



Oregon's Marine Treasures

The Case for Conservation



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Environment Oregon Research & Policy Center

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Executive Summary

Oregon's territorial waters—ocean within three miles of shore—are a national treasure. These waters are home to rare species, support the largest seabird population on the West Coast, draw thousands of visitors each year, and provide significant ecological and economic benefits to coastal communities.

But Oregon's ocean ecosystems are deeply stressed. A legacy of heavy fishing has depleted fish stocks, while other human activities pose challenges to the rich and varied coastal ecosystems that sustain seabirds, mammals, fish and countless other species. At the same time, changes in ocean currents—possibly linked to global warming—are exacerbating the stresses faced by species in Oregon's waters and with potential impacts on humans as well.

Scientific research shows that the creation of marine reserves and protected areas can play an important role in revitalizing ocean ecosystems. By creating a network of marine reserves and protected areas in Oregon's coastal waters, the state can protect some of its most valuable and important offshore resources.

Oregon's coastal waters include a wealth of important ecological

resources—resources that are threatened by human activity and long-term changes in natural patterns.

- The large bull kelp forest that grows in the **Otter Rock and Cape Foulweather** area provides important shelter for rockfish. While bull kelp has a remarkable ability to regrow each spring and summer after damage from winter storms, it is vulnerable to human interference. Protecting bull kelp forests is an important component of maintaining viable rockfish populations.
- The kelp-covered reef at **Redfish Rocks** provides habitat for a variety of fish that use the kelp forest, rocky crevices and steep, rocky terrain for shelter. Marine life living on rocky reefs is vulnerable to overfishing and destruction of habitat from fishing gear.
- The nine species of seabirds that nest on the rocky cliffs in the Tillamook Head area, which extends from **Cape Falcon to Tillamook Rock**, are relatively protected from direct human contact. However, the birds have been

harmed by the low-oxygen “dead zone” that has formed off the coast in recent summers due to shifting winds that have altered ocean circulation patterns. The phytoplankton on which small forage fish and krill feed cannot survive in the dead zone. Up the food chain, birds depend on the forage fish and krill and are harmed without phytoplankton survival. In one recent summer, this caused a large number of common murrelets to die of starvation.

- Siletz Reef, south of **Cascade Head** and off the Lincoln City coastline, is home to many species of rockfish, prized by both recreational and commercial fishers. Rockfish are slow-growing and long-lived, traits that make them vulnerable to overfishing. Unsustainable catch rates in the 1980s and 1990s reduced the population of yelloweye rockfish, for example, to just 13 percent of historic levels. Scientists estimate that the population may require the better part of a century to recover. Essential to this recovery is allowing juvenile fish to live undisturbed in their preferred habitat such as the rocky habitat of Siletz Reef and other nearshore areas.
- The intertidal area at Neptune State Park and Strawberry Hill, near **Cape Perpetua** and Yachats, depends on food delivered by the upwelling of nutrient-rich waters. In 2005, a two-month delay in the upwelling altered reproduction of barnacles and mussels. Disruptions to the timing and strength of the upwelling are among the expected impacts of global warming, so the problem could become more severe in the future.
- Simpson Reef near **Cape Arago and Seven Devils** is the West Coast’s

northernmost colony of elephant seals, a species that was on the edge of extinction at the beginning of the 20th century. The reef also harbors flat abalone, virtually extinct at the southern end of its range in California and common only in southern Oregon. Despite concerns among scientists that abalone can easily be overharvested, Oregon has allowed the harvesting of flat abalone since 2001.

- The tufted puffin population at **Three Arch Rocks** has declined by nearly 90 percent since the late 1970s. The cause of the decline is not clear, but rising sea surface temperatures may be partially to blame by making it harder for young puffins to grow and survive. Better protection of the ecosystems surrounding Three Arch Rocks may help to ensure the puffins’ food supply and enable them to better survive the effects of global warming.
- At **Orford Reef**, the large and productive rocky reef and bull kelp forest supports a rich variety of aquatic life, including red sea urchins. Valued for their roe, the red sea urchin population remains depleted after excessive harvesting in the 1990s.
- **Mack Reef** is home to a representative array of the marine species that thrive in Oregon, including a 300-acre bull kelp forest and 11 species of seabirds. It is hoped that Mack Reef would be the southernmost location in a network of marine reserves, offering geographic diversity and resilience to ensure no single disaster could damage all the reserves.

These places could be protected by the creation of a network of marine reserves, areas that are off-limits to fishing, collecting

specimens and other extractive or development activities such as energy generation. The benefits of marine reserves and marine protected areas that allow some extractive activities are well established. Scientists have studied marine reserves around the world, and have found that:

- The density of plant and animal populations increased within reserves on average by 166 percent compared to before the creation of the reserve.
- Individual animals grew an average of 28 percent larger. This is significant because larger fish are able to produce more offspring.
- The number of species increased by an average of 21 percent.

By protecting an entire area instead of just a single species, marine reserves allow complete ecosystems to flourish. This may make the broader marine ecosystem more resilient to shifts in natural conditions, including the anticipated consequences of climate change. Furthermore, healthy ecosystems within marine reserves can support large plant and animal populations

that may migrate to other, less protected areas, helping to rebuild fish, invertebrate and plant populations elsewhere.

Oregon should create a network of marine reserves and protected areas to protect aquatic ecosystems and the plants and animals that they support. Earlier efforts to protect individual species, even when designed with the best science available and with the full intention of maintaining a healthy population for the long term, have not succeeded. Establishing marine reserves will protect all the species in an ecosystem, even if we do not fully understand how they depend on each other. Marine protected areas that allow some activities like recreational fishing or commercial crab harvest are a valuable addition to a network of reserves by protecting adjacent habitat areas outside of the reserves from harmful activities and allowing for continued sustainable uses.

The state has taken the first step toward creating a network of reserves and protected areas by designating two marine reserve pilot projects at Otter Rock and Redfish Rocks, as well as initiating studies at four other locations. Oregon should add more locations to create a comprehensive network of reserves and protected areas.

