

Biological Monitoring Progress Report
Otter Rock and Redfish Rocks Pilot Marine Reserves
Oregon Department of Fish and Wildlife
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This document provides an update on monitoring activities that have been conducted to date for the Redfish Rocks and Otter Rock pilot marine reserve sites. In this progress report we highlight the extent of work completed as of September 2011, including monitoring activities that have taken place at the two marine reserve sites as part of our collection of baseline information. We are employing a variety of methods, prior to the cessation of extractive activities, as part of a comprehensive assessment of the marine reserve sites to set an ecological baseline from which we will be able to compare over time.

Monitoring Plan Development

ODFW staff, with assistance and collaboration from external scientists and marine reserve community team members, have drafted a *Biological Monitoring Plan* designed for the long-term monitoring of Oregon's limited-system of marine reserve sites. The monitoring plan documents and describes the objectives, sampling design, metrics, monitoring activities, and expected analyses that are a part of the ecological monitoring to be conducted at current and any future marine reserve sites. The *Biological Monitoring Plan* can be found online at www.oregonocean.info/marinereserves.

Schedule for Monitoring Reports

Detailed methods, analyses, and results from marine reserve monitoring are to be presented in biennial monitoring reports. The baseline *Biological Monitoring Report* for the Redfish Rocks and Otter Rock sites will follow our collection of two years of baseline data for each site and is scheduled to be completed and available to the public in Spring 2012.

Several approaches will be used to integrate and analyze all data collected to establish the ecological baseline and produce a site characterization and desired products. The desired products are: oceanographic condition, habitat maps, species present, abundance and density levels and species habitat correlations.

Overview of Monitoring Design

Here we provide a brief overview of our monitoring design, which is described in more detail in the *Biological Monitoring Plan*. Research questions, metrics, monitoring activities, and data analyses are designed to provide the necessary ecological information needed for marine reserves evaluation and to support nearshore resource management in general.

Research Questions

Our monitoring is designed to sample both spatially and temporally within and outside the reserves. A site includes both the reserve and its associated comparison areas.

Our ecological monitoring is designed to answer the following research questions:

- What is the oceanographic condition at each site? How does it change over time?
- What habitats exist within each site? How do they change over time?
- What algal, invertebrate, and fish species exist at each site?
 - How do species biometrics change over time?
 - How does biodiversity change over time?
- What are the species-habitat correlations at each site? How do they change over time?
- Does the prohibition of extractive activities change the community structure of the reserve?
- Are patterns or changes within the marine reserve consistent throughout the system?

Comparison Areas

Sampling is conducted within the marine reserves, and marine protected areas if applicable, as well as outside the reserve at selected comparison areas. Sampling both within the reserve and comparison areas is used to help determine and differentiate between natural versus human caused changes to the environment. To account for natural changes (variations), each marine reserve is paired to other areas that we refer to as **comparison areas**. Over the past two decades this approach has been chosen for scientifically rigorous and defensible studies for determining natural vs. anthropogenic caused changes, and has been applied to marine reserve monitoring elsewhere in the world (Michellie et al. 2004).

Comparison areas are systematically chosen based on similarity rather than randomly selected. Ideally, comparison areas will have similar habitats, dominant species, trophic structure and physical oceanography to the marine reserve (Pande and Gardner 2009). Although no perfect replicate exists for a given marine reserve site, careful measures are taken to choose comparison areas as similar as possible, to control for inherent variation and to avoid confounding of the results.

We chose comparison areas through analysis of available data and conversations with local fishermen to find areas with similarities in habitat, depth, oceanography, species, and fishing pressure. The hard bottom comparison area chosen for Otter Rock is at Cape Foulweather and the unconsolidated sediment comparison area is at Moolack (Figure A). The comparison areas chosen for Redfish Rocks are at McKenzie Reef and Humbug, both of which contain hard bottom and unconsolidated bottom types (Figure B).

Sampling approach

Our sampling is designed to:

- Characterize the habitat, oceanographic condition, and species that exist at each site
- Determine whether or not the marine reserve (prohibition of extractive activities) changes the environment over time
- Determine which components of the environment are affected
- Estimate the magnitude of the effects

We use three sampling approaches to accomplish this:

- 1) General site characterization
- 2) Systematic rapid assessment
- 3) Detailed assessment

The first two approaches are conducted over the first two years and before the prohibition of extractive activities take effect to generate a baseline for the reserve and comparison areas. The detailed assessment is conducted both before and after the prohibition of extractive activities take effect, for the long-term collection of data. For the detailed assessment sampling is focused on two bottom types, hard bottom and unconsolidated sediment. The two bottom types are stratified by depth and then sampling is conducted randomly within each strata.

