

Marine Reserves and Marine Protected Areas: A Case Study in Oregon and a Proposed National Model for Design and Implementation



Photo courtesy of Redfish Rocks Community Team

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Introduction

Although establishment of Marine Reserves (MRs) and Marine Protected Areas (MPAs) is a controversial idea, it has been gaining popularity on a national and global level. There is an abundance of scientific literature touting the positive effects of MRs and MPAs, and some touting their ineffectiveness, but it is not the purpose of this paper to argue in support of or opposition to them. Rather, I will examine the process of implementation within the United States, and specifically within Oregon.

Marine reserves and marine protected areas are tools used by fishery managers to meet goals for sustainability of our nation's fish stocks within the context of the current legal framework in the United States. In addition, marine reserves and marine protected areas are used to protect the interconnectivity between biota and their environments, by limiting or prohibiting extractive activities and protecting the habitat. There are varying definitions for what constitutes a marine reserve and marine protected area. For the purposes of this study I will define a marine reserve as an area of the ocean that is defined, delimited, and is closed to all extractive commercial activities. My working definition of marine protected area is a designated location that is limited to certain types of extractive activities to provide protection to the living and non-living marine resources therein.

A number of laws have been implemented in the United States that protect areas of our ocean. The use of marine reserves and protected areas is supported by the framework of these laws. One of the first, the Marine Protection Reserve and Sanctuaries Act of 1972 (through Title III, also known as the National Marine Sanctuaries Act), authorized the Secretary of Commerce

to designate and manage areas for protection of our national marine ecosystems with national significance as National Marine Sanctuaries. The criteria for sanctuary designation applied by the Act include: “conservation, recreational, ecological, historical, research, educational, or esthetic value.”¹ The Marine Mammal Protection Act (MMPA 1972), the Endangered Species Act (ESA 1973), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA 1976, amended 2006) all contain protections for habitat and ecosystem health analysis and monitoring recommendations.² The MMPA establishes a need to protect significant geographic areas, relating the health of the species to the health and stability of the marine ecosystem. The MSA establishes the need to define, designate, protect and restore Essential Fish Habitat (EFH). The ESA establishes critical habitat as geographic areas containing physical and biological features essential to conservation of species. Despite differing definitions, all of these Acts by Congress recognize that management of species is inextricably related to the ecosystem and marine environment. These habitat and ecosystem protections can be used to support the establishment of MRs and MPAs in the United States.

In this report, I examine the process of establishing marine reserves and marine protected areas both from a national and a state perspective. In order to do so, I have investigated the implementation process currently underway in Oregon. Specifically, I have chosen to perform a case study of the process at Redfish Rocks Marine Reserve and Marine Protected Area. I chose this example because of the commendable approach taken by the community of Port Orford in proposing their site and performing extensive baseline data collection in submitting their proposal. The Port Orford community demonstrated great marine

resource stewardship and a forward-minded approach to conservation and sustainability for their living marine resources in putting together their submission.

Finally, the goal of this paper is to present the lessons learned in the form of a proposed template for communities and fisheries managers to follow in the proposal and implementation process of designating and establishing marine reserves and marine protected areas both locally and nationally. It is my hope that such a proposal could be used to standardize a national approach to designation and implementation across Regional Fishery Management Councils (RFMCs) and their associated regional marine ecosystems within the United States.

Marine Reserves and Marine Protected Areas

Marine reserves and marine protected areas are important tools for fisheries managers in preserving stock health and species biodiversity. They are certainly one viable approach in a portfolio of management techniques seeking to utilize an Ecosystem Based Management (EBM) methodology. According to one definition, ecosystem based management is defined by the following components:

[EBM] emphasizes the protection of ecosystem structure, functioning, and key processes; is place-based in focusing on a specific ecosystem and the range of activities affecting it; explicitly accounts for the interconnectedness within systems, recognizing the importance of interactions between many target species or key services and other non-target species; acknowledges interconnectedness among habitats, ecological community systems, and integrates ecological, social, economic, and institutional perspectives, recognizing their strong interdependences.³

I will add to this definition some more unifying components that I have found tend to be contained within most definitions of Ecosystem-Based Management (EBM), or management principles and practices that : 1) account for ecological processes (e.g., interspecific interactions, natural mortality, trophic dynamics, energy/biomass transfer); 2) consider external influences (physical, chemical, climatological, and oceanographic processes, etc.); 3) include a socioeconomic dynamic that recognizes human interactions, pressures, influence, and place within the ecosystem; 4) account for fishery catch and bycatch (fishing mortality); and 5) use adaptive management techniques.

The concept of establishing marine reserves, marine protected areas, and no-take zones is a contentious one in the current field of fishery management. Some of the common goals to implementing no-take zones are to preserve essential fish habitat and nursery grounds, protect areas that are crucial to other life history stages of fishes, protect sedentary populations,

improve and maintain size structure of populations, improve adjacent fisheries through spill-over from healthy populations, and to promote ecosystem stability through species diversity. Advocates for establishing no-take reserves range from members of the affected fishing communities, some Non-Governmental Organizations (NGOs), fisheries managers, fisheries scientists and ecologists, politicians, and the general public. Due to the wide variety of proponents, reasons for creating no-take reserves also vary widely. There is also strong opposition to establishing reserves by much of the fishing community, who fear that they will not benefit from establishing no-fish zones but will be negatively impacted economically by lost access to resources, and also that giving up fishing rights to grounds will be irreversible and ongoing. However, there are examples of fishers who are active in advocating and establishing MRs and MPAs and foresee the benefits of implementing them.^{4,5}

Under Executive Order 13,158, the United States defines Marine Protected Areas (MPAs) as “any area of the marine environment that has been reserved by federal, state, territorial, tribal or local laws or regulations to provide lasting protection for part or all of the natural or cultural resources therein.” A Marine Reserve (MR) is defined as “areas of ocean completely protected from all extractive activities” and forbids extraction or disturbance of marine resources with the exception of allowances for the purposes of scientific monitoring.⁶ According to Oregon’s Ocean Policy Advisory Council (OPAC), a Marine Reserve is defined as “an area within Oregon's Territorial Sea or adjacent rocky intertidal area that is protected from all extractive activities, including the removal or disturbance of living and non-living marine resources, except as necessary for monitoring or research to evaluate reserve condition, effectiveness, or impact of stressors.”⁷

Legislative History of Marine Reserves in Oregon

In 1991, the Ocean Policy Advisory Council was created in Oregon to establish a broad-scale management plan for Oregon's Territorial Sea.⁸ The OPAC comprises seven state agencies that have jurisdiction over policy, management, and programs affecting the marine environment. These agencies are: the Department of Environmental Quality (DEQ); the Oregon Department of Fish & Wildlife (ODFW); the Department of Geology and Mineral Industries (DGMI); the Department of Land Conservation and Development (DLCD); the Department of Parks & Recreation (DPR); the Department of State Lands (DSL); the Governor's Natural Resources Office (GNRO); and the Oregon Sea Grant Program (OSGP).⁹ A list of current members can be found on the OPAC website.¹⁰

