NO PREP

Ecosystem Principles

How Marine Life Interacts and Survives

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Ecosystem Principles: How Marine Life Interacts and Survives

Foundations of Marine Ecosystems

Marine ecosystems are living communities woven together by energy flow, matter cycling, and interactions among organisms and their environment. Think of an ocean cove or offshore reef as a dynamic neighborhood. At the base of every neighborhood are producers—in the sea, mostly phytoplankton and marine algae—using sunlight, carbon dioxide, and nutrients to build organic matter by photosynthesis. Above them are consumers: zooplankton, small fish, larger fish, seabirds, and marine mammals that transfer energy upward through feeding. Completing the loop are decomposers such as bacteria and fungi, which break down dead material and recycle nutrients, making them available again to producers. Because the ocean is never static,

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Interactions That Shape Survival

Marine life doesn't just coexist; it interacts in ways that determine who thrives and who struggles. Predation regulates populations, preventing any one species from monopolizing resources. Competition happens when organisms need the same limited resource: light in shallow seagrass meadows, space on a crowded reef, or nitrogen in offshore waters. Species reduce direct conflict by occupying different ecological niches: specific roles that combine habitat, diet, behavior, and timing. Not all interactions are competitive. Symbiosis, long-term biological relationships, can boost

survival. Mutualism benefits both partners (think zooxanthellae living within coral tissues, sharing sugars for shelter). Commensalism benefits one partner without harming the other (a remora hitching a ride on a shark). Parasitism benefits one at a cost to the other (isopods that feed on fish). These interactions shape community structure as much as predator-prey relationships do. When interactions are balanced, ecosystems show stability; when key interactions are disrupted (say, by the loss of a top predator), communities can reorganize rapidly, sometimes into less diverse, less productive states.

Energy Flow and Stability

The ocean's energy architecture is often pictured as a trophic pyramid. Producers form a wide base; primary consumers feed on them; secondary and tertiary consumers sit higher up. At each step, only a fraction of energy moves forward, commonly summarized as the "10% rule." That means vast producer biomass supports smaller consumer biomass, and apex predators are necessarily fewer. Stability emerges when multiple pathways exist for energy to travel. If one forage fish declines, a predator with flexible diet options can switch to another prey. That redundancy (supported by biodiversity) helps the whole system resist shocks. By contrast, simplified systems with only a few dominant links are vulnerable: remove a single link and the structure wobbles.

Niches, Competition, and Carrying Capacity

Every species has a fundamental niche (the full range of conditions it could occupy) and a realized niche (the narrower slice it actually uses after factoring in competition and predation). On rocky reefs, space is gold. Sessile organisms like sponges, tunicates, and corals compete fiercely for hard surfaces, using rapid growth, stinging cells, or chemical defenses to hold territory. Mobile species compete by speed, schooling behavior, or smarter foraging. These strategies determine how many individuals an environment can sustainably support—its carrying capacity. When a powerful competitor or predator disappears, niches can expand for other species. Sometimes this is beneficial; often it triggers trophic cascades. If a pivotal grazer drops, algae can overgrow; if a top predator is removed, mid-level consumers may explode in number, suppressing lower levels and unraveling the web. Conservation often focuses on keystone species—those whose effects are

disproportionately large relative to their abundance—because protecting them can stabilize entire communities.

Key Information: Key Terms in Marine Ecology

Term	Definition
Producers	Organisms (like phytoplankton) that make their own food through photosynthesis
Consumers	Organisms that eat other organisms to gain energy
Decomposers	Break down waste and dead organisms, recycling nutrients
Ecological niche	The specific role or "job" a species has in its environment
Keystone species	A species with a disproportionately large impact on ecosystem balance

Case Study: Kelp Forests, Otters, and Urchins (Excerpt)

Along the wave-washed coasts of the North Pacific, underwater forests of kelp rise like redwood groves. Their blades capture sunlight, their holdfasts anchor life, and their towering fronds soften waves for fish nurseries below. In the mid-1900s, sea otters—voracious, intelligent mammals—were scarce in many regions due to historical hunting. Where otters were missing, divers noticed carpets of purple sea urchins blanketing rock. The urchins grazed continuously, clipping young kelp and chewing holdfasts until only "urchin barrens" remained—low-diversity patches with little canopy to slow waves, little shelter for juvenile fish, and reduced production to feed the web. As otter populations recovered under protection, researchers tracked a dramatic shift. Otters consumed large urchins, reducing grazing pressure; kelp forests rebounded; fish communities diversified; and the entire food web grew more complex. The change wasn't uniform—storms, disease, and temperature still mattered—but the presence of otters consistently tipped systems toward kelp dominance. Today, managers watch urchin densities, kelp growth, and otter foraging signs to predict whether a forest is holding or slipping toward barrens. In places where otters are still absent, divers sometimes remove excess urchins by hand to kick-start recovery. The lesson is clear: a single keystone species can regulate a community by controlling a powerful grazer.

1. Why are sea otters considered a keystone species in kelp forests?

2. How does the balance between otters, urchins, and kelp illustrate the concept of a trophic cascade?

Multiple Choice

1. Which group forms the base of most marine food webs?

    a) Decomposers

    b) Phytoplankton

    c) Large fish

    d) Marine zooplankton

2. What term describes the total number of individuals an environment can support?

    a) Niche overlap

    b) Symbiotic relationships

    c) Keystone species

    d) Carrying capacity

3. Which type of symbiotic relationship benefits one species without affecting the other?

    a) Commensalism

    b) Parasitic relationships

    c) Competition

    d) Mutualism

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Trophic pyramid	A) A long-term interaction where both species benefit
2. ___ Mutualism	B) Species with a disproportionately large effect
3. ___ Niche	C) Energy decreases as it moves up levels
4. ___ Decomposer	D) Role a species plays in its ecosystem
5. ___ Keystone species	E) Breaks down waste and dead material

Fill-in-the-Blank

1. The _____ rule states that only about 10% of energy is transferred between trophic levels.

2. The narrower slice of conditions a species actually uses is its _____ niche.

3. _____ are microscopic algae that form the foundation of most marine ecosystems.

Short Answer

Answer each question in 2-4 complete sentences.

1. Explain how biodiversity contributes to the resilience of marine ecosystems.

_____

_____

_____

2. Give one example of commensalism in the ocean and explain why it fits that category.

_____

_____

_____

3. Why does removing a top predator often cause a trophic cascade?

_____

_____

_____