Focal Species. While we make efforts to identify and enumerate all species sampled, limitations of the sampling gear and limited time, staff, and funds dictate that reporting and analysis be focused on a select group of species for each site. These focal species are chosen based on their ecological or economic importance and their potential to show a response, or change, to the marine reserve. A list of focal species for each site will be provided in the *2012 Biological Monitoring Report*.

Sampling Tools and Methods. Sampling tools and methods were chosen based on their ability to sample within given bottom types and to derive specific species and habitat metrics. The next section provides more detail on what sampling tools we have been using during our baseline data collection.

Monitoring Activities and Efforts to Date

We have chosen our sampling activities and methods based on their ability to sample within given bottom types and to derive specific metrics. Our methods are integrated to collect a baseline/ T_0 and long-term data set to generate algal, invertebrate and fish species biometrics and for us to characterize the general ecology and oceanography of each site and comparison area.

Field Logistics

The majority of our sampling has been carried out between April and October, when the swell is smaller for logistical and safety reasons. The degree of exposure to prevailing swell, currents and winds affects the ability of researchers to access sites to conduct studies.

Redfish Rocks site: Redfish Rocks Marine reserve and Marine Protected Area as well as the Humbug comparison area are both fairly protected from the strong north winds and swell in the

summer months. McKenzie reef on the north side of Port Orford Head is subject to these strong northerly winds and swell, making sampling more limited in this area.

Otter Rock site: The Otter Rock marine reserve is located in shallow water with a depth ranging from 3-5 fathoms. Our sampling at Cape Foulweather and Moolack (comparison areas) are also restricted to this depth range. For safety reasons, these shallow conditions dictate that sampling is conducted when the swell is 6 feet or less.

Our monitoring activities are divided into four themes: **1) Oceanographic Assessment, 2) Seafloor Mapping, 3) Visual Surveys and 4) Extractive Surveys.** Below we provide a brief description of the metrics we derive for each theme, the sampling activities we use to obtain those metrics, and a report of what sampling has been conducted as of October 2011 at each site.

1) Oceanographic Assessment

Metrics derived: Temperature, salinity, chlorophyll, dissolved oxygen, and light.

Sampling activities: To assess the oceanographic variables and processes within the reserve sites we utilize three different methods: moorings, benthic oceanographic platforms and examination of remotely sensed data. Given the high sea conditions combined with the shallow water of the reserves, maintaining moorings throughout the winter months is risky. A combination of these instruments and tools enables the continuous collection of some oceanographic variables through the winter, with a more thorough examination in the summer months.

Sampling conducted to date:

Otter Rock Marine Reserve Site:

- Oceanographic moorings were deployed and collected temperature, salinity, chlorophyll dissolved oxygen and light from June-September 2010 and April-September 2011.
- A Benthic Oceanographic Platform (BOP) was deployed in April 2011 and has been collecting continuous temperature and light data.

Redfish Rocks Marine Reserve Site:

- Oceanographic moorings were deployed and collected temperature, salinity, chlorophyll dissolved oxygen and light from July-September, 2010 and May-September 2011.
- A Benthic Oceanographic Platform (BOP) was deployed in December 2010 and has been collecting continuous temperature and light data.

2) Seafloor Mapping

Metrics derived: Depth, relief, substrate type, habitat classification.

Sampling activities: The Active Tectonics and Seafloor Mapping Lab, directed by Dr. Chris Goldfinger at Oregon State University, in conjunction with the National Oceanographic and Atmospheric Administration, have been conducting a multi-beam sonar mapping project of Oregon's Territorial Sea (2009-2010). We have been working in coordination with Dr. Goldfinger and his lab to identify and prioritize areas for bathymetric mapping.