After the passage of amendments to the Magnuson Stevens Act in 1996, it was established that Essential Fish Habitat (EFH) should be defined ("those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity"), delimited and protected.¹¹ In order to promote this protection and create a system of EBM in Oregon's waters, Governor John Kitzhaber of Oregon requested that OPAC make recommendations for instituting MRs and MPAs in 2000. From 2000 through 2002 OPAC conducted coastal community outreach regarding the reserves. However, after this, the process stalled. It was not until 2005 that Oregon's Governor Theodore Kulongoski directed OPAC to recommence work on the subject.¹²

In response to recommendations by the United States Commission on Ocean Policy and the Pew Oceans Commission, the governors of California, Oregon, and Washington created the West Coast Governors' Agreement on Ocean Health (now known as the West Coast Governors'

Alliance).¹³ In 2007, Governors Gregoire, Kulongoski, and Schwarzenegger drafted the Agreement, which set forth an impetus to take immediate actions to protect the oceans using management schemes from an EBM angle, as well as requiring that an Action Plan be laid out within a year (this Action Plan was published in May of 2008¹⁴). In January 2008, Governor Kulongoski developed Legislative Concept 89, and called for proposals for MRs and MPAs in Oregon by the public.¹⁵

Kulongoski then published Executive Order 08-07, which officially empowered the Ocean Policy Advisory Council (OPAC) to call for and review proposals to designate “not more than nine” marine reserves in the state managed waters. The Order empowered Oregon Department of Fish and Wildlife to lead the process of reviewing and recommending these MRs through OPAC. In order to do so ODFW and OPAC sought the advice of the Science and Technical Advisory Committee (STAC). On April 10th and 11th, 2008, at the request of the Marine Reserves Working Group (MRWG), the STAC of Oregon’s Ocean Policy Advisory Council conducted a meeting at the Oregon Institute of Marine Biology to discuss recommendations on marine reserve size and spacing. The goal was to establish specific guidelines that can be used in the site proposal process. The meeting comprised 31 scientists, advisors and 5 support staff. They compiled recommendations to OPAC for site size and space guidelines in a preliminary report on April 21st, 2008.¹⁶ A finalized document was later published on July 2nd, 2010.¹⁷

On August 19th, 2008, OPAC set forth a document outlining the marine reserve policy recommendations, which established guidelines and criteria by which proposals would be submitted and evaluated.⁴ Proposals were submitted by the deadline of September 30th, 2008; there were 20 proposals put forth by various coastal community nominating teams or

nearshore action teams (NSATs).¹⁸ Oregon Department of Fish and Wildlife then began reviewing the proposals, and came up with a comprehensive analysis document on November 07, 2008.¹⁹ The proposal for each of the 20 sites was analyzed, and the document was then submitted to OPAC for review and acceptance or rejection of the proposals. OPAC accepted ODFW's counsel and proposed 2 of the 20 sites be established as Pilot Reserves: Redfish Rocks Marine Reserve and adjacent Marine Protected Area, and Otter Rock Marine Reserve. OPAC drafted a letter to Governor Kulongoski on November 29th, 2008, detailing these recommendations for pilot sites, and further proposing "three areas, Cape Falcon, Cascade Head, and Cape Perpetua, as deserving of further study and evaluation as sites for potential marine reserves."²⁰ Governor Kulongoski reviewed the proposal by OPAC, and finalized the acceptance of the proposals on January 29th, 2009.²¹

Work then began on House Bill 3013 A (HB 3013), which was published on May 21st, 2009.²² HB 3013 established the two proposed pilot sites: Redfish Rocks Marine Reserve and Marine Protected Area and Otter Rock Marine Reserve, and called for the evaluation of three other sites by Nov. 30th 2010. On July 17th 2009, the Senate approved HB 3013, making the reserves official.²³ It also required the Department of State Lands to transfer \$1 million in funds to ODFW to pay for an evaluation of the two pilot sites, and the three proposed sites of Cape Falcon, Cascade Head, and Cape Perpetua for establishment of reserves, plus looking into a proposal at Cape Arago, by Nov. 30th 2010. HB 3013 requires collaboration amongst eight stakeholder groups: local government, recreational fishers, commercial fishers, non-fishing industry members, recreationalists, conservationists, coastal watershed councils, and relevant marine and avian scientists. In addition, HB 3013 mandated biological assessment;

socioeconomic assessment; the establishment of community teams; the provision of data and information transfer to interested parties and the public; the establishment of scientific goals and of baseline data by which to measure efficacy; an enforcement plan with Oregon State Police; community and volunteer support in implementing the plan; and the delivery of data by ODFW to OPAC for review.

Development, Implementation, and Monitoring

Development and Implementation

After House Bill 3013 was passed, the Pilot Reserves were established and enacted, and work began at writing a plan to monitor, develop and enforce the regulations of the no-take reserves. In November of 2009 Oregon Department of Fish and Wildlife put together a Workplan.²⁴ The Plan sought to: 1) solidify the community teams—Port Orford Ocean Resource Team (POORT) and Depoe Bay Near Shore Action Team (NSAT)—and 2) develop fishery management plans (FMPs) addressing biological and socioeconomic monitoring, outreach and education, and rulemaking, compliance and enforcement in collaboration between state agencies and these teams, and finally 3) to implement baseline surveys (scientific monitoring for species abundance and diversity, habitat composition, *et cetera*). Regarding outreach, the Plan established that the Department of Land Conservation and Development will create and upkeep the Oregon Marine Reserves website, and Oregon Sea Grant will act as an impartial liaison between interest groups and impacted communities. The Plan delineated rulemaking processes (from the development stage to enactment) between Oregon Department of Fish and Wildlife, Department of State Lands, and Oregon Parks and Recreation Department. In addition to dictating biological and socioeconomic monitoring, the Plan described reporting to State Legislature. The Plan also outlined the evaluation process to be utilized in the three other proposed sites of Cape Falcon, Cascade head, and Cape Perpetua.

Work began immediately to implement and enact the Plan, and remains ongoing. The Port Orford Ocean Resource Team also formed the Redfish Rocks Community Team (RRCT) in 2009, to specialize in the development of the Redfish Rocks Marine Reserve and Marine

Protected Area, and the team has been collaborating with ODFW on the process since. In January of 2010, the community teams RRCT and Depoe Bay NSAT were finalized.¹⁸

By December of 2010, the OPAC approved the proposal by ODFW to accept the three evaluation reserve sites, and henceforth the proposals for the sites moved to the Governor and the Legislature for assessment and pending approval.²⁵ On July 18th, 2011, Oregon Governor Kitzhaber and Secretary of State Brown announced that limited funding was approved for the three proposed reserve sites.²⁶

Implementation of the two approved sites began officially in 2012. On January 1st, 2012, harvest restrictions went into place for the first two sites at Redfish Rocks and at Otter Rocks reserves.²⁷ In addition, baseline data are now being collected for the three evaluation reserve sites at Cape Falcon, Cascade Head, and Cape Perpetua. Harvest restrictions and rules have been finalized for the three evaluations sites and the current projection for execution of these rules is January 1st, 2014 for Cape Perpetua and Cascade Head, and January 2016 for Cape Falcon.²⁸