Introduction

Oregon's most beautiful and ecologically important land is protected in hundreds of state parks, 40 wilderness areas, 18 national wildlife refuges, and one national park.¹ These special designations protect all the components of an ecosystem and provide room for plants and animals to thrive. They limit human activities that could cause permanent damage, protecting some of the state's most treasured places for future generations.

Though Oregon controls 1,200 square miles of ocean, the state has done far less to protect important marine sites. The state's territorial marine waters have one wildlife refuge, selected fishing restrictions, limitations on how birds and mammals can be disturbed and, thanks to recent action by the Governor and Legislature, two pilot marine reserves and one adjacent protected area.² But Oregon's marine ecosystems are under threat from both human activities and natural changes—including commercial and recreational fishing, offshore development, and climate change and associated changes in ocean currents—and are in need of greater protection than they currently receive.

Fish stocks are depleted: the red sea urchin harvest has plummeted due to heavy commercial fishing pressure, and some rockfish have been harmed by both recreational and commercial fishing. While two managed rockfish species that reside in part in Oregon's ocean are considered to be depleted, the status of the vast majority of species is unknown. Of forty-three managed fish populations, managers have population assessments for only eight.³

Changes in natural patterns are also stressing Oregon's marine ecosystems. Every year since 2002, a "dead zone" of water containing little to no oxygen has formed in shallow water off the Oregon coast.⁴ Formed by wind-driven nutrient-rich waters that cause an unsustainable boom in the phytoplankton population, Oregon's dead zone typically appears in the spring and summer months. The dead zone in 2006 was particularly severe, reaching from Florence north to Cascade Head and lasting four months.⁵ Aquatic animals cannot survive in low-oxygen conditions and suffocate unless they are able to flee beyond the dead zone. As the dead zone recedes at the end of the summer, animals that managed to find temporary habitat elsewhere

return, but the affected ecosystem does not fully recover.

Creating marine reserves and protected areas will not prevent the formation of dead zones or fully eliminate the impacts of a legacy of overfishing, but doing so can help affected areas recover faster. Marine reserves provide refuges where animals can reproduce and more readily repopulate areas depleted by dead zones, overfishing,

oil spills, or other damage.

Just as the forests, wetlands and meadows that support Oregon's diverse ecosystems have benefited from park, wilderness and wildlife refuge protections, the state's most treasured marine ecosystems should be afforded similar protection. Comprehensive protection also ensures that these places will be available for future generations of Oregonians to enjoy.

Value of Marine Reserves

Marine reserves are areas of the ocean where animals, plants and even non-living features of the ocean are protected from extractive activities. Typically, fishing and collecting animals are prohibited, as are dredging or offshore developments such as energy-generation projects. Non-extractive activities such as diving, boating, whale-watching and surfing are usually allowed inside marine reserves.

This insulation from human pressures provides substantial and rapid benefits. Studies of marine reserves around the world have shown that plants and animals flourish when compared to nearby areas.

- The density of plant and animal populations increases on average by 166 percent.
- Individual animals are an average of 28 percent larger. Larger fish are able to reproduce more effectively. For example, a 14.6-inch vermillion rockfish can produce 150,000 young, while a 23.6-inch rockfish—just 60 percent bigger—can produce 11 times as many offspring.

- The number of species increases by an average of 21 percent.⁶

Marine protected areas provide similar benefits by restricting some harmful activities such as bottom trawling or offshore development but allowing other less invasive activities and uses. Marine protected area designations for other important habitat areas along the Oregon coast could enhance habitat protection, help prevent localized depletions and maintain the integrity of the food web. Scientists from around the country participating in a National Research Council review of marine reserves and protected areas found that both marine reserves and protected areas, in concert, provide effective tools for addressing conservation needs as part of an integrated coastal and marine area management.⁷

Marine reserves can quickly yield benefits. In 2001, a marine reserve was established in the Dry Tortugas, west of the Florida Keys. No fishing is allowed in the reserve, while commercial and recreational fishing is still permitted in nearby areas. Researchers surveyed fish populations in the reserve before and after the reserve was created, and also compared it to areas

where fishing and other activities were allowed to continue. By 2004, three years after the reserve was created, black grouper were 120 percent more abundant within the reserve than before, the red grouper population rose 38 percent, and the mutton snapper population more than tripled. In contrast, fish populations remained steady or declined in the fully fished areas.⁸

However, the full benefit of establishing marine reserves may not be apparent for years. Different species mature at different rates and rebound within marine reserves on different timelines. Giant kelp can mature within nine months, while vermillion rockfish need 8.8 years.⁹ The density of seaweed in a marine reserve in New Zealand increased for 22 years after the creation of the reserve.¹⁰ The full ecosystem may require many years before it arrives at a new equilibrium.

The benefit of marine reserves extends beyond the boundaries of the reserve. Because animals within reserves achieve a larger size than those elsewhere, they are able to produce more offspring. Those offspring may migrate out of the reserve and increase populations elsewhere. Juvenile fish may travel more than 100 miles from the marine reserve where their parents live.¹¹ Adult fish, too, may migrate out from reserves. Lingcod that were first tagged in a marine reserve in Alaska have been tracked nearly 100 miles away.

Unlike more narrowly focused policies such as seasonal fishing bans or restrictions on catching particular fish, the comprehensive protection offered by marine reserves allows all elements of the area's ecosystem to flourish and may increase its resilience to global warming. For example, the marine reserve off Anacapa Island in California has withstood the effects of El Niño events far

better than surrounding areas.¹² Outside the reserve, the small number of lobsters has not been able to keep the sea urchins in check, who have weakened kelp forests. After stressful El Niño events, the reserve area has maintained its kelp forest, while areas outside the reserve have been barren.

Creating Marine Reserves in Oregon

In 2008, Governor Kulongoski initiated a process to create marine reserves off Oregon's coast. In 2009, the state legislature passed House Bill 3013, which creates marine reserve pilot projects at Otter Rocks and Redfish Rocks; requires a science-based study of potential reserves at Cape Falcon, Cascade Head and Cape Perpetua; and requires the development of a proposal to designate a reserve at Cape Arago – Seven Devils.