Hydrographic surveys using multi-beam bathymetric mapping equipment are conducted in the marine reserve sites. Specifics of survey methodology, such as equipment used and target resolution will be included in the *2012 Biological Monitoring Report*. In addition to the multi-beam work, grab samples are conducted on a 2 km grid at the site to ground-truth the multi-beam work. These surveys produce

image mosaics of back scatter and multibeam. These images are analyzed to determine habitat type and rugosity. These maps and areas that are not able to be surveyed will be ground-truthed with video imagery taken with other methods such as remotely operated vehicle (ROV), video sled and video lander surveys.

Sampling conducted to date:

Otter Rock Marine Reserve Site:

- Multi-beam survey was conducted in August, 2010.

Redfish Rocks Marine Reserve Site:

- Multi-beam surveys were conducted for the reserve and comparison areas in 2010 by the Active Tectonics Laboratory.

3) Visual Surveys

Metrics derived: For algal, invertebrate, fish, and seabirds we derive presence, relative abundance, abundance, density, species-habitat correlations, and a biodiversity index.

Sampling activities: We utilize several different tools to conduct visual surveys to classify habitat and determine algal, invertebrate and fish species presence and abundance levels. Bottom type and depth dictate which type of visual survey and equipment is used to characterize habitat and collect species biometrics. Video lander, remotely operated vehicles (ROV) and SCUBA divers are used to conduct visual surveys in hard bottom habitats. Video sled and ROV are used to conduct visual surveys in unconsolidated and deeper areas.

Sampling conducted to date:

A total of 394 (in the 2010 field season) and 173 (in the 2011 field season) video lander drops were conducted across both reserves. A total of 26 (in the 2010 field season) and 9 (in the 2011 field season) video sled tows were conducted across both reserves.

Otter Rock Marine Reserve Site:

- Video lander drops conducted on a 250 m x 250 m point grid in hard bottom and unconsolidated sediment
- Video lander drops conducted on a stratified random sampling regime in hard bottom areas
- 700-100 meter video sled transects conducted in unconsolidated sediment
- SCUBA surveys conducted in August 2010 and 2011 (limited surveys in 2010 due to inclement weather)
- ROV surveys were not conducted at this site due to shallow water depth

Redfish Rocks Marine Reserve Site:

- Video lander drops conducted on a 350 m x 350 m point grid in hard bottom and unconsolidated sediment
- Video lander drops conducted on a stratified random sampling regime in hard bottom areas
- 700-100 meter video sled transects conducted in unconsolidated sediment
- SCUBA surveys conducted in August 2010 and 2011
- ROV surveys focused on hard bottom areas with limited surveys in unconsolidated sediment

4) Extractive Surveys

Metrics derived: Habitat classification; algal presence and biomass, small invertebrate presence and density, index of biodiversity and focal fish species composition, size, sex and age structure;

Sampling activities: We conducted two extractive surveys: a fishery independent survey and a benthic extraction survey. Fishery independent surveys are used to extract specific fish species to obtain species length, weight and selective age data prior to closure. Since we are looking to evaluate marine reserve effectiveness and examine natural versus human-induced changes, and the primary change at marine reserves is the prohibition of extractive activities, priority response variables are those that will measure change in harvested species. Harvested species most likely to show a biological response to the marine reserve are those species with smaller adult home ranges. These species are the highest priority to sample and analyze during our fishery independent survey method.

We also conducted a focused benthic biodiversity study for small algal species and sessile invertebrates in hard bottom areas of the site. We will be assessing species richness, multiple biodiversity indices, and density at each site. In addition, to assess the importance of environmental factors on biodiversity, correlations between community structure and environmental factors such as depth, relief, and rugosity will be calculated.

Sampling conducted to date:

Otter Rock Marine Reserve Site:

- Fishery independent survey method is NOT used at this site
- Extraction was conducted at thirty 0.25m² quadrats in order to identify small algae and invertebrate species

Redfish Rocks Marine Reserve Site:

- 12 fishing days were conducted to collect fish for length, weight and age structure analysis
- 1,108 fish were measured and weighed, species included: black, blue, China, quillback, yellowtail, and canary rockfishes, lingcod, kelp greenling, cabezon
- Statistical tests (power analysis) were used to define a target number of black rockfish to extract for age structure analysis.
- 356 black rockfish were extracted
- Extraction was conducted at thirty-six 0.25m² quadrats to identify small algae and invertebrate species

Table 1: Marine Reserve monitoring activities and metrics produced.

