.

15.2 The Diversity of Ocean Life

Marine Life Zones

- Hydrothermal Vents
  - Here seawater seeps into the ocean floor through cracks in the crust.
  - At some vents, water temperatures of 100°C or higher support communities of organisms found nowhere else in the world.

Hydrothermal Vents



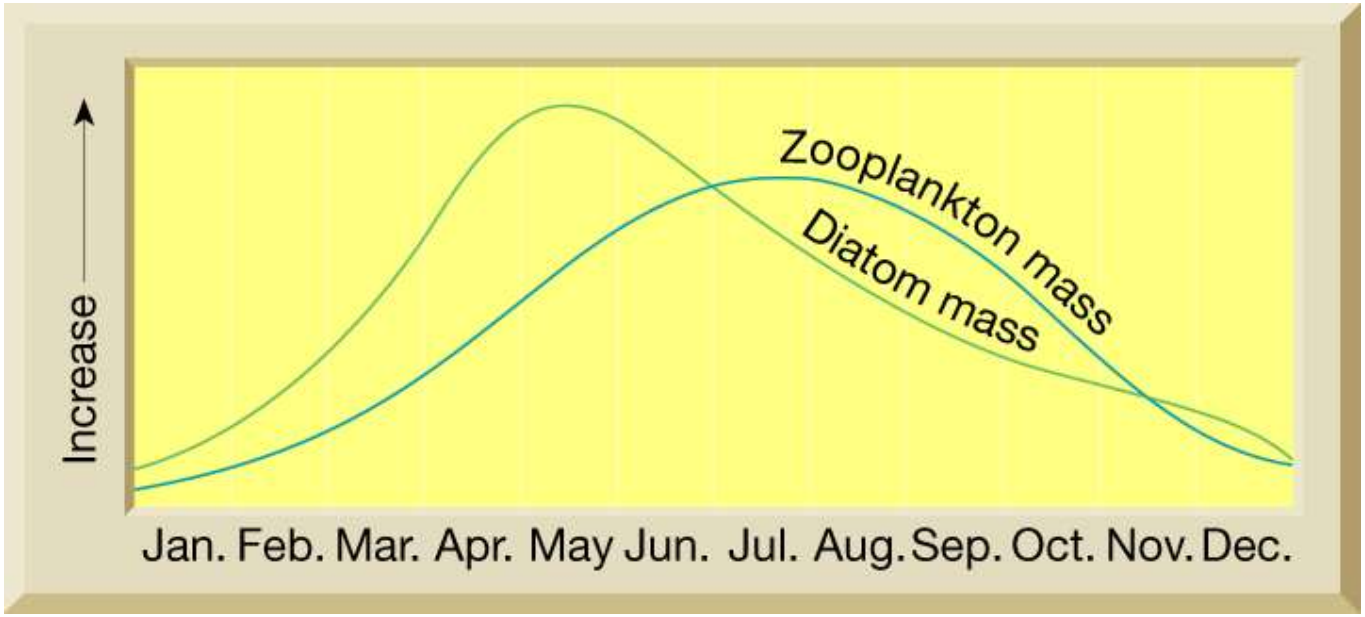
Tube Worms Found Along Hydrothermal Vents

15.3 Oceanic Productivity

Primary Productivity

- **Primary productivity** is the production of organic compounds from inorganic substances through photosynthesis or chemosynthesis.
- **Photosynthesis** is the use of light energy to convert water and carbon dioxide into energy-rich glucose molecules.
- **Chemosynthesis** is the process by which certain microorganisms create organic molecules from inorganic nutrients using chemical energy.