What follows is a discussion of some of the important but threatened animals, plants and ecosystems that exist off the Oregon coast and that could be protected by a strong network of marine reserves and protected areas. A sufficiently large network of reserves and protected areas—including locations in addition to those identified in House Bill 3013—will protect the greatest diversity of Oregon's nearshore ocean species and represent the range of habitat types distributed along the Oregon coast.¹³ The locations discussed below are not the only locations for these conservation areas, but are intended to provide Oregonians with a better understanding of the types of resources that could be protected with a designation.

Oregon's Diverse Marine Ecosystems

Otter Rock

The area from Cape Foulweather to Otter Rock hosts Oregon's largest kelp forest north of Cape Arago.¹⁴ Bull kelp provides a source of food for invertebrates such as sea urchins and provides shelter that plays an important role in the development of juvenile rockfish.¹⁵

Rockfish species found in this area include the China, copper and quillback rockfish, which are important in both sport and commercial fisheries.¹⁶ They prefer rocky habitat, and quillback and copper rockfish have a strong preference for reefs



Vermillion rockfish. Credit: Steven Billings, Portland, Oregon

with kelp cover.¹⁷ As kelp and other plants become more dense in the summertime, the concentration of quillback and copper rockfish in the reef rises. Bull kelp cover is especially important over low-relief rocky habitat, where the rock formation provides less protection for rockfish.¹⁸

Bull kelp begins its remarkable regeneration each spring in shallow, rocky nearshore areas of the coast, adding 2 inches per day or more to its length during the peak period of growth.¹⁹ By summer, the kelp have created a visible, floating “canopy” at the surface of the ocean.²⁰ Winter storms—such as those that gave Cape Foulweather its name—tear bull kelp loose from the sea floor, causing it to wash up on shore. In spring, the cycle of growth begins again.

Yet, bull kelp is also fragile and susceptible to human interference. Careless harvesting of bull kelp can eliminate the plant's ability to grow and reproduce.²¹ There has been little study of the impact of harvesting on bull kelp populations. And while there has been little commercial harvesting of bull kelp off the coast of Oregon to date, kelp can be used in a variety of products, ranging from sushi wraps

and snacks to fertilizer, herbal medicines, and consumer product additives.²² In recognition of the critical role that bull kelp forests play in maintaining healthy marine habitats, in 2008 Oregon adopted an indefinite moratorium on kelp harvesting.²³ Bull kelp is also susceptible to pressures beyond harvesting, such as oil spills.²⁴

As stipulated in House Bill 3013, the protection and study of the area around Cape Foulweather and Otter Rock, and the bull kelp and the creatures that live there, could help Oregon more fully understand bull kelp's response to harvesting and develop better strategies for protecting bull kelp along the state's coast.

Redfish Rocks

The six rocky outcroppings that comprise Redfish Rocks, south of Port Orford, are home to more than 21,000 birds, nearly all of which are common murrelets.²⁵ To help protect the birds from human disturbance, the rocks are part of the Oregon Islands National Wildlife Refuge. Boaters are advised not to come closer than 500 feet from the rocks, and aircraft are asked to stay at least 2,000 feet above the islands.²⁶

The unseen rocks just below the water are no less important in providing shelter to a variety of fish, invertebrates and plants. The rocky reefs at Redfish Rocks are home to black, blue and canary rockfish, juvenile rockfish of various species, lingcod and kelp greenling. These species comprise more than three-quarters of the fish found in the Redfish Rocks area, but dozens of other species are present as well.²⁷ Now, the pilot marine reserve designation and adjacent marine protected area established by House Bill 3013 will provide additional protection for the Redfish Rocks area.

Rockfish, a type of groundfish, are vital to Oregon's recreational fishery. The quantity of blue and black rockfish



Kelp greenling. Credit: Steven Billings, Portland, Oregon

taken by recreational fishers was three times that taken by commercial fishers in 2000.²⁸ Some species of rockfish are especially prized by recreational fishers for their beauty, size and the quality of their meat.²⁹ But rockfish have several characteristics that make them particularly vulnerable to overfishing. Many species of rockfish are extraordinarily long-lived. For example, canary rockfish have a lifespan of as much as 75 years, and yelloweye rockfish can live for 100 years or more.³⁰ One yelloweye caught off the coast of Washington was determined to be 147 years old.³¹ Rockfish are also slow-growing and take a long time to reach maturity.³² In addition, these reef-dwellers are highly dependent on the right habitat.

A survey of what habitat types fish preferred at Siletz Reef—another rocky reef home to many of the same fish species as are present at Redfish Rocks—showed the highest concentration of fish in crevices, followed by areas with large boulders and steep slopes with many rocky outcroppings.³³ Areas with smaller boulders and gravel had lower fish density. Sand, level bedrock and other areas with few hiding places had the fewest fish. Some species, such as lingcod and kelp greenling, were more tolerant of sandy and less varied

terrain. Juvenile rockfish were found to be highly sensitive to habitat type, strongly preferring large boulders and steep slopes.

The rocky habitat and associated marine life (like sponges and large anemones) so valuable to reef-based species can be easily damaged by fishing equipment. Bottom trawlers use chains and nets weighted down by heavy steel slabs that ensure the net remains in contact with the seafloor. As groundfish, such as rockfish, are scooped up into the net, the heavy equipment damages the seafloor habitat that it comes into contact with.³⁴ Trawling equipment may crush, flip over, or flatten rocks, rock piles and the habitat, destroying hiding places used by fish.³⁵ At the same time, other organisms that provide food for fish may be killed by the equipment or smothered by increased sediment levels.

Repeated use of bottom trawling equipment in a given area can reduce habitat complexity. This has the result of reducing

the diversity and number of animals that live in a reef.³⁶

The establishment of a marine reserve at Redfish Rocks should help to protect the reef habitat that is so important to the long-term health of species that rely on rocky terrain for shelter and the complex ecosystems that support them.