Ecological: Oceanographic, Geomorphologic, Biological, and Ecosystem Monitoring

In October of 2011, ODFW provided an interim biological and scientific monitoring progress report, updating the status of their studies of Redfish Rocks and Otter Rock Pilot Reserves. ODFW established comparison sites lying adjacent to the reserves, to act as controls by which to measure any trends. These comparison sites were chosen due to similar location, similar depth and substrate type, as well as analogous living and non-living marine resource composition. ODFW was planning to release official biennial biological and ecological monitoring reports beginning in spring of 2012, but staffing changes prevented the report from

being issued this year. ODFW plans to release the first official monitoring report in spring of 2013.²⁹

Monitoring activities to date have included: placing of oceanographic moorings and benthic oceanographic platforms; conducting video lander surveys, video sled surveys, ROV (remotely operated underwater vehicle) surveys, SCUBA surveys, aerial kelp canopy surveys and biomass studies, benthic extractive surveys of invertebrates and algae, fishery-independent surveys; and bathymetric mapping.³⁰ Although mark-recapture studies are permitted for scientific data accrual and analyses, there have been none utilized by ODFW to-date for either pilot reserve.³¹

ODFW's Marine Reserve Program staff met with leading marine scientists at a workshop on February 3rd 2012 to subject their current monitoring plan to scientific scrutiny and review.³² They used the workshop to describe the current monitoring plans and techniques to these experts, and discuss possible changes and suggestions for improvement. ODFW then incorporated ideas into the Ecological Monitoring Plan.

In April, 2012, ODFW released a document detailing specific plans for biological, oceanographic, and ecosystem-based monitoring for the MR process in Oregon. The Oregon Marine Reserves Ecological Monitoring Plan provides specific details into the reserve and comparison site selection process, historical information on the application and implementation processes for the two pilot sites, details about the specific monitoring activities performed (baseline studies), ongoing, and future studies planned.³³ Already employed, current, and planned monitoring techniques are described in greater detail in this Plan than in the previously released progress report.

Moorings and Benthic Oceanographic Platforms have been deployed to collect in situ oceanographic measurements including dissolved oxygen, light, conductivity (salinity), temperature, depth, and chlorophyll. From 2009 through 2011, multibeam sidescan sonar hydrographic surveys were conducted in Oregon's territorial seas. Multibeam sidescan sonar can be used to map ocean floor in great detail, and has extremely high resolution capable of determining not only topography but also substrate composition. Funded by Oregon Department of State lands, ocean floor mapping was conducted by the Active Tectonics and Seafloor Mapping Lab at Oregon State University. ODFW and the National Oceanic and Atmospheric Administration collaborated with AT&SML to target much of Oregon's territorial seas, but specifically the pilot reserve sites and proposed evaluation sites for marine reserves.³³ ODFW will take substrate samples and use video lander, video sled and ROV data to supplement and verify the accuracy of the substrate data generated by the sonar surveys. Dive teams will be used to count and identify fish, classify habitat (confirmation and support of sonar classification), count and identify invertebrates, and quantify brown, green, and red algae to the highest taxonomic resolution possible. Extractive surveys will include Red Sea Urchin, focused benthic dive surveys (subsampling quadrants for invertebrates), and chartered hook and line surveys to supplement video lander, sled, ROV and SCUBA surveys with sexed-length frequency, age, fecundity, and weight data. Hook and line gear will include rod and reel and cable-type longline gear to ensure capture of all common species.³³

In addition to the studies defined by the Ecological Monitoring Plan, monitoring activities and studies are encouraged through external organizations with the proper permitting.

Human Dimensions: Social and Economic Monitoring

On September 12, 2011, Oregon Department of Fish and Wildlife released a progress report on the human dimensions aspect of monitoring for Redfish Rocks and Otter Rock MRs.³⁴ The review process provides an overview of the social and economic backdrop of the affected areas, direct uses, general attitudes regarding execution of the FMP, and a study of the non-industry ecosystem services of the affected area. ODFW is analyzing commercial and recreational fishery use of the areas, non-fishing industry uses, spatial modeling of the economic uses and the relationship to habitat type, previous socioeconomic data collected, general use (such as tourism), generation of an ecosystem services list, and collection of “sociocultural profiles” data.

In April of 2012, ODFW released a human dimensions monitoring plan.³⁵ This further details the strategy to monitor short- and long-term impacts to various stakeholder groups who may be affected by the marine reserves. The plan seeks to use historical data, demographics such as employment data and social structure, cultural and social events, tribal connections to the area, and local market information to characterize the shoreside communities.

Commercial fishing logbook data, observer data, port sampling data, survey data, and interview data are some of the major tools available to analyze the consumptive use and users of the area. Charter and recreational fishing data are similarly used. In addition, non-consumptive uses are studied for social and economic impact from the implementation of the reserves and valuation of ecosystem services. By performing baseline data collection about the consumptive uses and users, and the economic impacts of displacing them from no-take reserves, ODFW can quantify economic impacts of site implementation. ODFW will attempt to

gather information on the various stakeholder groups' attitudes/perceptions toward all aspects (research and monitoring, enforcement, and management) of establishing the marine reserves in order to aim their outreach efforts accordingly. Assessing the non-market values of the affected areas will complete the approach for ODFW to gauge the human dimension impacts of the implementation of the pilot marine reserve sites as well as the proposed sites. By putting together a comprehensive list of the non-consumptive recreational users (such as surfers, whale watchers, tourists, beach goers, etc.), ODFW can attempt to define the ecosystem services provided by the area, creating a metric by which to measure changes and impacts after the reserves are implemented.

The Oregon Department of Land Conservation and Development contracted with Ecotrust to generate a report analyzing the current coastal economy that will be impacted by marine reserves and wave buoys proposed in the Oregon Territorial Sea Plan. In addition, Ecotrust generated for the DLCD commercial and recreation fishing ground maps for the whole Oregon Territorial Sea, which will be used to determine impacts of consumptive use displacement. The final report by Ecotrust detailing their findings about the baseline economic background of shoreside users was published in October 2011.³⁶ It details the economic impact of Oregon's territorial sea planning, including marine reserve implementation.

Enforcement

Enforcement of Oregon's Territorial Sea is quite complicated and intricate. There are many state and federal agencies involved in varying jurisdictions based on area and habitat. As previously mentioned,²⁴ Oregon Department of Fish and Wildlife, Department of State Lands, and Oregon Parks and Recreation Department are the agencies responsible for creating laws

within Oregon's marine reserves. In Oregon, ODFW has a small role in enforcement, but, as mandated by House Bill 3013, the majority of enforcement is carried out by the Fish and Wildlife Division of Oregon State Police. Members of the Nearshore Action Teams, Oregon Department of Fish and Wildlife, and Oregon State Police have teamed together to develop compliance and enforcement strategies. Enforcement is also carried out by members of the local fishing community, who police their own waters and report illegal exploitation of the MRs and MPAs.³⁷ In addition, other non-commercial members of the community (recreational fishers and other recreational users) play a role in stewardship and enforcement by reporting unauthorized activity within the MRs and MPAs. Other aspects considered in informing the compliance and enforcement strategies were defining procedures to legally retrieve lost fishing gear, legal means to conduct scientific research (obtaining a scientific take permit from ODFW), and obtaining permits for removal-fill research from the Division of State Lands.³⁸

