PART THREE:
Rocky Shores Management Strategy

E. THE CONTEXT FOR MANAGEMENT

1. Setting

a. Ocean Currents

Oregon's coastal ocean waters are but a small thin ribbon at the eastern edge of the vast Pacific Ocean. But it is at the edges of such environments where life is the most productive, the most used, and the most vulnerable to disruption from human activities. This edge is a transition zone between the land and sea. It is also situated in a transition zone between colder subarctic waters of the Gulf of Alaska and subtropical waters to the south off California.

The complex mix of ocean currents and other phenomena in the territorial sea is part of what scientists refer as "boundary conditions." These conditions result from eastward-flowing ocean currents encountering the landmass of North America. Ocean currents are then forced to flow north or south, parallel to the coastline, over the relatively shallow waters of the continental margin where local topography such as capes and submerged banks, cause local complexities in the great moving water mass. These local, more detailed oceanographic conditions along the Oregon coast are not fully understood. In fact, with the advent of broad scale satellite-derived imagery of surface currents and the ability of extremely powerful computers to synthesize and visualize vast quantities of ocean data, scientists are just beginning to realize how little is known.

The broad outlines of ocean dynamics off Oregon, however, are known. Generally, the movement of ocean water over Oregon's continental margin is the broad, slow, southward flow of the California Current. This current is 500 to 1,000 miles wide and flows 2.5 to 5 miles per day, although strong northwest winds can reinforce the flow and double the speed. A narrow, relatively fast undercurrent, the Davidson Current, flows northward below 600 feet. In winter, southwesterly storms can reinforce the Davidson Current so that it flows 6 to 12 miles per day northward at all depths across the continental margin and pushes the California Current farther offshore.

Two other phenomena greatly affect ocean waters off Oregon. One is the freshwater discharge of the Columbia River, which pours vast amounts of fresh water onto the more dense, salty ocean water and creates a surface lens of lower salinity water traceable as a plume spreading west and south from the river's mouth as far south as Cape Mendocino. The river's water carries dissolved minerals and other nutrients from the watershed and acts as fertilizer at a time when daylight hours are greatest and ocean productivity highest. The boundary between the Columbia River Plume and surrounding ocean generates productive conditions that attract many species of fish, seabirds, and marine mammals.

The other major phenomenon is known as "upwelling." During the summer, when strong northwest winds blow, surface waters near the coast are actually driven west, away from shore. This offshore movement causes deep, cold, nutrient-rich waters to rise to the surface. Although the most active upwelling is restricted to a narrow band approximately 6 to 15 miles from shore, the upwelling has a great influence over currents across the entire continental shelf, including those within Oregon's territorial sea. Upwelling tends to be strongest south of Cape Blanco.

There are several aspects of ocean circulation and transport conditions near shore that are not well understood. One is the exchange of near coastal ocean waters with estuaries and how estuaries contribute to the productivity of ocean habitats, including rocky shores. Another is how local topographic features, such as Cape Blanco or Heceta Bank, affect ocean flow and subsequent movement of pollutants or dispersal of eggs and larvae of marine creatures.

The complex, dynamic marine environment that flows past Oregon's coast and supports the resources and uses of Oregon's rocky shores is understood only in the broadest terms. Extensive additional research is needed to better understand this environment and provide appropriate management of rocky-shore resources.

b. Geology

Oregon's rocky shores are artifacts of dynamic geologic processes; for thousands of years the Pacific Ocean has worked against the rocks of the land, exploiting variations of hardness and orientation in the rocks, seeking out the zones of weakness caused by fractures and faults, eroding deeper into the coastal mountains. In some places the ocean has eroded entirely around a particularly resistant rock formation, leaving it exposed on all sides to the waves, vulnerable to the inevitable reduction to rubble.

On the north coast, the steep cliffs of Cape Lookout, Yaquina Head, Seal Rocks and other headlands are composed mostly of dense basalt, a volcanic rock resistant to the relentless energy of the ocean. Likewise, the offshore rocks of Haystack Rock (both at Cannon Beach and Pacific City), Gull Rock at Arch Cape, and Otter Rock are remnants of basalt headlands that long ago succumbed to the sea.