Productivity in the Barents Sea

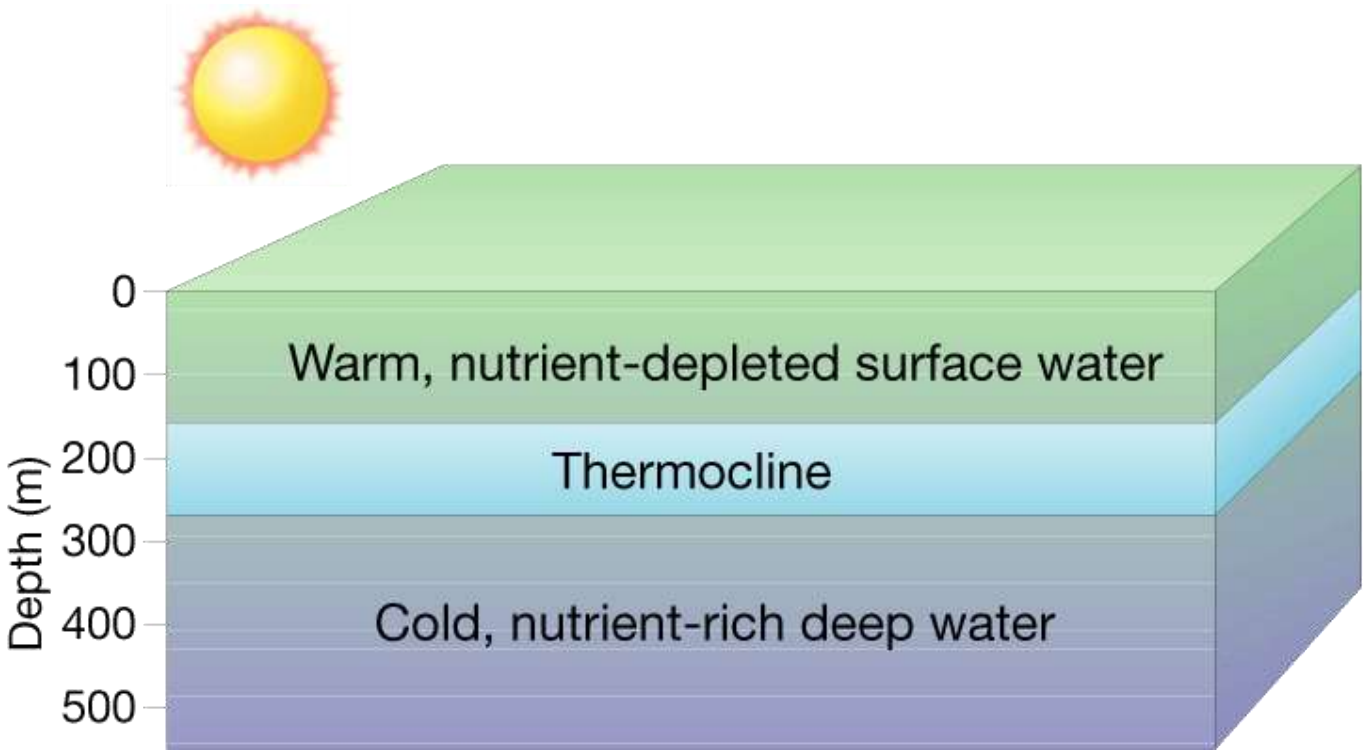


15.3 Oceanic Productivity

Primary Productivity

- Productivity in Polar Oceans
  - The low availability of solar energy limits photosynthetic productivity in polar areas.
- Productivity in Tropical Oceans
  - Productivity in tropical regions is limited by the lack of nutrients.