Monitoring Activities	Metrics Produced
Oceanographic Mooring	Temperature, salinity, dissolved oxygen and chlorophyll, light (April-September)
Benthic Oceanographic Platform	Temperature, light (Year-round)
Video Lander Surveys Visual surveys in hard bottom habitat	Habitat classification, invertebrate and fish presence (organisms > 5 cm), abundance and composition
Video Sled Surveys Visual surveys in unconsolidated habitats	Habitat classification, invertebrate and fish species presence (organisms > 5cm), species abundance, composition
ROV Surveys Visual surveys in hard bottom & unconsolidated habitats	Habitat classification, invertebrate and fish presence, abundance, approximate size and composition
SCUBA Surveys Visual surveys in rocky habitat	Habitat classification, algal, invertebrate and fish species presence, species abundance, approximate size and composition
Aerial Surveys of Kelp Canopy Kelp Biomass Study	Location and percentage cover of kelp canopy. Kelp biomass
Benthic Extractive Surveys	Algal presence and biomass. Invertebrate presence, abundance, density
Bathymetric Mapping	Depth, rugosity, habitat classification
Fishery Independent Survey	Length, weight and age data from select fish species

**Otter Rock Marine Reserve
and Associated Comparison Areas**

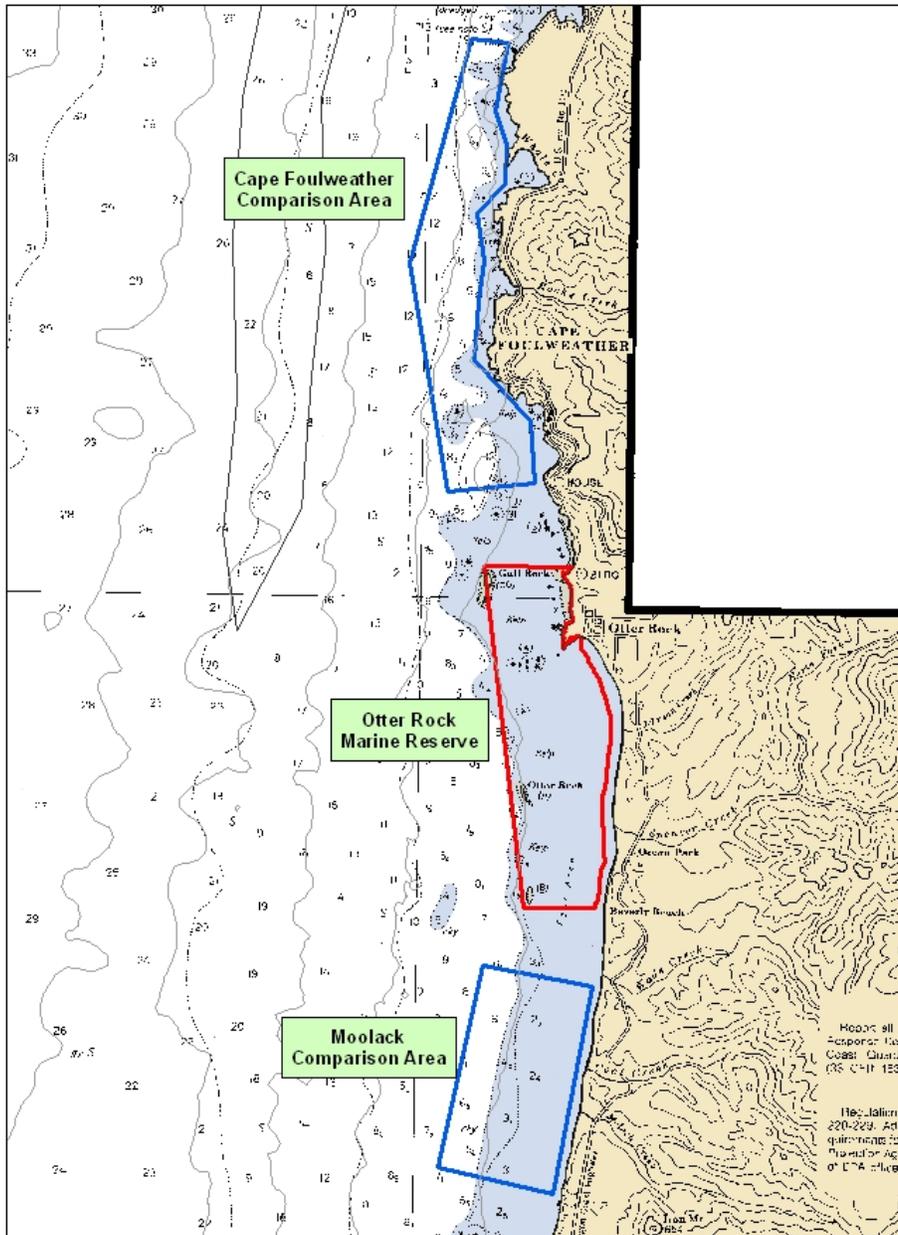


Figure 1: Otter Rock Marine Reserve Comparison Area

Redfish Rocks Marine Reserve, Marine Protected Area and Associated Comparison Areas

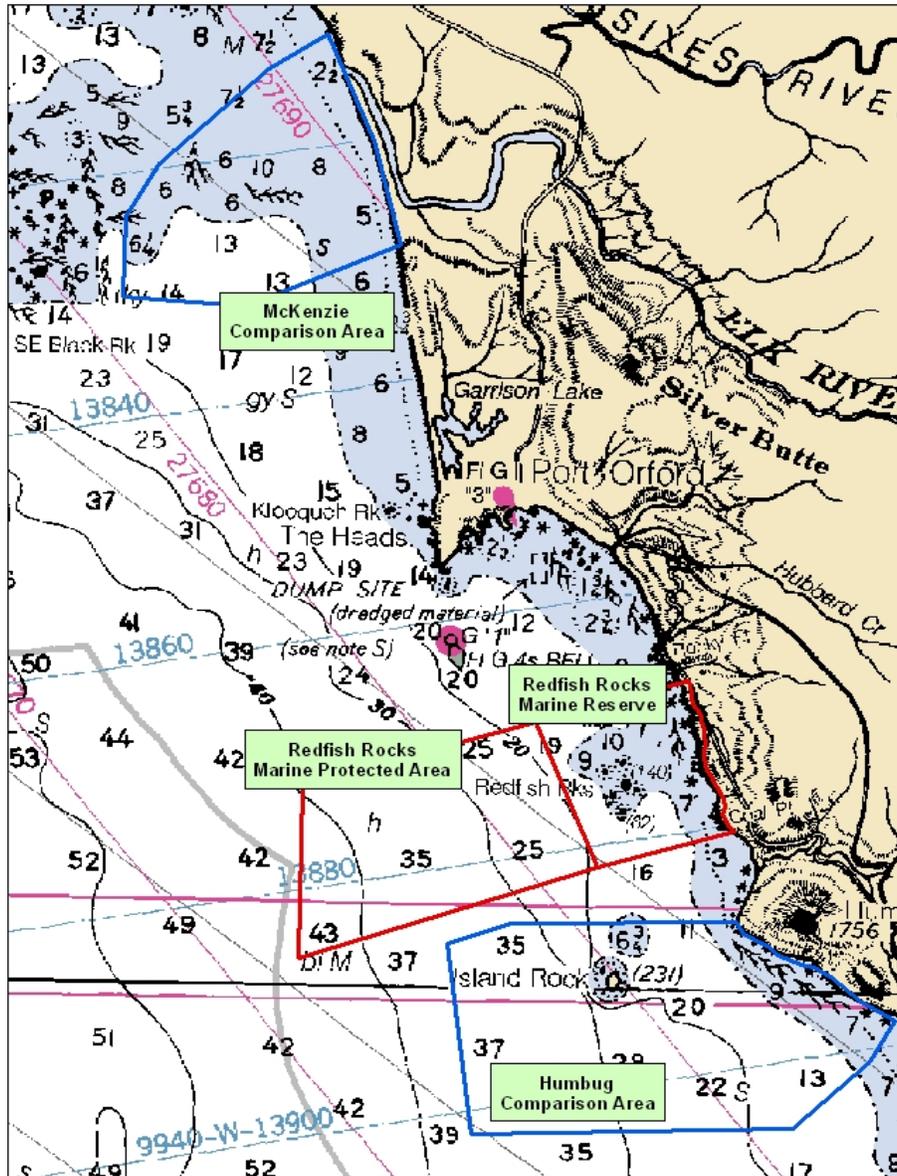


Figure 2. Redfish Rocks Marine Reserve, Marine Protected Area and Associated Comparison Areas.