South of Coos Bay, the coastal geology changes: the complex of cliffs, reefs, and rocks of Cape Arago are tilted layers of sedimentary rocks, once formed on the floor of the continental shelf, now uplifted and tilted at a resistant angle to the sea. South of the Coquille River headlands and rocks are primarily remnants of truly ancient metamorphic rocks, which have anchored this region against the sea for more than 200 million years. The resistance of this entire region is revealed in Oregon's coastal map profile, which shows a seaward bulge along the south coast culminating in the tip of Cape Blanco, Oregon's westernmost point.

Other geologic events have punctuated this endless erosive process and created additional opportunities for the sea; the rise of sea level after Earth's most recent ice age accelerated erosion against the land and drowned remnant rocks and islands before they could be completely worn away; repeated episodes of gradual uplift and sudden down-drop of Oregon's coastline have varied the rate of erosion and submergence of coastal rocks. Rogue, Orford, and Blanco reefs are the largest of these drowned remnant rocky landscapes covering thousands of acres with only the tips of rocky spires now visible above water.

Because of this variety of geologic origins and processes, Oregon's rocky shores are mixtures of kinds, types and conditions. While there are some similarities among sites, each is unique. Many sites have a mixture of cliff face, rocky wave-cut platform and submerged and exposed rocks in or just beyond the surf. In some cases, a good low tide will enable foot access to rocks which are otherwise islands at high tide. In other cases, reefs, rocks, and islands are well beyond the surf and remain accessible only by boat or aircraft.

c. Marine Biology

Oregon's rocky shores provide many distinct habitats for plants and animals. These habitat opportunities arise from various factors such as substrate (the kind and shape of rock to which they are attached), exposure to wave energy and flowing ocean currents, height above or below various stages of the tide, freshwater inflow, proximity to an estuary, sunlight, and others. Once certain plants or animals become established, such as kelp or mussels, additional habitat opportunities are created and add to the complexity and productivity of marine life. The upper limit of distribution of these organisms is determined by physical factors such as temperature and duration of exposure to air, while lower limits are commonly determined by biological factors such as predation or competition for food, or overgrowth.

Some plants and animals are uniquely adapted to both sea and land as they are exposed to the air when sea level recedes at low tide; others live completely submerged, adapted to living at certain depths below the sea surface. Seabirds and marine mammals take advantage of rocky shores, attracted by isolated nesting or pupping sites and food in the surrounding waters. No community of plants or animals lives in isolation; all are interrelated in ways not yet fully understood.

Plants and animals that are covered by the ocean's waters for at least part of the tidal cycle and exposed to air during other times are referred to as "intertidal" and live on "submersible" land. Those plants and animals covered by ocean water during all stages of the tide are "subtidal" and live on (or above) "submerged" land.

Areas uncovered by the falling tide reveal plants and animals with remarkable adaptations and abilities to stay put in the pounding surf. Some plants and animals have adapted to various lengths of exposure to air; some can thrive in saltwater spray and splash a dozen or more feet above the low water line. Distinctive communities of plants and animals live in zones at different levels in relation to water depth . Mussels, barnacles, and limpets, all hard-shelled and capable of closing tightly, can survive relatively long periods of time out of the water in the high-tide zone. More delicate organisms --such as anemones; nudibranchs; sponges; and red, green, or brown algae-- cannot withstand drying or pounding and thus spend little or no time out of the water in the lower tide zone. Some creatures, such as seastars, range about the bottom in search of prey, but limit their vertical forays to avoid drying out.

Below the lowest of low tides the water provides a continuous but energetic environment. This subtidal zone, like the intertidal, has vertical differences in habitat and communities as it grades downward away from surface-wave energy toward the limits of light penetration. This zone extends down to a depth of about 150 meters on some submerged reefs in the territorial sea. One marine plant, the bull kelp, grows across much of this subtidal zone out to a depth of sixty to eighty feet, with its holdfast anchored to the rocky bottom and its long stalk extending upward to the fronds floating at the sunlit surface.