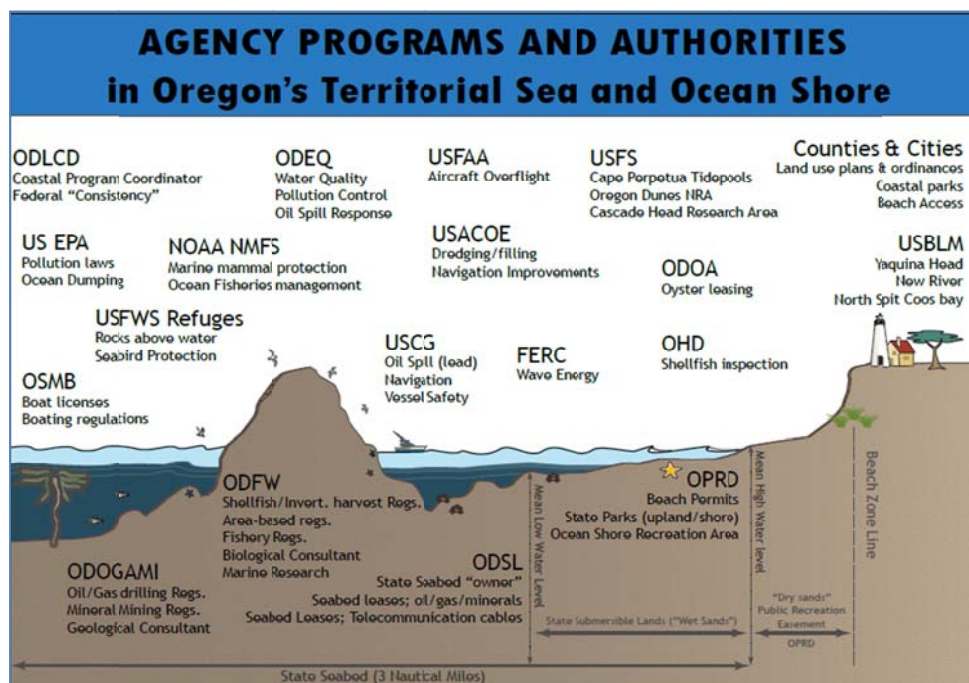


Figure 1. Graphic Depicting Territorial Sea Managing Agencies³⁹

The preceding graphic depicts the roles of state and federal agencies with jurisdiction and enforcement responsibilities in Oregon's state territorial waters inside the three-nautical-mile Territorial Sea. It should be noted that ODFW has enforcement and jurisdiction above Extreme High Tide Line, and in the case of Redfish Rocks, the US Fish and Wildlife Service has jurisdiction over the emergent rocks and islands since they are part of the Oregon Island National Wildlife Refuge system.⁴⁰

Redfish Rocks Marine Reserve and Adjacent Marine Protected Area

The Port Orford Ocean Resource Team (POORT) is a group of local community members who were disenchanted with top-down management of their fisheries, and decided to form a community-based team to deal with fishery and fishery management-related issues. The POORT began forming of their own volition in 1999, and were officially founded in 2001, with the election by the fishing fleet of five officials. POORT immediately began working to designate their local fishing grounds as a Community Stewardship Area (CSA). In 2007, Leesa Cobb drafted a proposal to have the CSA recognized at the state and federal governmental level.⁴¹ The goal was to utilize community-based input in management decisions affecting their 1320 square mile CSA. Looking to protect many species of rockfish that were designated as overfished by the National Marine Fisheries Service, the fishing community has seen great response from this bottom-up management approach. The fishing fleet and other community members have gained a sense of stewardship over their local living marine resources, and take great pride in their ability to influence local management decisions.

In response to Kulongoski's call for proposals in 2008, POORT put together a plan for a marine reserve and an adjacent marine protected area within their already designated Community Stewardship Area. A very forward-thinking group composed of local fishermen, local government, as well as community members and local scientists, POORT rose to the call for submissions and put together a very comprehensive and well organized proposal for the establishment of a marine reserve and adjacent marine protected area. The report was submitted on the Sept 30th, 2008 deadline.¹⁹ Comprehensively, POORT are very protective of their local fishing grounds, and have sought to protect these grounds from overexploitation,

over-extraction, and overfishing through a diverse portfolio of management actions and techniques. As such, the call for proposals to create reserves was well met by the Port Orford community in general, although there was of course dissent amongst some community members and stakeholder groups. POORT conducted much community outreach and enlisted the guidance of a very diverse group in the community to compile and compose their proposal, exemplifying a truly “bottom-up” approach to management.

The POORT submission thoroughly addressed all aspects laid out by OPAC⁴ in their proposal guidelines. They did much research into the socio-economic impacts to fishers, as well as baseline research into the geomorphologic, ecosystem, and biological diversity components of reserve establishment as outlined by OPAC and the Scientific and Technical Advisory Committee’s “STAC size and Spacing Workshop.”¹⁷ In the proposal, the Resource Team made use of preexisting survey data including multi-beam bathymetric imaging to determine substrate composition, topography and depth. They also compiled historical habitat characterization data from previous surveys of the area. Once HB3013 passed in 2009 and the pilot reserve sights, including Redfish Rocks, were accepted, POORT established a group (previously mentioned) called the Redfish Rocks Community Team to specialize in all aspects of developing the MR and MPA off of Port Orford.¹⁸

Fishers within the Port Orford community voluntarily conducted fishery-independent extractive surveys for biospecimen length data analyses to establish a baseline data set for future comparison, post-implementation. In addition, the proposal outlined economic surveys of the affected region, looking at data collected and compiled from fishers and shoreside fish receivers (fish buyers). The fisheries examined were the local live rockfish fishery, the local

fresh (dead) rockfish fishery, local crab fishery, and local salmon fishery. It was determined that the percentage of fishing grounds lost to the MR and MPA would have insignificant/negligible economic impact to the fishers, fish buyers, and local community and economy, although ongoing socioeconomic monitoring will be performed to test this assertion.

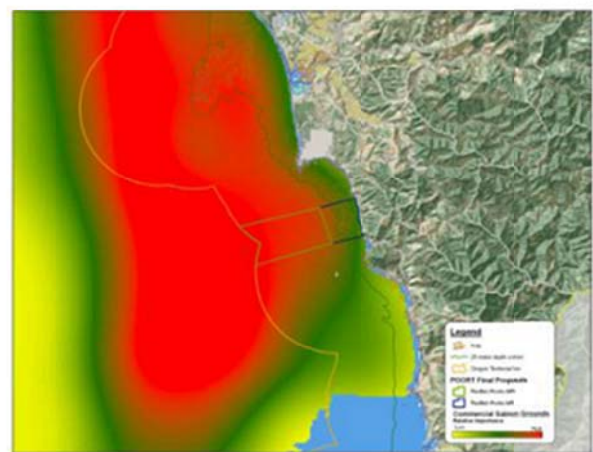
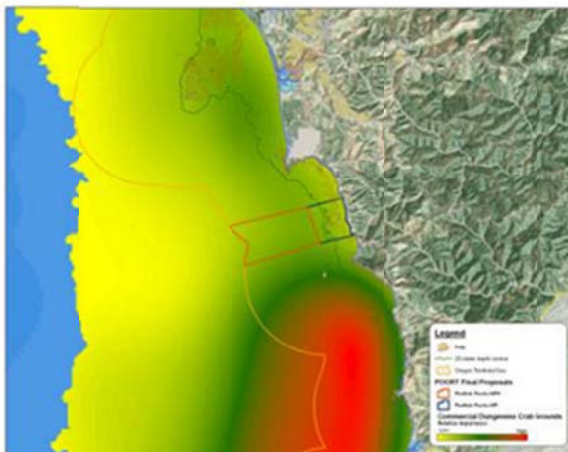
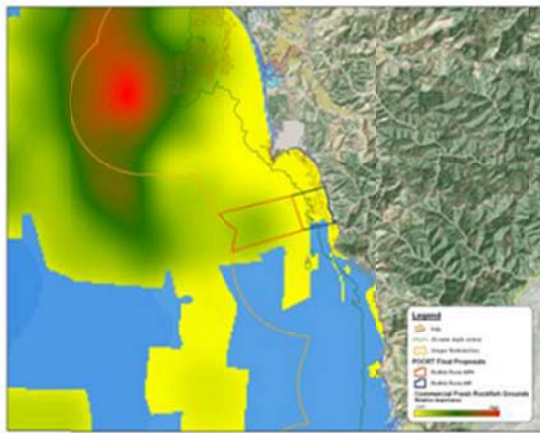


