Fact Sheet: The Rocky Intertidal


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The rocky shores that lie at the edge of the ocean, between the high and low tides, are called the rocky intertidal. Rocky intertidal areas along the west coast of North America are some of the richest and most diverse places in the world. Over 1,000 species of invertebrates and algae can be found in the rocky intertidal of central California, and this wide variety of life makes exploring the rocky shores fun and exciting, but more importantly, this biodiversity is essential for the coastal ecosystem and the communities that rely on it.

Physical and Biotic Conditions

Changing tides, pounding waves, and competition for food and space are among many physical and biological factors that determine the nature of rocky intertidal communities. At the rocky intertidal, organisms live part of their days under water and part of their days exposed to the air. When the tide is high, wave action threatens to crush the animals and algae or tear them away from their homes. When the tide is low, organisms are more visible to predators, more susceptible to desiccation (drying out), and can be exposed to rainfall or direct sunlight. Sea stars, snails, seaweeds, and other intertidal organisms have adapted to these conditions in many ways and can thrive in these harsh and changing environments.

Tides are one major factor that determines the diversity of organisms living within the rocky intertidal. Tides can be defined as the regular rise and fall of water along the ocean's shores. Most places on earth experience two high tides and two low tides each day. The rise and fall of the ocean is a result of the combined effects of the gravitational forces from the moon and the sun.

As the tide goes out, water loss becomes a problem for residents of the intertidal zone. Motile animals avoid desiccation by hiding under wet algae and rocks or in crevices or tidepools. Sessile animals close up, like a mussel pulling together its valves or a limpet tightening down its shell onto the rock. Seaweed can lose up to 90% of its moisture and survive until the tide rises again.

As the tide rises, organisms must deal with the physical pounding of waves. Many rocky intertidal organisms anchor firmly and hold tight to the rocks. Limpets hold on with their muscular foot, mussels with their byssal threads, and seaweed with their holdfasts (algae's attachment structure to rocks). Morphology, an organism's physical characteristics, such as being flexible or very flat and close to the rocks, can minimize the impact of waves. Behavior, such as hiding in cracks and under ledges, can also help animals survive and stay put.

Competition for food and space are other important features that structure communities. The rocky intertidal has a limited amount of surface area for algae and animals to live on. Organisms cope with limited space either by living on top of each other, bulldozing others out of their territory, or growing quickly to out-compete their neighbors.

Organisms must also face underwater predators such as fish and above water predators including birds.

Zonation

Rocky shores are divided into a series of vertical zones that are defined by the amount of time the rocks are exposed to air and water. Zones range from the splash zone, closest to the terrestrial environment, to the low zone, closest to the ocean.

SPLASH ZONE: As the name implies, this zone gets merely splashed by waves on most days, and organisms are rarely submerged. Few organisms can survive here. A type of green algae, *Ulva intestinalis*, live in the splash zone.

THE HIGH TIDE ZONE: Organisms that inhabit this zone are exposed to air more than 70 percent of the time and have unique adaptations to survive the long dry periods. Limpets, chitons, and black turban snails form a watertight seal on the rocks with their shell to protect themselves from drying out.

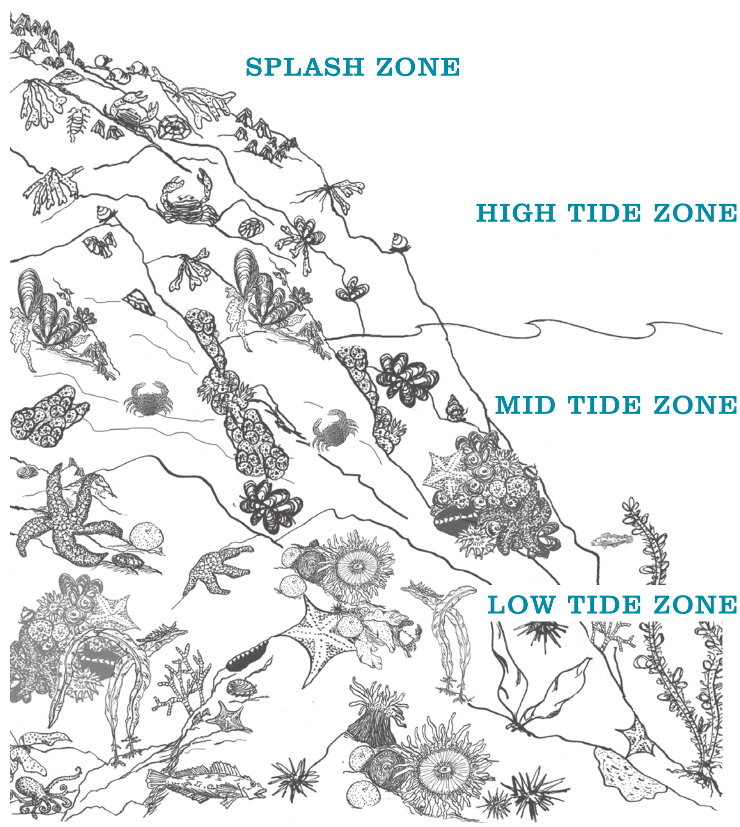
THE MID TIDE ZONE: This zone is densely populated. California mussels often form large beds that provide important refuge and habitat for a variety of other invertebrates and algae. When the tide ebbs, mussels tightly close their two shells to avoid dessication. They also form byssal threads that anchor themselves to other mussels and to the substrate, so they do not wash away with the crashing waves. Ochre sea stars live in the mid and low zone. They have tube feet that work like suction cups and are uniquely adapted to pull apart the shells of their prey.