Rock cliffs on coastal headlands and offshore rocks and islands provide a variety of habitat possibilities for seabirds and marine mammals. Oregon's coast is rich in these rocky habitats, and thirteen species of seabirds take advantage of the vertical or isolated nature of these features to nest here. Some, such as the common murre, lay eggs on bare rock, while others, such as the storm petrel, burrow deep into the soil to escape predators. In addition, the lower ledges of many rocks and islands provide resting or pupping sites for marine mammals. A few sites have both significant bird and mammal populations. For both birds and mammals, these rocks and islands offer some measure of isolation and protection from humans and are launch sites for foraging in the surrounding ocean.

d. People and the Rocky Shores

Rocky shores have attracted people for a variety of reasons since the Oregon country was first reached by Indian people thousands of years ago. Excavation and analysis of camp and village sites commonly show ages of 6,000 to 7,000 years ago; some experts believe Indian people came to the Oregon coast 15,000 years ago. These original Oregonians found that rocky shores, like the mudflats of estuaries, were easily reached sites where food could be predictably and readily be gathered. The jumble of rocks washed by the surf provided a rich source of fish that could be speared or trapped among the rocks. Mounds of debris from hundreds or thousands of years of food gathering, called middens, provide a glimpse of the rich source of food provided by the ocean shore; broken and burnt shells of clams, crabs, chitons, limpets, mussels and other invertebrates, bones of ling cod, surf perch, sculpins and other fish, bones from sea lions, seals, and sea birds.

In contemporary times, rocky shores continue to be very attractive to people but for different reasons: tidepools provide a window into the sea for a glimpse of exotic marine life; submerged reefs attract divers and fishermen for recreation and food gathering; offshore rocks are picturesque silhouettes in the sunset and points of interest for aircraft pilots who fly along the coast.

Oregon's rocky shores are quite accessible, at least visually, along the entire coast and many areas may be easily reached by car and then on foot, because US 101, the Oregon Coast Highway, parallels the shore for much of its length. Other sites, especially offshore rocks and reefs and outer cliffs of headlands, can be reached by boat from coastal ports and, of course, by aircraft. Oregon's State Parks provide public access to most of the major rocky intertidal areas; visitor numbers in coastal parks fluctuate with the national economy and fuel prices but have generally increased in recent years. Schools use intertidal areas as outdoor laboratories and groups of several hundred students during a single low tide cycle are common at some sites. An increasing number of ethnic groups find traditional foods in rocky shore plants and animals, particularly on the north coast within a day's drive of the Willamette Valley.

Uses of Oregon's rocky shore areas are heavily influenced by population growth well beyond coastal communities; it is estimated that over one million people who live in the Willamette Valley from Portland to Eugene are within a ninety-minute drive of the coast. Out-of-state visitors also have easy access to the coast and can readily combine visits to coastal rocky shore areas with trips to Cascade Mountain or Columbia Gorge sites. Sites between Yaquina Head near Newport and Ecola State Park near Cannon Beach are especially accessible from the state's major population centers. For instance, the rocks at Three Arch Rocks National Wildlife Refuge near Tillamook are a popular destination for fishermen, divers, and boaters. In this respect Oregon's rocky shores are part of the urban recreational landscape.

Studies at Yaquina Head, Haystack Rock, Cape Arago, and other sites reveal that significant damage is occurring in some rocky intertidal sites simply from human foot traffic. A study at Three Arch Rocks and evidence from other sites shows that the habitat values of some offshore rocks are being adversely affected by disturbance from boat and aircraft traffic. These and other human impacts are some of the issues Oregon seeks to address through this Territorial Sea Plan.