Figure 2. Maps Showing Area Uses of Proposed Grounds by Fishery Type²⁷

Since the delimitation of the reserve boundaries on July 17th of 2009, ODFW has been monitoring the MR and MPA using the guidelines outlined by the Marine Reserves WorkPlan presented by ODFW.²⁴ ODFW is also adhering to the newly organized and laid out testing guidelines established by the human dimensions monitoring plan and the ecological monitoring plan completed in April 2012.^{33,35} The following map (Figure 3) depicts the type of monitoring performed through 2010 by ODFW. ODFW's monitoring activities are also being updated to an interactive map on the Oregon Ocean Information's website.⁴²

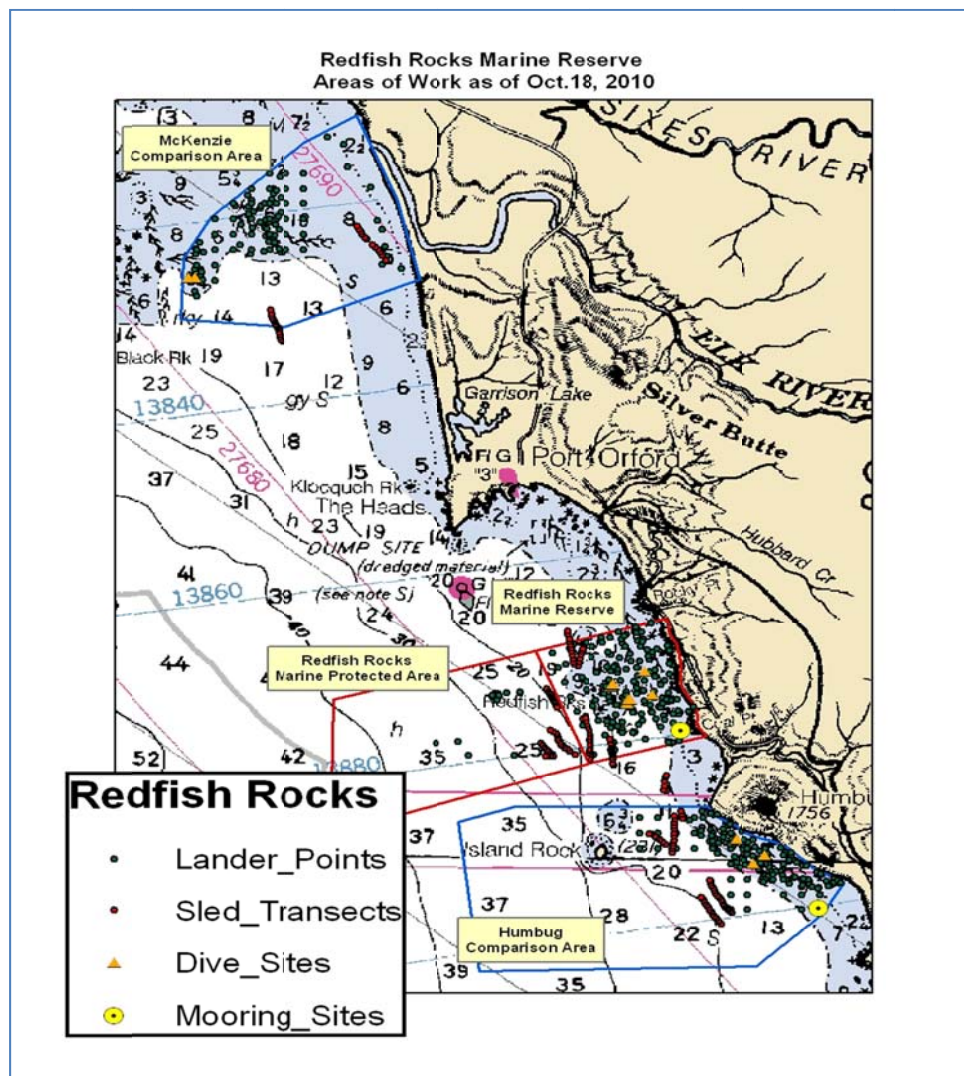


Figure 3. Map Depicting Type and Location of Monitoring Activities by ODFW⁴²

It should be noted that there are two comparison areas illustrated where studies are being performed to determine if there will be realized differences in trends of population structure, density, species diversity, ecosystem stability and robustness to environmental and anthropomorphic perturbations. The comparison areas were chosen based on similar geographic location, topography and depth, substrate composition, vertebrate and invertebrate species composition, etc.

A Model for US Fishery Managers

There are a number of lessons that Oregon can teach the nation in creating a model for designing and implementing marine reserves. There are, too, some areas that Oregon could improve its model for establishment. I will first provide an outline for future fishery managers to follow in establishing marine reserves in the United States. I will then evaluate the Oregon process critically to determine whether the process successfully exemplifies aspects of the model recommendations.

National Model for Establishing Marine Reserves

1. Education and outreach are crucial tools for the fishery manager seeking to implement marine reserves. I listed these components here because they are crucial to the entire process.

Education and outreach must be used at the onset of establishment, in order to enlist the support of the local affected communities. This support can be used to supplement efforts in site design, site monitoring, funding assistance, enforcement ideas, and enforcement in practice. All possible affected stakeholders should be given voice in the processes of implementation from the ground up. A bottom-up approach will be the most successful for establishing effective long-term sites. Stakeholder groups include: local government, recreational fishers, commercial fishers, non-fishing industry members, recreationalists, conservationists, coastal watershed councils, and relevant scientists.

2. The manager must formally define the location of the reserve, and in doing so, define the goals of site establishment. Although ultimately fishery managers implement reserves, utilizing public outreach to solicit input into the site design process is crucial for gaining community support. Site design should be informed by the best available science, such as the size and

spacing data provided by the Science and Technical Advisory Committee to the OPAC.¹⁷ Some questions managers must ask in site development follow: What does creating a no-take zone in this location hope to accomplish? What are the economic and social goals? What are the ecological and biological goals? What are the real and possible negative impacts of establishing the reserve? The goals should be framed within the current legal framework in place (e.g. Magnuson Stevens Act), the current state of the fishery (ecosystem, social, and economic statuses), and the desired changes effected by reserve implementation. It should be noted that, from a fishery management perspective, having a national-level organization to standardize our approach to marine reserves and MPAs would aid in making implementation processes more uniform, but within each state's territorial sea the federal government defers to state regulations. It should also be noted that networked reserves (allowing interaction of spillover animals) provide the greatest benefit to the various components within an ecosystem complex.⁴³ Clearly defining metrics that will measure success over time are necessary to an effective implementation model.