Cape Falcon

The area between Cape Falcon and Tillamook Head near the communities of Cannon Beach and Seaside is one of Oregon's great scenic treasures. The rigorous climb up Tillamook Head (which explorer William Clark called "the Steepest worst and highest mountain I ever assended") rewards visitors with breathtaking views of the Pacific Ocean and of the decommissioned Tillamook Rock lighthouse perched on a rocky outcropping a mile offshore.³⁷



Common murre. Credit: Paul and Judy Wilcox

In addition to being a well-known Oregon landmark, Tillamook Head also plays an important role in the ecology of the Oregon coast. Rocks along the shoreline serve as a haulout and pupping area for harbor seals, while the offshore Tillamook Rock and rocky areas just south of Tillamook Head are haulouts for California and Steller sea lions.³⁸

Tillamook Head, Tillamook Rock, and other rocky areas to the south, including Cape Falcon, also serve as nesting places for a wide variety of seabirds. At Tillamook Head, there are nine seabird colonies with an estimated population of 1,000 birds.³⁹ Among the seabirds that nest in the area are the common murre and Brandt's cormorants.

Oregon's coast is among the most important seabird nesting areas in the United States. Approximately 700,000 common murres nest along the Oregon coast—more than anywhere south of Alaska.⁴⁰ And more seabirds are estimated to nest along the Oregon coast than on the Washington and California coasts combined.⁴¹

The relative lack of human influence is one of the major reasons for the success of seabird colonies at Tillamook Head. While the peak of Tillamook Head and inland areas are well used by visitors, the rocky cliffs and shoreline are virtually inaccessible, and Tillamook Rock is among the more than 1,800 offshore rocks protected as part of the Oregon Islands National Wildlife Refuge, where human access is largely prohibited.⁴²

But while Tillamook Head and nearby nesting sites are relatively secluded, they are not free from human influence. Common murre colonies are easily disturbed by human activity of any kind. Studies of murre colonies in California documented that adult murres can be “flushed” from their nesting sites by low-flying aircraft, leaving eggs and chicks vulnerable to predators and the elements and threatening the reproductive success of the colony.⁴³

And the potential for human disturbance by small boat or on foot remains real.⁴⁴

To thrive, seabirds such as the common murre and Brandt's cormorant also need ready sources of food, such as the krill and juvenile fish consumed by infant murres.⁴⁵ In that regard, seabirds are challenged both by potential competition from fishermen and by shifting ocean circulation patterns consistent with predictions of global warming.

Nesting seabirds and much of the wildlife of coastal Oregon depend on an annual ocean circulation phenomenon, known as upwelling. Upwelling occurs when strong winds and sea currents, aided by seafloor topography, carry cold, nutrient-rich water into nearshore areas, feeding the growth of the phytoplankton that serve as the base of the coastal food chain. This high concentration of food at the surface ultimately draws a wide variety of birds. El Niño years, in which the upwelling may occur late, have been associated with large die-offs in seabird populations along the West Coast.⁴⁶ In recent years, however, shifting wind patterns have altered the timing of the upwelling and led to the development of oxygen-deprived “dead zones” off the Oregon coast. Scientists believe that these events were unprecedented in Oregon waters prior to 2002, but have occurred every year since.⁴⁷ In 2005, there was a massive die-off of common murres along the Oregon coast, a die-off linked to absence of food due to the lack of upwelling.⁴⁸

Scientists are still working to understand whether the changed ocean patterns that have disrupted life along the Oregon coast in the last several years are temporary or permanent. But with new challenges facing Oregon's nesting seabirds, it becomes imperative for the state to protect them from other threats.

Minimizing human disturbances has been demonstrated to have a large impact on the health of bird populations. The number of common murres nesting at

Tillamook Rock lighthouse, for example, increased dramatically between the mid-1970s and mid-1990s, a period in which restrictions on access to the island were progressively tightened.⁴⁹ (A similar phenomenon occurred with Steller sea lions in an area just south of Tillamook Head, where sea lions reestablished a long-abandoned haulout soon after a trail to the area was washed out, limiting human access.⁵⁰)

Reducing the threat of human interference at locations like Tillamook Head and Cape Falcon, and providing marine reserves that will allow for the regeneration of fish and bird species, can give Oregon additional tools to safeguard these important species.

Cascade Head

South of Cascade Head, Siletz Reef is a rocky, underwater reef that runs parallel to the coastline opposite Lincoln City. A portion of the reef—known variously as Nelscott Reef or Tackle Buster Reef—has become famous in recent years for its annual tow-in surfing contest, where surfers from around the world come to tackle the 20 to 40 foot waves breaking a half-mile offshore.

Underneath the waves, the same rocky features that provide world-renowned surfing also shelter a wide variety of fish,



View from Cascade Head. Credit: Sheryl Eldridge, Seal Rock, Oregon

including lingcod, kelp greenling and numerous species of rockfish.⁵¹ As mentioned in earlier case studies, rockfish are vulnerable to overfishing and other pressures. The fish are long-lived, making populations slow to recover from disturbances.

As early as the mid-1980s, fishers began to recognize that stocks of some rockfish species were becoming depleted. As fishing continued in the 1990s—despite increasingly strict limitations—stocks of some rockfish species became dangerously depleted. Stocks of yelloweye rockfish, for example, were estimated to have been reduced by two-thirds in the 1990s alone, leaving the species at just 13 percent of the levels estimated to have been present before fishing.⁵²

In 2000, the U.S. government declared a groundfish disaster along the West Coast.⁵³ And in 2002, the Pacific Marine Fishery Management Council declared nine species of groundfish to be “overfished,” resulting in additional limitations on fishing.⁵⁴ Currently, it is illegal for recreational fishers to keep any yelloweye rockfish and canary rockfish that they happen to catch.⁵⁵ The state of Oregon has also closed Stonewall Bank—a shallow area approximately 15 miles southwest of Newport—to all groundfishing in an effort to protect yelloweye rockfish.⁵⁶ Closures of groundfishing areas are necessary because yelloweye rockfish often die from decompression or temperature shock when brought to the surface. As a result, even accidental catches of yelloweye rockfish can damage the health of the species.

Recovery of Oregon’s yelloweye and canary rockfish stocks is a long-term endeavor. Scientists estimate that the yelloweye rockfish population will not recover until late this century.⁵⁷

That recovery will have to begin in rocky reef areas like Siletz Reef. Juvenile rockfish prefer shallow, broken-rock habitats like those available at Siletz Reef, before moving off into deeper water as they



Tidepools at Cape Perpetua. Credit: David Champion

age.⁵⁸ There is still much that scientists do not know about the path to recovery of Oregon's depleted fish stocks. Only a small portion of the Oregon coast has been mapped for the habitat it provides to fish, and only a small number of fish species have been fully assessed for the health of their species.