2. An Ecosystem Approach to Management

Oregon's Rocky Shores Strategy is distinguished by its emphasis on managing and protecting marine ecosystems. This approach is different from past management programs that have been oriented toward particular sites, certain resources, or a limited set of uses based on a case-by-case basis. Ecosystem management, on the other hand, attempts to work within an understanding of the complex and interrelated natural environment, how resources and areas change over time, and how certain uses of sites or resources may effect others at a distance or over time.

a. Introduction

The Rocky Shores Management Goal of this Territorial Sea Plan,

"To protect the ecological values and coastal biodiversity within and among Oregon's rocky shores while allowing appropriate use,"

is, in effect, an ecosystem management goal. For Oregon to successfully meet this goal, resource managers and the public must understand and apply the principles of ecosystem management. The purpose of this section is to explain some basic concepts of "ecosystem management" in the context of the Rocky Shores Strategy.

b. What Ecosystem Management Seeks to Do

Ecosystem management is the application of land and water management practices that support the goal of maintaining long-term ecosystem viability and sustainability. Conservation of biodiversity is central to the notion of sustaining ecosystems.

Ecosystem management relies on stewardship of ecosystem components, their processes and interactions, and their intrinsic values. This stewardship is often difficult to translate into practical on-the-ground management actions in the traditional sense. Like the ecosystems they attempt to conserve, ecosystem-management programs can be complex, variable, and interconnected.

Ecosystem management entails long-term goals that provide a vision for the landscape and its habitats. Achieving these ecosystem goals will require an understanding of the underlying structure, composition, and functions of ecosystems, as well as how they develop over time. This will require collecting new information and rethinking traditional ways of analyzing and presenting scientific data; a detailed understanding will require decades of work. However, there are steps that Oregon can take, in fact is taking, to begin the transition to an ecosystem management approach for its rocky-shore habitats. In the coming years Oregon can then work to refine and adapt its management in response to improved information and to new management needs.

c. Toward a Program of Ecosystem Management

Oregon's Rocky Shore goal "to protect ecological values and coastal biodiversity within and among Oregon's rocky shore areas while allowing appropriate use" provides the basis for all other management actions and creates the long-term ideal toward which the state will work. This clear expression of a desired future condition of the landscape and associated ecosystems is a prerequisite for building a management program. Five basic elements should be incorporated into Rocky Shores planning and management programs as initial steps toward meeting this overall goal. These five elements are:

1. Represent all native ecosystem types and stages across their natural range of variation.

2. Maintain viable populations of all native species in natural patterns of abundance and distribution.

3. Maintain ecological and evolutionary processes, such as disturbance regimes and biotic interactions.

4. Respond to short-term and long-term environmental change and maintain the evolutionary potential of lineages.

5. Accommodate human use and interaction with the environment.

Each of these elements, discussed below, has implications for studying, understanding, and managing Oregon's rocky shores.

d. Elements of Ecosystem Management

1.) Represent Ecosystem Types

Management programs must conserve ecosystems along their full range of variation instead of simply conserving the "best" examples of ecosystem types as in much contemporary land management. All native ecosystem types must be represented in the management program in order to maintain the full spectrum of biodiversity. However, incorporating these representative areas into a management program does not mean that they will automatically be off limits to outside uses; rather, a variety of management techniques tailored to the unique ecosystem type will be needed to maintain ecosystem functions and attributes.

Achieving this representation requires that all ecosystem types be defined and mapped. This, in turn, requires an inventory and mapping system that is consistent across a broad region and accounts for differences in the scale of resolution at which ecosystems can be considered. Oregon's entire rocky shoreline has been inventoried at a series of scales from large to small. This area-wide, multi-level approach provides an overarching framework for achieving this first step toward making sure that ecosystem types are represented. The Rocky Shores Classification System and the Rocky Shores Inventory provide Oregon with the ability to identify and represent all habitat types along the Oregon shoreline and territorial sea.

Ecosystems exist at many scales of reference. For example, an entire forest is a large complex ecosystem while a single decaying log within the forest harbors its own miniature ecosystem. The scale of reference selected for management influences how ecosystems are represented in management programs. Thus, even though site inventories can identify many representative samples of ecosystem types, these samples may not constitute the ecosystem itself. Rather, they are symbols of the represented ecosystem types.