3. The fishery manager looking to establish a marine reserve must establish necessary and possible sources of funding. Funding must cover aspects that will be mentioned in detail hereafter, such as baseline data collection, monitoring, and enforcement. Funding resources can include government management agencies, Non-Governmental Organizations, and even non-prohibited resource users, to name a few. Examples of the latter could include day-use fees for parking at MRs, use fees for whale-watching and bird-watching tours, as well as extra fees for SCUBA divers wishing to dive on the site. Outreach can also play an important role in securing funding sources.

4. In establishing marine reserves nationally, the fishery manager must define the resources affected by implementation. This includes performing baseline studies of all practicable data sources. Quantifying biota (fish and invertebrate stocks), detailing geomorphology, and quantifying or establishing economic and social value baselines given the status quo that will be affected by reserves are all essential elements to an effective reserve model. Defining users, both consumptive (e.g. fishers) and non-consumptive (e.g. tourists), of the proposed reserve sites, and further establishing the possible effects to them from implementation, is essential to the model process.

5. The manager seeking to create marine reserves or marine protected areas must define both prohibited and permitted activities within the site, as well as defining who the eligible participants are. Eligible participants are loosely defined as any stakeholder who has an interest in the site. These participants may include fishers if extractive activities are allowed, members of the scientific community wishing to use the site for study, recreational users, and businesses looking to drill on the seafloor or site wave buoys, etc.

6. The model must contain provisions for enforcement. I will list some elements of enforcement that I believe to be effective. Enforcement tends to benefit from a bottom-up approach.⁴³

Enlisting the local communities to set regulations and enforce them is an excellent idea that does not require great governmental investment. Using a cross-jurisdictional approach will make enforcement more feasible practically and financially through the support of local, state and federal authorities.⁵ As diversity, size-structure, and health of stocks within reserves improves, so too does the incentive for consumptive infractions.⁴³ This is related, because enlisting the local users into the creation process leads first to greater respect for boundaries,

and hence incentive for local community enforcement (reporting of infractions), and therefore pride in the reserve is improved. I recommend patrolling established reserves at random times (using an enforcing agency or body) and random frequencies, and administering high penalties for infractions, thereby making risks of infraction cost-prohibitive. Different surveillance technologies (radar, hydrophone⁴³) to detect illegal incursions into no-take zones can provide cost effective alternatives to personnel resources for enforcement.

7. Finally, ongoing assessment and innovation are necessary to a successful reserve implementation model. Metrics for measuring success, both ecologically and socioeconomically, require ongoing analysis to provide accurate results. As mentioned, parameters for measuring success include defining what information is necessary to inform all aspects of scientific and socioeconomic data collection and enforcement. Regular reviews of the program should be scheduled and conducted to determine relative performance against the goals laid out in section one [of the model]. Based on these reviews, innovative and adaptive management techniques should be administered to better the data collection techniques, update size and spacing (expanding or shrinking reserve boundaries), and generally to inform best practices nationally.

The following chart depicts a template for the proposed system. It demonstrates the model list, showing the influences and interrelatedness between each step in the process of establishment. The red bars radiating from the center show a one-sided influence that stakeholder input has on the other steps. The grey arrows indicate one way influence, and the black two-way arrows show relationships where processes demonstrate reciprocal relationships affecting one another.

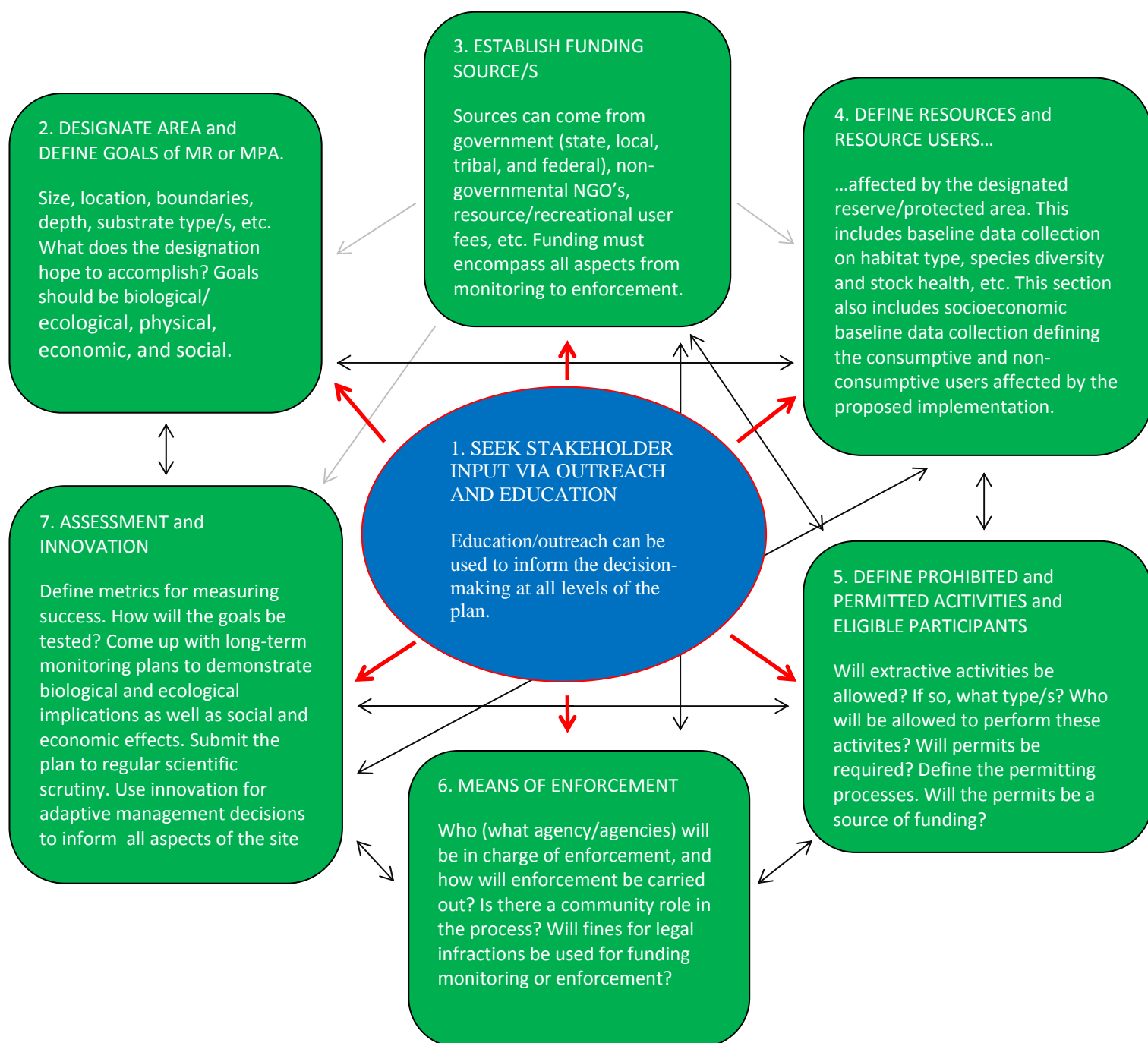


Figure 4. **Proposed Template for Implementing Marine Reserves and Marine Protected Areas**

Evaluating the Oregon Process via the Proposed National Model

1. Seek Stakeholder Input. Overall, Oregon did a good job of soliciting the input of the local communities into the site locations and design, as well as many other aspects aforementioned.

