



Ocean Properties

Seawater Composition

Salinity	Measure of dissolved salts in seawater (typically expressed in parts per thousand, ‰). Average ocean salinity is around 35‰.
Major Ions	Chloride (Cl ⁻), Sodium (Na ⁺), Sulfate (SO ₄ ²⁻), Magnesium (Mg ²⁺), Calcium (Ca ²⁺), Potassium (K ⁺).
Density	Determined by temperature, salinity, and pressure. Density increases with decreasing temperature and increasing salinity/pressure.
pH	Seawater is slightly alkaline, with a typical pH range of 7.5 to 8.5.
Gases	Dissolved gases include oxygen (O ₂), carbon dioxide (CO ₂), and nitrogen (N ₂). Oxygen is vital for marine life, while CO ₂ influences ocean acidity.
Nutrients	Nitrates, phosphates, and silicates are essential nutrients for phytoplankton growth.

Temperature Profiles

Thermocline	- Layer of rapid temperature change with depth. Separates the warm surface waters from the cold deep waters.
Isothermal	- Having a uniform temperature. Polar regions often exhibit isothermal conditions.
Mixed Layer	- Surface layer with relatively uniform temperature due to wave action and wind mixing.
Deep Ocean	- Cold and relatively stable temperatures, typically around 2-4°C.

Light Penetration

Euphotic Zone	Upper layer of the ocean where sufficient light penetrates for photosynthesis (typically down to 100-200 meters).
Disphotic Zone	Also known as the twilight zone, where light is minimal and insufficient for photosynthesis.
Aphotic Zone	Deep ocean zone where no light penetrates.
Factors Affecting Penetration	Water clarity, suspended particles, and dissolved substances.

Ocean Dynamics

Ocean Currents

Surface Currents	Driven by wind patterns and influenced by the Coriolis effect. Important for heat distribution around the globe.
Deep Ocean Currents	Driven by density differences (thermohaline circulation). Critical for nutrient transport and climate regulation.
Gyres	Large circular currents formed by wind patterns and the Coriolis effect (e.g., North Atlantic Gyre).
Upwelling	Process where deep, nutrient-rich water rises to the surface, supporting high biological productivity.
Downwelling	Process where surface water sinks, transporting oxygen and nutrients to deeper layers.

Waves and Tides

Waves	Generated by wind. Wave height, wavelength, and period are key characteristics. Breakers occur when waves approach the shore.
Tides	Periodic rise and fall of sea level caused by the gravitational forces of the Moon and Sun.
Spring Tides	Occur during new and full moons when the Sun, Earth, and Moon are aligned, resulting in higher high tides and lower low tides.
Neap Tides	Occur during first and third quarter moons when the Sun, Earth, and Moon form a right angle, resulting in lower tidal ranges.

Ocean-Atmosphere Interactions

El Niño-Southern Oscillation (ENSO)	- Periodic climate pattern involving changes in sea surface temperatures in the central and eastern tropical Pacific Ocean. Affects global weather patterns.
La Niña	- Opposite phase of El Niño, characterized by cooler-than-average sea surface temperatures in the central and eastern tropical Pacific.
Hurricanes/Typhoons	- Intense tropical cyclones that form over warm ocean waters. Transfer heat and energy from the ocean to the atmosphere.
Ocean Acidification	- The ongoing decrease in the pH of the Earth's oceans, caused by the uptake of carbon dioxide (CO ₂) from the atmosphere.

Marine Life and Ecosystems

Marine Organisms

Phytoplankton	Microscopic algae that form the base of the marine food web. Perform photosynthesis.
Zooplankton	Microscopic animals that feed on phytoplankton and other zooplankton.
Nekton	Actively swimming organisms, such as fish, marine mammals, and squid.
Benthos	Organisms that live on or in the seafloor, such as crabs, worms, and sea stars.

Marine Ecosystems

Coral Reefs	- Highly diverse ecosystems found in warm, shallow waters. Built by coral polyps. Threatened by bleaching and ocean acidification.
Kelp Forests	- Underwater ecosystems dominated by kelp. Provide habitat and food for many marine species.
Estuaries	- Coastal areas where freshwater rivers meet the ocean. Highly productive due to nutrient input.
Deep-Sea Vents	- Hydrothermal vents that release chemicals from the Earth's interior. Support unique chemosynthetic communities.

Ecological Interactions

Food Webs	Complex networks of organisms that transfer energy and nutrients through feeding relationships.
Symbiosis	Close ecological relationship between two different species (e.g., mutualism, commensalism, parasitism).
Predation	One organism (the predator) consumes another organism (the prey).
Competition	Occurs when organisms compete for limited resources (e.g., food, space).

Human Impacts on the Ocean

Pollution

Plastic Pollution - Accumulation of plastic waste in the ocean. Harms marine life through entanglement, ingestion, and habitat destruction.
Chemical Pollution - Introduction of harmful chemicals (e.g., pesticides, heavy metals) into the ocean. Can lead to bioaccumulation and biomagnification in the food web.
Nutrient Pollution - Excessive input of nutrients (e.g., nitrogen, phosphorus) from agricultural runoff and sewage. Can cause eutrophication and harmful algal blooms.
Oil Spills - Release of crude oil into the ocean. Devastating to marine ecosystems and wildlife.

Overfishing

Definition	Harvesting fish at a rate faster than they can reproduce, leading to population declines.
Impacts	Disrupts marine food webs, reduces biodiversity, and affects livelihoods of coastal communities.
Sustainable Practices	Implementing fishing quotas, protecting marine reserves, and promoting responsible aquaculture.

Climate Change

Ocean Warming - Increasing ocean temperatures due to global warming. Leads to coral bleaching, shifts in species distributions, and altered ocean currents.
Sea Level Rise - Rising sea levels due to thermal expansion of water and melting of glaciers and ice sheets. Threatens coastal communities and ecosystems.
Ocean Acidification - The ongoing decrease in the pH of the Earth's oceans, caused by the uptake of carbon dioxide (CO ₂) from the atmosphere.
Changes in Ocean Currents - Altered circulation patterns can affect heat distribution, nutrient transport, and marine life.