As the natural-resource information base is increased and refined, so too will be the understanding of ecosystem representation and the need to adjust management programs to more nearly fit management needs.

2.) Maintain Species Populations

Maintaining healthy populations of various species is central to the conserving of biodiversity. Simply managing a series of areas to represent ecosystems will not necessarily ensure that all species will survive and be successful in those areas. A second objective of maintaining viable species populations must complement the first objective of including representative ecosystem types.

The job of maintaining healthy, viable populations is complex and uncertain. There are thousands of species to consider in Oregon's coastal area. In order to work with an optimal array of information, the state should initially direct management programs toward the most vulnerable species. Vulnerable species include those subject to human-impact pressure, species with small populations or patchy distribution, species with low reproductive rates or poor dispersal mechanisms, and threatened or endangered species.

The rocky shores inventory provides a means of systematically identifying the key habitat locations and requirements of species that are vulnerable to effects of human activity. This mapping in relation to human activity provides an additional consideration for defining and addressing vulnerability. For instance, seabirds are particularly vulnerable because they nest in dense colonies on individual rocks. Similarly, marine mammals concentrate in large numbers on convenient rocks or beaches during pupping, rearing, and migration. In both instances, a single catastrophic event, such as an oil spill or chronic disturbances from boat or aircraft traffic, can effect large numbers of animals during a critical part of their reproductive cycle.

3.) Maintain Ecological Processes

Ecosystem management must also consider ecological processes that have resulted, over time, from the interactions of the various species of plants and animals and their habitat conditions. This process component has several complex, interrelated aspects. For rocky intertidal sites, for instance, these ecosystem processes include:

- natural disturbance and recovery

- invertebrate and algal dispersal and recruitment

- space competition and utilization

- predator-prey interactions

- physiological and other adaptations

All of these processes have implications for site management. Two of these--- natural (vs human) disturbance and predator-prey interactions---are discussed below.

Natural disturbance and recovery is an important process shaping most ecosystems. Evidence of this continual process is the "patchiness" of many ecosystems from the forest to the shore. Nowhere is this dynamic process more evident than in rocky intertidal areas where crashing waves, coupled with scouring sand and surging water, remove or destroy organisms and alter sections of established communities and allow new organisms to take their place. Once an area is disturbed--mussels torn away, seaweed ripped loose, etc.--the recovery process can take several different pathways depending on the nature and composition of the original community and the level of disturbance. Each patch is a community of organisms at a distinct stage of development. Together, these patches form a rich mosaic of species and related communities, one of the reasons that rocky intertidal environments support such a high species diversity.

Ecosystem management must account for the effects of time and the frequency of natural disturbances over time at a particular location. Some disturbances happen hourly or daily or with the lunar cycle. Others are less predictable and may happen every decade or only once in a thousand years. For example, small-scale disturbances of rocky intertidal areas occur very frequently, literally with each crashing or surging wave. On the other end of the time scale are large-scale disturbances that are less frequent and somewhat less visibly dramatic. An El Nino climatic event, for instance, alters the baseline oceanographic conditions along the entire Pacific Coast; the average water level of the ocean rises and temperatures increase. To humans these changes are slight but to certain creatures they are very significant and can result in major changes in the ecosystem dynamics of vulnerable areas. Even a hard winter freeze during a low-tide cycle can kill plants and animals in the intertidal zone, thus disturbing--or stressing--the ecosystem and creating conditions that allow destruction and recovery or recolonization. Management must include large enough habitat units to ensure that disturbance regimes and recovery processes are represented.

Human disturbance patterns often differ significantly from natural disturbance and may, by their very nature, foreclose or prevent recovery. For example, heavy wave action and human trampling both can remove mussels and result in a bare patch that exposes the underlying rock and opens the area to recolonization and recovery. But while recovery from wave damage begins immediately as new algae and tiny invertebrates settle, recovery from human trampling may not occur because the disturbance continues many times a day over many successive days. Similarly, a predator or other intrusion into a seabird colony may occur infrequently while boat and aircraft disturbance can happen repeatedly in a day and then over many days, especially during summer.