This was especially evident in the case study performed by this paper of the Redfish Rocks MR and MPA. The community was truly involved from the onset of the site design process, through the process of implementation.

2. Designate Area and Define Goals. The OPAC set clear goals and objectives for the marine reserves in Oregon with their 2008 recommendation:

Goals:

Protect and sustain a limited system of **ecologically-special** places in Oregon's Territorial Sea to **conserve** marine habitats and **biodiversity**; provide a **framework** for scientific research and effectiveness monitoring; and avoid, to the extent practicable, potential adverse social and economic effects on **ocean users** and ocean-dependent communities.

A limited system is a collection of individual sites that are representative of marine habitats and that are **ecologically significant** when taken as a whole.⁴

Objectives:

1. Protect areas within each **biogeographic region** of Oregon's Territorial Sea that are important to the natural diversity and abundance of marine organisms, including areas of high biodiversity and special natural features.
2. Protect key types of marine habitat in multiple locations along the coast to enhance **resilience** of nearshore ecosystems to natural and human-caused effects.
3. Site marine reserves and design the limited system of reserves in ways that are compatible with the needs of coastal communities by avoiding, to the extent practicable, potential adverse social and economic effects.
4. Use the marine reserves as **ecological reference areas** by conducting ongoing research and monitoring of reserve condition, effectiveness, and the effects of natural and human-induced stressors. Use the research and monitoring information in support of **adaptive management**.⁴

Although OPAC addressed all three aspects defining goals and objectives (biological and ecological, economic, and social), I believe that Oregon could have done a better job with this.

Future managers should cite the positive aspects that have resulted from other case studies for marine reserves such as larval dispersal, size-structure improvements, enhanced species diversity, and spillover of economically important stocks to adjacent areas, in order to recruit more widespread support for implementation. It is important to mention not only avoiding

adverse effects **but also** explain possible beneficial effects of MRs and MPAs in order to remain objective but positive.

3. Establish Sources of Funding. Oregon relies on [state] government funding for establishment, monitoring, and enforcing reserves. I believe that Oregon could do a much more thorough job of defining funding sources, whether this be through permitting fees, NGO funding, enforcement actions (monetary fines), or fees to recreational users.

4. Define Resources and Resource Users. I maintain that ODFW's Marine Reserve Program did an excellent job (in collaboration with the nearshore action teams and Ecotrust) of collecting these data and establishing these baselines for the pilot sites, and that the collection of such is being adequately performed on the three proposed sites as well. The data collection process takes a lot of financial resources, and thus-far the state has received sufficient funds to make the process of data collection feasible to a large degree, as demonstrated by the diversity of the biological and ecological, and social and economic data collection and monitoring performed heretofore and henceforth.

5. Define Prohibited and Permitted Activities and Eligible Participants. By collaboration between ODFW, Oregon Department of State Lands, Oregon Parks and Recreation Department, Oregon State Police, and finally through seeking the input from the communities themselves, Oregon did an excellent job of defining these parameters. Not only were prohibited activities clearly outlined (outreach and education are ongoing), but permitted activities were also clearly described, including use of extractive techniques for scientific research.

6. Define Means of Enforcement. Oregon did a fair job with this, especially in the case study example of Redfish Rocks. Education and outreach are crucial to acceptance of, and adherence

to, marine reserves, and this is another example of how the Oregon case study [performed by this document] was successful to-date in its process of establishing MRs. The Oregon model uses the State Police and ODFW agents to police its reserves. It is clear from the case study that the community members in Port Orford, due to their sense of pride and stewardship of their local environs, will be proactive in collaboration with these enforcing agencies by reporting incursions and infractions.

7. Perform Assessment and Evaluation, and use Innovation for Adaptive Management. To date, Oregon has done an excellent job of scheduling dates for periodic programmatic review for many of the measurables that will determine the relative success of each site in realizing OPAC's goals for the reserve system in Oregon.^{33,34} Additionally, submitting reports publicly and holding peer-reviewed workshops^{16,17,32} to inform and critique the science utilized in implementation and monitoring has been a strong suit of the Oregon implementation process.

Conclusions and Recommendations

It will be interesting to see if the 2013 ODFW biennial report for biological monitoring will show significant benefits to the reserve, such as increased average fish size, benefits to community structure, improved fishing on the adjacent grounds due to spillover, improved species diversity, *et cetera*. Continuing monitoring studies, both ecosystem-based and socioeconomic in nature, are going to be necessary to fill in gaps of scientific knowledge as the fledgling Marine Reserve Program in Oregon matures.

I recommend using mark-recapture studies, bolstered by increasing the number of chartered extractive hook and line surveys, in place of and supplement to some of the quantity of dive surveys proposed to be performed by Emily Saarman of UC Santa Cruz.³¹ A mark-recapture study uses extractive techniques (e.g. hook and line fishing), paired with tagging (e.g. coded wire tags, spaghetti tags) and live release. When subsequent extractive surveys are performed, tags can be seen or detected (e.g. metal detecting wands) and data can be taken on the animal (time since last capture, location of capture, health of individual (length, weight, sexual maturity, etc.) and then the fish can once again be freed using careful release techniques to minimize injury and fatality. Mark-recapture studies, given knowledge about catch efficiency (catch per unit effort metrics), can be an excellent source of data for biomass estimates. Expanding mark-recapture studies and extractive studies could serve several purposes simultaneously; they could be used to supplement the visual surveys and be used for comparative analyses to determine which method is the most accurate, and they *may* cut down on monitoring costs versus the SCUBA transect survey methods, although a comparative cost analysis would need to be performed. Visual dive surveys have been shown to be highly

variable in accuracy for enumerating fish and informing biomass estimates.⁴⁴ The process of observation may affect the behaviors of motile observed fish and invertebrates. There is a “diver effect” on certain fishes that tend to hide from SCUBA divers performing transect surveys. In addition, there are biases introduced by variation in observer efficiency in conducting visual surveys.⁴⁵ Extractive and mark-recapture surveys should be enhanced and dive surveys should be limited in order to mitigate this bias.

Oregon made excellent use of existing information regarding the establishment of marine reserves, and developed a very thorough and detailed approach to implementation from the ground up. The Port Orford Ocean Resource Team and Redfish Rocks Community Team were exemplary in their dedication to public outreach and education, their community involvement, and their thoroughness in establishing Redfish Rocks as a pilot marine reserve site for Oregon. In comparison to the other proposed marine reserve sites (the other pilot site at Otter Rock and the proposed sites), the Redfish Rocks proposal was very effective in that POORT and the RRCT were instrumental in collecting the baseline data for future studies. With much of the preliminary data collection already complete, it was much easier for the POORT and the RRCT to pitch the benefits of their proposed site to ODFW and the OPAC.