It is clear, however, that marine reserves and protected areas can play a key role in the recovery of rockfish and other fish species under stress. Studies of marine reserves in Washington state suggest that the density, size and reproductive success of certain species of groundfish are greater in marine reserves than in areas open to fishing.⁵⁹

Protection of areas such as Siletz Reef, as contemplated in House Bill 3013, can ensure that Oregon's rockfish species are able to survive and regenerate, while protecting other species for future generations to enjoy.

Cape Perpetua

It is difficult to fully comprehend the diversity of life that exists in Oregon's nearshore ocean waters. But any Oregonian who has ever explored tide pools at low tide has gotten a taste of it.

Oregon's rocky intertidal areas—the rocky shorelines that are periodically covered by the tides—teem with aquatic life, from sea stars to snails and from hermit crabs to barnacles. The colorful and strange collection of organisms present in tide pools attracts curious humans, but it also attracts a variety of hungry birds, including gulls and black oystercatchers. Harbor seals also use the tidally exposed rocks at some areas of the Oregon coast as haulouts and pupping locations. Nearby, the Sea Lion Caves serve as the primary winter nursery for Steller sea lions, which are listed as threatened under the Endangered Species Act.⁶⁰

While Oregon's coast abounds with interesting and important intertidal areas, Neptune State Park and Strawberry Hill, which follow a length of coastline south of Yachats and within the Cape Perpetua area being studied for protection, are among the state's crown jewels. The intertidal areas at Neptune State Park host a wealth of algae species as well as snails, anemones, whelks, limpets and mussels.⁶¹ Visitors to Strawberry Hill can watch the harbor seals on offshore rocks and, if they are fortunate, perhaps spy a whale in the distance.

The intertidal areas at Neptune State Park and Strawberry Hill already enjoy protection as a research reserve, used by scientists to explore and monitor intertidal habitat, but the current level of protection may not be enough to safeguard this special part of the Oregon coast. Removal of shellfish and marine invertebrates from the area is prohibited, but there are numerous exceptions. Individuals with a state permit can collect abalone, clams, Dungeness crabs, mussels, scallops and shrimp from the area.⁶² Recreational fishing and algae harvesting is also permitted.

The area's harbor seal population is also highly susceptible to disturbance by humans. The Cape Perpetua area is one of the best sites along the Oregon coast for viewing harbor seals, but because the rocks on which harbor seals haul out are accessible at low tide, it is possible for visitors to get close enough to disturb the animals. A 2006 report by the state of Oregon noted that "people regularly disturb the seals" at Strawberry Hill.⁶⁴

The health of Oregon's intertidal areas is integrally connected to the fate of the ocean itself. Researchers at Oregon State University have documented that a delay in the annual upwelling of cold, nutrient-rich waters along the Oregon coast during 2005 had large impacts on organisms living in intertidal zones and the species that depend on them for food. A two-month delay in the upwelling in 2005 led

to a similar delay in the reproduction of barnacles and mussels—with potentially significant impacts for the sea stars, crabs and shore birds that use these invertebrates for food.⁶⁵ Ominously, the changes in the timing and strength of the upwelling are consistent with the predictions of the scientific models used to forecast the impacts of global warming.⁶⁶

The upwelling at Cape Perpetua is important not only for aquatic animals in intertidal areas but also to birds. Several large underwater seamounts and ridges off the coast near Cape Perpetua help support strong upwelling in the area, attracting a diverse bird population. Species include scoters, harlequin ducks, Brandt's cormorants, and marbled murrelets.⁶⁶ The marbled murrelet, on the Endangered Species List, requires old growth forest for nesting habitat and access to fish in the nearshore area. The Cummins and Rock Creek wilderness areas within Siuslaw National Forest just onshore from the proposed Cape Perpetua reserve are important nesting areas for murrelets and thus maintaining healthy fish populations in the Cape Perpetua area is important.

Scientific research has shown that the mix of species in intertidal areas is shaped by a variety of forces that vary from place to place along the shoreline, including water temperature, wave force, competition among species and even large-scale ocean processes.⁶⁷ The quality of the surrounding on-shore area has an impact, also. In other words, every intertidal area is unique, and extraordinary areas such as those near Cape Perpetua must be preserved.

The current level of protection as a research reserve has already allowed researchers to make important discoveries about the importance of intertidal areas and the broader workings of Oregon's nearshore ecosystems. Further protection for these areas—both establishing a marine reserve and ensuring sufficient protection

for the adjacent Siuslaw National Forest—can ensure that they continue to thrive in decades to come and continue to offer an opportunity to study intertidal areas and pelagic seabirds in the context of marine reserves.

Cape Arago – Seven Devils

Simpson Reef, a chain of offshore rocks and a submerged reef just off Cape Arago, is a symbol of both the successes and challenges of efforts to protect sensitive coastal nearshore ecosystems. The reef's large kelp forest—which includes Oregon's largest bed of giant kelp, along with bull kelp—sustains a rich and productive marine ecosystem.⁶⁸ The area is also the largest marine mammal haulout on the Oregon coast.

The reef is a haulout area for four types of pinnipeds—or flipper-footed mammals—including California and Steller sea lions, and harbor and elephant seals.⁶⁹ Shell Island at Simpson Reef is the northernmost pupping site for elephant seals in the world.⁷⁰

The sight of large numbers of northern elephant seals—the second-largest seal species in the world and easily recognizable by their trunk-like noses—off the Oregon coast would have been unthinkable as recently as 100 years ago and impossible as recently as 30 years ago. By the early part of the 20th century, northern elephant seals were presumed to be extinct as a result of hunting, with only about 100 left off the coast of Mexico.⁷¹ Elephant seals returned to the Cape Arago area in the 1980s and began having pups at Shell Island in the 1990s.⁷² Simpson Reef is the only place in Oregon where elephant seals haul out regularly—many of them younger seals who come to the area to go through the difficult process of molting.⁷³

Northern elephant seals have nearly

fully recovered from their near extinction, now numbering more than 150,000 animals.⁷⁴ Some scientists suggest that the onset of elephant seal pupping at Cape Arago, which is north of the seal's traditional pupping sites in California and Mexico, may be a signal of adaptation to climate change.⁷⁵ But regardless of the future challenges facing the species, the recovery of the elephant seal and other marine mammals of the Pacific coast is one of the true conservation success stories of the last century.