Natural recovery of sites takes years even for natural disturbances and is compounded dramatically by human disturbance. An intertidal mussel bed takes an average of eight years to allow for a slow series of recovery stages, from new algae and tiny invertebrates to a full mussel cover, to be complete. A bird colony may take more than a dozen years to even reveal the effects of reproductive failures due to chronic disturbance; recovery time is unknown. Most human impacts occur during spring and summer just when the invertebrate larvae are attempting to become established on intertidal rocks and birds or mammals are in their single reproductive season. Continued human disturbance means that, at a minimum, the entire year of recovery is lost or, more likely, that recovery never occurs.

Because predator-prey interactions also have a profound influence on biodiversity, management of "keystone species" can have significant effect on the ecosystem. For instance, the ochre sea star (*Pisaster ochraceus*) is the principal predator on mussels which are a "competitive dominant" species that will fill nearly all space within the lower to middle tide range unless physically disturbed or removed. The sea star seeks and devours mussels as prey, thus providing a check on the mussel population and opening up patches in the mussel beds. A variety of organisms fill the available space, thus increasing diversity of the shore. The ochre star is a keystone species because of its key role in controlling the community of organisms and, in this case, contributing to high diversity. If management were to allow excessive collection of ochre stars, mussels might have little competition from other species.

4.) Respond to Change

Natural-resource management models have traditionally assumed that systems should be preserved as they are found, in a kind of steady state or static condition. However, change is being increasingly understood as an inherent and important part of ecosystems. Ecosystem management must incorporate recognition of and responsiveness to change by conserving large enough blocks of habitat to ensure a replacement source of organisms if any particular area is wiped out. In addition, linkages between habitat blocks must be maintained to provide pathways for organism movement and possible slow migration of communities in response to long-term conditions such as climatic change. Maintaining ecosystems in large connected blocks is important not only for natural change but also for recovery from a catastrophic human-caused event such as an oil spill.

5.) Accommodate Human Use

Ecosystem management recognizes that humans and the environment cannot be separated. Humans have always interacted with the environment and always will. Ecosystem-management programs must anticipate and make provisions for that interaction by modifying or directing the use where necessary to reduce adverse affects on the entire ecosystem, humans included, and to achieve ecosystem viability and sustainability.

e. Using Ecosystem Management

This plan contains no direct prescriptions for applying the five elements to the management of Oregon's rocky shores. Rather, they are woven into the fabric of the entire rocky shores strategy. Consequently, they will be applied at the local level in actions taken by agencies and individuals. To use these elements in the rocky shores management program, Oregon will need to:

1.) Complete and refine the coastwide rocky shores inventory at a level of detail that will allow representative ecosystem types to be identified at both small and large scales so that management actions at the site level account for the various ecosystem types. The state will need to work with California, Washington, British Columbia, and Alaska to develop a larger regional ecosystem view so that Oregon's management program can successfully address representative ecosystem types throughout the Northern California Current Ecoregion.

2.) Inventory and monitor populations of organisms to account for variations in population levels and shield them from the adverse effects of human disturbance. The state should also work with adjacent states and federal agencies to develop a regional view of species populations to better understand the significance of Oregon's marine habitats to overall population viability.

3.) Increase understanding of rocky shore ecosystem processes and interactions through scientific study, particularly those of rocky reef and shore line subtidal areas. The Cooperative Reef Ecosystem Study, coordinated by the Oregon Department of Fish and Wildlife, provides a comprehensive, interagency research framework for developing and carrying out these studies.

4.) Incorporate monitoring measures and activities to make sure that the management measures for sites and activities have the intended effect and that the health of the habitat and ecosystem are maintained. Monitoring activities can take many forms depending on level of information, cost, and frequency of need.

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