Water Layers in the Tropics

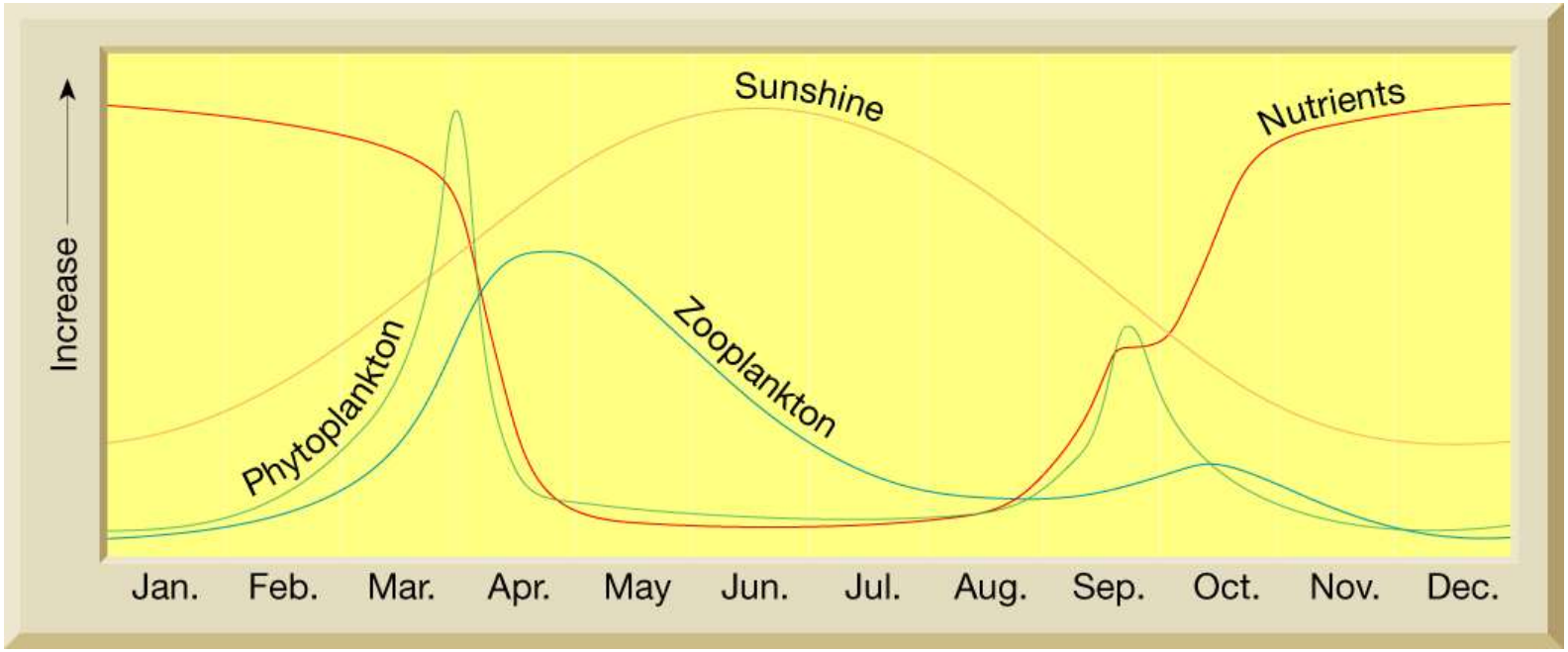


15.3 Oceanic Productivity

Primary Productivity

- Productivity in Temperate Oceans
  - In temperate regions, which are found at mid-latitudes, a combination of these two limiting factors, sunlight and nutrient supply, controls productivity.
  - Winter
    - Low productivity
    - Days are short and sun angle is low.

Productivity in Northern Hemisphere, Temperate Oceans



15.3 Oceanic Productivity

Primary Productivity

- Productivity in Temperate Oceans
  - Spring
    - Spring bloom of phytoplankton is quickly depleted.
    - Productivity is limited.
  - Summer
    - Strong thermocline develops so surface nutrients are not replaced from below.
    - Phytoplankton population remains relatively low.

15.3 Oceanic Productivity

Oceanic Feeding Relationships

- Trophic Levels
  - A **trophic level** is a nourishment level in a food chain. Plant and algae producers constitute the lowest level, followed by herbivores and a series of carnivores at progressively higher levels.
- Transfer Efficiency
  - The transfer of energy between trophic levels is very inefficient.

15.3 Oceanic Productivity

Oceanic Feeding Relationships

- Food Chains and Food Webs
  - A **food chain** is a sequence of organisms through which energy is transferred, starting with the primary producer.
  - A **food web** is a group of interrelated food chains.
  - Animals that feed through a food web rather than a food chain are more likely to survive because they have alternative foods to eat should one of their food sources diminish or disappear.

Food Chains and Webs