Below the water's surface, however, another rare species tells a less-inspiring story of conservation efforts off Oregon's coast. To be sure, the flat abalone is not nearly as charismatic and fun to watch as the elephant seal. A resident of the ocean floor in shallow, subtidal areas, the flat abalone has a brownish, one-piece shell. One of several types of abalone that live off the Oregon coast, the flat abalone is relatively rare, common only in southern Oregon.⁷⁶

Oregon is also the only place in the United States and Canada where flat abalone can be commercially harvested.⁷⁷ In 1993, Oregon created the developmental fishery program, which was designed to both encourage and regulate the development of new fisheries in the state. In 2001, a commercial diver received a permit to



Flat abalone. Credit: Brian Tissot, Washington State University

take flat abalone under the developmental fishery program, and has continued to harvest flat abalone in the years since. About 9 percent of the flat abalone harvested from Oregon waters between 2001 and 2006 came from Simpson Reef, with most of the remainder coming from Rogue Reef, Nellies Cove and Orford Reef.⁷⁸

The continuation of Oregon's commercial flat abalone fishery, even at low levels, has set off alarm bells among scientists. Every previous wild abalone fishery in the United States has had to be shut down due to concerns about survival of the relevant species. The fate of the white abalone is a cautionary example. Once relatively abundant along the California coast, overfishing and other threats have reduced the density of white abalone populations by 99 percent since the 1970s.⁷⁹ Because all abalone reproduce by spewing eggs and sperm into the surrounding waters, reduced density can make it difficult or impossible for abalone to reproduce. Indeed, white abalone is currently listed as an endangered species and without successful human intervention, white abalone could disappear from the California coast as soon as 2010.⁸⁰ A similar downturn in population has led to a proposal to list the black abalone as an endangered species as well.⁸¹

The flat abalone is particularly vulnerable because of the species' virtual disappearance from the southern end of its range in California. Flat abalone have decreased dramatically in central and northern California since the 1970s, possibly in part due to die-offs resulting from El Niño events in the 1990s.⁸² As a result, the fate of the entire species may ride on the success of the flat abalone population of southern Oregon.

The tale of the abalone shows the dangers of a policy that allows exploitation of marine resources before they are fully understood. It also shows the potential weakness of a species-by-species approach to marine conservation and the promise of

marine reserves in restoring and replenishing marine species. Research conducted in California found that juvenile red abalone and flat abalone were more frequently found in marine reserves with red sea urchins present.⁸³ Red sea urchins provide protection for juvenile abalone, suggesting that a management strategy for an area that allows red sea urchin harvesting could have an indirect effect on the health of abalone populations.

Simpson Reef and other rocky nearshore sites in the Cape Arago area are important both for what happens at the surface and for what happens beneath the waves. Comprehensive protection as a marine reserve for these areas can help protect both the marine mammals that draw awed spectators and the humbler species that are so important to the health of Oregon's coastal ecosystems.

Three Arch Rocks

Three Arch Rocks, off the coast of Ocean-side, is one of Oregon's most recognizable coastal landmarks. It also has an important place in the history of wilderness preservation in the United States. In 1907, responding to threats by hunters to the survival of marine mammals and seabird colonies on the rocks, President Theodore Roosevelt declared the area a national wildlife refuge—the first one west of the Mississippi River.⁸⁴

Today, Three Arch Rocks still has the capacity to awe observers. The striking formation of arched offshore rocks is the only pupping site for Steller sea lions on the northern Oregon coast, and hosts nearly a quarter million nesting seabirds.⁸⁵ Three Arch Rocks is home to the largest and most diverse seabird colony on the Oregon coast, hosting every species of Oregon seabird except the marbled murrelet.⁸⁶ Offshore and underwater, a large rocky reef extending to



Tufted puffin. Credit: Paul and Judy Wilcox

the west of the rocks provides valuable and rare habitat for many fish species.

Tufted puffins may be the most instantly recognizable birds at Three Arch Rocks, known for their black and white plumage with golden tufts on either side of the head, their thick red bills, and by the way they carry their prey crosswise in their bills to feed their young. Tufted puffins nest at several sites along the Oregon coast, but the colony at Three Arch Rocks is the largest colony in the state.⁸⁷ Tufted puffins return to their colonies each spring after having spent the winter in ocean waters far offshore. Once back on the rocks, the puffins prepare burrows, mate, and lay and hatch their eggs.

Offshore rocks like Three Arch Rocks are ideal homes for tufted puffins. The remoteness of the rocks protects puffins and their eggs from land-based predators such as foxes and reduces potential for disturbance by humans and other mammals. The high, sheer slope of the rocks also gives

puffins, which have short wings, a “launching pad” to help them take flight.

Visitors can view puffins and other seabirds from viewing areas on the mainland at Cape Meares, itself a protected National Wildlife Refuge. Visitors can also venture closer to the rocks by boat, although boats are prohibited within 500 feet of the rocks during summertime.

But visitors have seen fewer and fewer tufted puffins at Three Arch Rocks in recent years. The population of tufted puffins on the rocks has plummeted over the last several decades. Between 1979 and 1988, the population of tufted puffins at Three Arch Rocks declined from more than 4,000 to just over 3,000.⁸⁸ The population has continued to decline since then, although hard numbers are difficult to come by. The number of tufted puffins at Three Arch Rocks has declined to 500, or possibly even fewer.⁸⁹

The reason for the decline of the tufted puffin colony at Three Arch Rocks is not

known. Climate change may be having an impact, just as it has on other species along the Oregon coast. A study conducted in British Columbia suggests that warmer sea surface temperatures make it harder for young puffins to grow and survive, possibly because the fish species used as prey by the puffins prefer colder waters.⁹⁰ In addition, Oregon is already near the southern end of the tufted puffin's range, possibly making it more susceptible to the impacts of global warming. While tufted puffin populations in Oregon have declined, the species remains abundant in Alaska and British Columbia.