THE LOW TIDE ZONE: In this zone, organisms may only be exposed to air during extreme low tides, or spring tides, which occur approximately twice per month. They are therefore well adapted to withstand the forces of waves and less resilient to air exposure. It is in this zone that most life exists within the rocky intertidal. The giant green anemone and the purple sea urchin are two types of larger invertebrates that inhabit the lower zone. Anemones firmly attach themselves to the substrate with a pedal disk and have stinging tentacles that catch and paralyze prey that drift by in the water. Sea urchins rely on their tube feet to survive in the low zone. Similar to sea stars, urchins use tube feet for movement and attachment.

Human Impact

The rocky intertidal is vulnerable to many types of human activities. As coastal populations continue to grow, more people visit, use and exploit our rocky shores. As a result, threats to California's rocky shores are increasing. The following briefly describes some of the major threats to California's rocky intertidal.

- **Harvesting**: Sea urchins, mussels, abalone, turban snails, limpets and algae are all exploited by humans for food. On rocky shores throughout California, over-harvesting has severely depleted stocks of some species (e.g. abalone) and has compromised biodiversity in these areas. As a result, overharvested areas have become extremely vulnerable. California has recently established a system of Marine Protected Areas (MPAs) where, in some cases, no collecting is permitted.



Intertidal life and zones.

- **Oil spills**: Oil spills pose a significant threat to the health and balance of life on rocky shores. Past spills, such as the 2007 Cosco Busan oil spill in San Francisco Bay, deposited oil on rocky shores, including one of our LiMPETS sites Duxbury Reef. Oil can smother mussel beds and kill acorn barnacles, limpets and other species.
- **Invasive species**: Invasive species have made their way to California's rocky shores and can be especially prevalent near areas with high volumes of shipping traffic, like the Port of Los Angeles and San Francisco Bay. A brown alga from Asia, *Sargassum horneri*, was first discovered in 2003 in Long Beach harbor and has spread rapidly throughout Southern California. Invasive species threaten the abundance and diversity of native species, disrupt ecosystem balance and threaten local marine-based economies.
- **Pollution**: Water from streams and culverts that drains onto rocky shores often bring contaminants that can have a variety of biological effects.
- **Climate change**: Because rocky intertidal environments lie at the land and sea interface, they are expected to be strongly influenced by climate change. In response to rising air and sea temperatures, we may expect the distribution of species along our coast to change. Indeed, that was what was seen when species abundance was compared between the early 1930s and the mid 1990s at one site in Monterey Bay: several common southern California species that were rare or absent in the 1930s are now abundant in the Monterey Bay area. Moreover, as sea levels rise along the rocky intertidal, the different zones may begin to shift higher onto the shore.
- **Ocean acidification**: Human activities such as burning fossil fuels and deforestation have lead to a rapid increase in atmospheric carbon dioxide levels. The ocean absorbs approximately 1/3 of the atmospheric carbon dioxide from human activities, or anthropogenic carbon dioxide. Carbon dioxide acts as a weak acid when it dissolves in seawater. The dissolution of carbon dioxide causes a chemical reaction that consumes some of the chemical compounds that calcifying organisms, like oysters, use to build their shells. So the dissolution of anthropogenic carbon dioxide into the ocean is changing ocean chemistry and making it difficult for some organisms to live..

Sea Star Wasting Syndrome

Since 2013, sea stars along the North American Pacific coast have been declining in great numbers from a mysterious wasting syndrome. The current bout of this wasting syndrome was first documented in ochre stars (*Pisaster ochraceus*) in June 2013 along the coast of Washington state. Similar die-offs have occurred before in the 1970s, 80s, and the 90s, but never before at this magnitude and over such a wide geographic area. *Pisaster ochraceus* and many other species of sea stars have been affected by the current sea star wasting syndrome event. The progression of wasting disease can be rapid, leading to death within a few days, and its effects can be devastating on sea star populations. The dramatic decline of sea star populations may have a ripple effect across food webs. Researchers are working together to find the root causes of the syndrome, and LiMPETS is contributing by counting sea stars and searching for signs of recovery. Learn more about the latest trends and research in sea star wasting at www.seastarwasting.org.

Monitoring programs like LiMPETS are important because they can identify changes over the short term, like discovering the spread of an invasive species. But even more valuable is the ability for long-term data to help reveal the natural variability, or the ups and downs, in a system. If we understand what is 'normal' in a system, we can then begin to identify trends that could be a result of destructive human activities. Long-term data therefore lead to better conservation and protection of our oceans. The data help us understand what species need protection (like abalone) and what places are most vulnerable to human activities.

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