An ominous sign of the challenges facing tufted puffins came during the winter of 2007, when an estimated 200 seabirds, including tufted puffins, washed up dead on Oregon shores, apparent victims of starvation.⁹¹ Scientists do not know exactly what caused the phenomenon, which included the beaching of several birds rarely

seen in Oregon, but it was reported to be the worst die-off of puffins in 20 years.⁹²

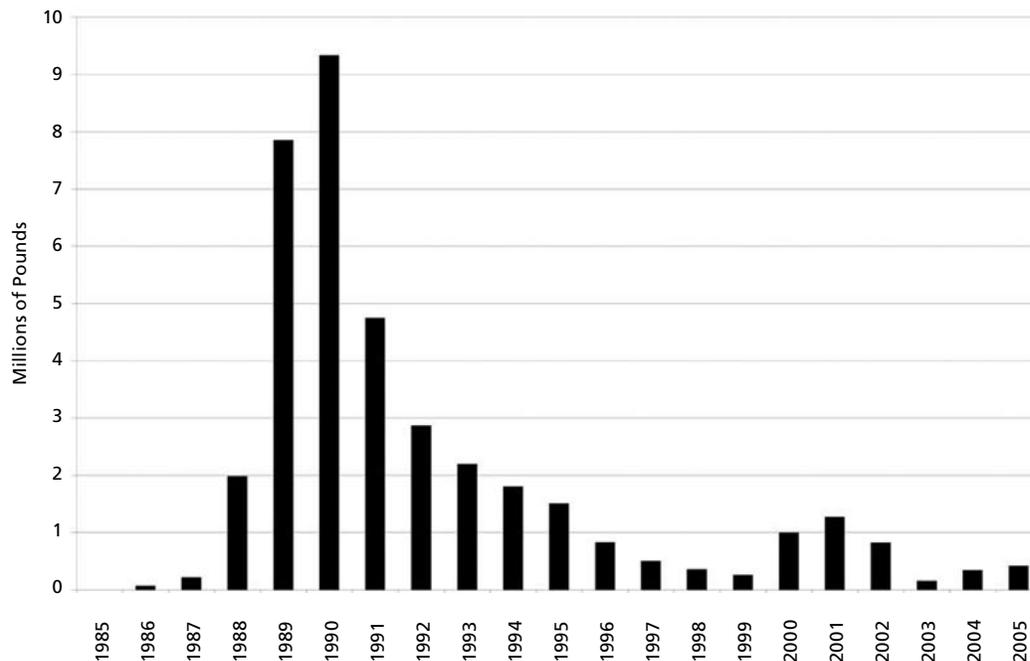
Human activities can also disturb tufted puffins and prevent them from breeding. A single disturbance can cause puffins to abandon their nests, leaving eggs or chicks vulnerable to predators and the elements. The sensitivity of tufted puffins to disturbance has even hindered scientists' ability to study the species.⁹³ While boats are prohibited from coming within 500 feet of the rocks during the summer, and climbing on the rocks is prohibited year-round, the potential for human disturbance—whether from low-flying aircraft, boats, jet-skis or fishing—remains.

Tufted puffins also depend on ample supplies of forage fish near their colonies in order to sustain their chicks. In California, a decline in the abundance of forage fish is thought to be one cause of declining tufted puffin populations in the Farallon Islands.⁹⁴ Therefore, efforts to protect and regener-



Red urchin. Credit: David Biddle

Figure 1. Red Sea Urchin Harvest, 1985-2005¹⁰⁵



ate Oregon fisheries through establishment of fully protective marine reserves can help aid the survival of seabirds such as tufted puffins.

For more than a century, Three Arch Rocks and the surrounding waters have delighted Oregonians with their natural splendor and provided important habitat for nesting seabirds and other marine animals. The tufted puffin is part of what makes Three Arch Rocks special, and Oregon should take steps to ensure that it, and all other species that use the rocks, can survive for future Oregonians to enjoy.

Orford Reef

Orford Reef, a collection of eight large rocks and many small ones approximately three miles southwest of Cape Blanco, is a focal point of Oregon's rich marine

ecosystem. The rocks themselves are the second-largest pupping site for the threatened Steller sea lion south of Alaska. About 1,000 sea lions, a quarter of Oregon's total population, use Orford Reef.⁹⁵ The reef supports a nesting population of more than 39,000 seabirds as well as 5 percent of the state's population of common murre.⁹⁶ Below water level, the reef teems with a rich variety of aquatic life, including rockfish and various species of invertebrates.⁹⁷

The reef's extraordinary diversity of life is rooted in its vast forest of bull kelp. Orford Reef's bull kelp forest is the most extensive in its section of the Oregon coast—stretching for more than 1,600 acres in peak years.⁹⁸ The size of the bull kelp forest at Orford Reef varies dramatically from year to year—during one four-year period in the 1990s, the extent of the forest varied by a factor of 10.⁹⁹

Red sea urchins are among the many species that depend on the bull kelp forest,

consuming the kelp as food. Red sea urchins are believed to be among the most long-lived creatures on earth, with life-spans that can stretch for 100 years or more, and possibly as much as 200 years.¹⁰⁰ It is possible that some of the red sea urchins living in Oregon's coastal waters could have been present when Lewis and Clark first arrived at the Pacific coast in 1805.

Yet, red sea urchins face their own set of threats. Red sea urchin roe is consumed as sushi in Japan and elsewhere, and divers in other West Coast states have harvested sea urchins since the early 1970s.¹⁰¹ When Oregon initiated its commercial red sea urchin fishery in the mid-1980s, the state took steps intended to prevent overharvesting—issuing a limited number of permits, imposing minimum size limits, and limiting where urchins could be harvested.¹⁰² The fishing industry took additional steps to limit urchin harvesting, with the goal of preserving an economically sustainable fishery over the long haul.

Despite these efforts, however, Oregon's red sea urchin fishery quickly became depleted. After peaking at 9.3 million pounds in 1994, commercial harvesting of red sea urchins plummeted to only 494,000 pounds in 2005.¹⁰³ (See Figure 1.) Orford

Reef experienced the greatest removals of red sea urchins from Oregon waters between the mid-1980s and the mid-1990s, with more than 15 million pounds of red sea urchins removed from the area between 1986 and 1996—nearly half of the entire state harvest over that time period.¹⁰⁴ Researchers also raised concerns that sea urchin harvesting was having a negative impact on the reproductive activities of Steller sea lions, prompting the fishing industry to adopt voluntary closures of some areas of the reef and other measures to protect sea lions.

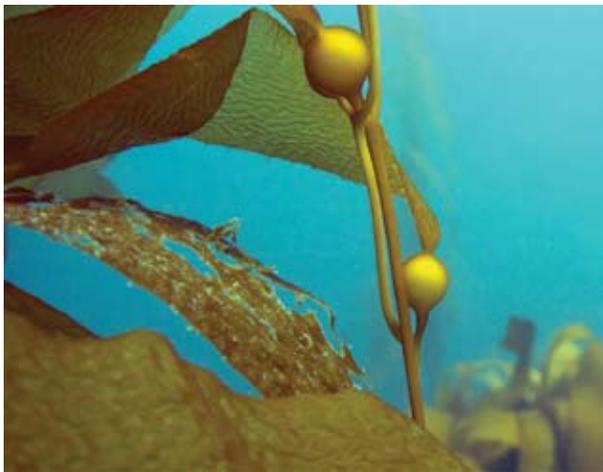
The saga of the red sea urchin—in which a vulnerable resource was overexploited before it was ever fully understood (and despite the well-intentioned efforts of government officials and voluntary steps from industry)—is a powerful cautionary tale arguing for protection of Orford Reef as a marine reserve. By minimizing human impacts on the reef's vibrant and diverse ecosystem, Oregon can ensure that it remains vital for enjoyment by future generations.

Mack Reef

Near Pistol River State Park, the Mack Reef complex stretches from Cape Sebastian to Whaleshead Island and is home to a diverse array of the marine species that thrive in Oregon.

A 300-acre bull kelp forest—or 7.5 percent of all bull kelp forest along the Oregon coast—provides testament to Mack Reef's value as a subtidal habitat.¹⁰⁶ As discussed in earlier case studies, bull kelp provides food and shelter for invertebrates and fish.¹⁰⁷

The Mack Reef complex is a major nesting area for seabirds. The area is the second-largest seabird colony in the state.¹⁰⁸ More than 200,000 birds of 11 species nest at the rocks near Mack Reef. Species include the threatened peregrine falcon



Kelp. Credit: Ignati Grigentch, <http://www.flickr.com/photos/ignati/3607140032/in/photostream/>

and brown pelican, as well as 43 percent of the Leach's Storm-Petrels that mate in Oregon.¹⁰⁹

Mack Reef would be the southernmost location in the state's network of marine reserves and protected areas. Establishing a reserve at Mack Reef would ensure that the state has an ecologically significant system of reserves and protected areas along the full length of the Oregon coast, a measure that provides several important benefits. Marine reserves provide shelter allowing fish, birds and aquatic plants to grow undisturbed. As those populations strengthen, they outgrow the reserve and

repopulate surrounding areas. Spacing out the reserves delivers this repopulation benefit to more areas.

By creating reserves off the northern, central and southern coast, Oregon can make the reserve network more resilient. A single disaster—whether an oil spill or a severe storm—might damage one reserve, but will have a less severe impact on the others, provided the reserves are far enough apart. Protecting the habitat and nesting areas around Mack Reef will be a key component of Oregon's network of marine reserves and protected areas.

Conclusion

Oregon's coastal waters are home to an astounding diversity of fish, invertebrates, birds, sea mammals, aquatic plants and ecosystems. These resources are threatened by a variety of activities, including over-exploitation, habitat damage, pollution, offshore development, and broad changes in the ocean that may be early indications of global warming.

Scientists do not fully understand how Oregon's marine ecosystems will respond to growing resource demands and coming challenges. Establishing marine reserves and protected areas will help protect Oregon's important offshore ecosystems in their entirety, allowing them to recover and protecting them from future threats and for future generations.

Oregon should establish an ecologically significant network of marine reserves that will protect fish, invertebrate and aquatic plant populations and the overall health of our marine ecosystem. The reserves should be large enough to protect the greatest diversity of Oregon's nearshore ocean species and habitat types distributed along the full Oregon coast.¹¹⁰ Adequate long-term funding for study of the reserves' benefits and enforcement of their boundaries will

help to ensure the greatest benefit.

The state has taken the first step toward creating this system of reserves and protected areas by establishing two marine reserve pilot projects at Otter Rocks and Redfish Rocks, as well as supporting work that could create additional reserves at Cape Falcon, Cascade Head, Cape Perpetua, and Cape Arago – Seven Devils. Oregon should establish marine reserves at these four locations currently under study, as well as reserves and protected areas for the other locations discussed in this report.

Establishing marine reserves alone will not be enough to protect Oregon's ocean waters. Other necessary protections include:

- Stronger policies to prevent unsustainable harvests of fish populations. In anticipation of the potential impacts of global warming, the state may need to reconsider what levels of harvest are sustainable so as to maintain fish populations that are able to rebound from stressful climate events.
- A precautionary approach in situations of uncertainty, such as when researchers

lack full information about the health of a fish population. An initial decision to err on the side of protecting a species or habitat will reduce the risk of irreversible damage. The level of protection can be modified after scientists have better data.

- Continued resources to monitor and enforce existing laws that protect marine resources.
- Adequate protection for the watersheds and onshore areas that affect marine reserves, as established in Oregon's statewide land planning goals, and protection of federal waters beyond Oregon's Territorial Sea.¹¹¹
- Public education efforts about

the importance of leaving some ecosystems undisturbed and about the amazing underwater creatures that live off Oregon's coast.

- Policies and leadership to fight global warming by reducing pollution. Oregon has already adopted a number of meaningful policies to reduce its global warming pollution, but action at the federal and international level is needed. Oregon should strive to articulate the impacts of warming on ocean resources to encourage stronger action by other states and countries.

Only a comprehensive set of ocean protections will enable future generations of Oregonians to enjoy the state's marine treasures.

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