I recommend that the federal government adopt a universal guideline/procedure document for the establishment of marine reserves in this country, following recommendations by the Science and Technical Advisory Committee, to streamline the nation’s process of marine reserve and marine protected area implementation in the future. Variations in management styles and Fishery Management Plans enacted by the various Regional Fishery Management Councils here in the United States create incongruences and inconsistencies in management

and monitoring. I believe that the Pew Oceans Commission's request that a managing agency be created under the National Ocean Council to alleviate these discrepancies in management, and establish consistency between the Regional Fishery Management Council agencies to standardize the process of marine reserve designation is an excellent one and should be adopted immediately.²

I learned a great deal in performing the study of Oregon's system and the case study of Redfish Rocks, which led me to the conclusion that the United States could take lessons (both in what was done well and in what could be improved upon) from the Oregon process in creating a standardized model for marine reserve and marine protected area establishment.

I assert that by creating a national-level governing agency under the National Ocean Council to standardize the fishery management (not only of reserves and protected areas, but of all aspects of fishery management currently handled by the regional fishery management councils), national-level funding for implementation, monitoring, and enforcement would be easier to secure. Currently, the National Marine Fisheries Service organization is used to inform and perform many levels of fishery management (including data collection and enforcement) for federally designated fisheries. However, the NMFS adheres to management rules and regulations put forth by the relevant Regional Fishery Management Councils. Each RMFC uses data collected through fishery-dependent and fishery-independent techniques to inform management decisions, but the processes of data collection and analysis are far from uniform across regions. I contend that the United States would benefit greatly by creating a governing agency that would oversee the national standardization informing our regulatory management frameworks, both within our States' territorial seas, and within the 200 miles Exclusive

Economic Zone established by the Magnuson Stevens Act. In addition, standardizing the processes for implementation would lead to more uniform scientific metrics, measuring successes against standardized goals for reserves.

Although marine reserves and marine protected areas are a relatively new concept, they certainly are a viable fishery management tool supporting an ecosystem-based approach. As more reserves are implemented nationally and globally, we can use the existing lessons and glean future data informing their efficacy to advance and adapt our fishery and ecosystem management. Marine reserves and protected areas serve to improve the size and age structure of fish populations, enhance species diversity which in turn can bolster an ecosystem's ability to recover from natural and anthropogenic perturbations, and generally support management goals for sustainability of our living marine resources. While each region will want to adapt a model process for their local environmental conditions, having a template could help communities and managers in the design and implementation process, enhancing site effectiveness and assisting in the realization of program goals.

Notes:

¹ 16 U.S.C. §§ 1431-1445 (2000, amended from 1972). Retrieved 11/30/2012 from <http://sanctuaries.noaa.gov/welcome.html>.

² Baur, D.C., Eichenberg, T., and Sutton, M. 2008. Ocean and Coastal Law and Policy. American Bar Association, Chicago.

³ McLeod, K. L., J. Lubchenco, S. R. Palumbi, and A. A. Rosenberg. 2005. Scientific Consensus Statement on Marine Ecosystem-Based Management. Signed by 217 academic scientists and policy experts with relevant expertise and published by the Communication Partnership for Science and the Sea at <http://compassonline.org/?q=EBM>.

⁴ Worm et al. 2006. Impacts of biodiversity loss on ocean ecosystem services. Science: 314, 787-790

⁵ Roberts et al. 2001. Effects of Marine Reserves on Adjacent Fisheries. Science: 294, 1920-1922.

⁶ 65 C.F.R. 34,909. Executive Order No. 13,158 (2000).

⁷ Ocean Policy Advisory Council. 2008. Oregon Marine Reserve Policy Recommendations. Ocean Policy Advisory Council. Retrieved 11/12/2011 from http://www.oregon.gov/LCD/OPAC/docs/resources/OPAC_MarResPolRec_081908.pdf?ga=t

⁸ Oregon Coastal Management Program. 2011. Ocean Resources: Program Elements. Retrieved 11/12/2011 from http://www.oregon.gov/LCD/OCMP/Ocean_Intro.shtml

⁹ Oregon.gov. 2010. Ocean Resources: Program Elements. Retrieved on 11/14/2011 from http://www.oregon.gov/LCD/OCMP/Ocean_Intro.shtml

¹⁰ http://www.oregon.gov/LCD/OPAC/OPAC_Members_April_2011.pdf

¹¹ 16 U.S.C §§ 1801-1883 (2000). Magnuson Stevens Act. 16 U.S.C. § 1853 (a)(7). From Baur, D.C., Eichenberg, T., and Sutton, M. 2008. Ocean and Coastal Law and Policy. American Bar Association, Chicago.

¹² Our Ocean: Preserving Oregon's Coastal Legacy. State Process. Available at: <http://www.ouroregonocean.org/stateprocess.html> . Retrieved 11/14/2011.

¹³ Gregoire, Kulongoski and Schwarzenegger. 2006. West Coast Governors' Agreement on Ocean Health. Retrieved 11/15/2011 from: <http://westcoastoceans.gov/docs/WCOceanAgreementp6.pdf>

¹⁴ Gregoire, Kulongoski and Schwarzenegger. 2008. West Coast Governors' Agreement on Ocean Health Action Plan. Retrieved 11/15/2011 from http://www.westcoastoceans.gov/docs/WCGA_ActionPlan_lowest-resolution.pdf

¹⁵ Chambers, S. 2008. Marine reserves legislation sails through committee (January 16). The World. Coos Bay. Retrieved 11/17/2011 from http://theworldlink.com/news/local/article_9100faa2-9a3a-5a8e-9957-c0c73983c81b.html.

¹⁶ Barth, J., Heppell, S., and Young, C. 2008. Preliminary Report to MRWG on STAC Size and Spacing Workshop DRAFT. STAC. Retrieved 11/20/2011 from http://www.yachats.info/resource/reserves/PrelimRepSTACSizeandSpacingDRAFT_20apr2008.pdf.

¹⁷ Heppell, S., Barth, J., and Reiff. 2010. Size and Spacing of Marine Reserves Workshop Report. STAC and MRM Program, Oregon State University. Retrieved on 11/19/2011 from

http://www.oregonocean.info/index.php?option=com_docman&task=doc_download&gid=483&Itemid=19.

¹⁸ Personal interview with Anna Pakenham, Nearshore Resources Assistant Project Leader/ Marine Reserves. ODFW. 11/21/2011.

¹⁹ ODFW. 2008. State Agency Review: Site Analysis Worksheet. ODFW.

²⁰ McMullen, S. 2008. Oregon Ocean Policy Advisory Council letter to Kulongoski. OPAC. Retrieved 11/12/2011 from

http://www.oregon.gov/LCD/OPAC/docs/MR_Recomendation_to_Gov_Kulongoski.01Dec.pdf?ga=t.

²¹ Kulongoski, T. 2009. To the Ocean Policy Advisory Council. Retrieved on 11/25/2011 from http://www.oregonocean.info/index.php?option=com_docman&task=doc_download&gid=65&Itemid=19

²² Committee on Rules. 2009. 75th OREGON LEGISLATIVE ASSEMBLY--2009 Regular Session: A-Engrossed

House Bill 3013. Retrieved on 11/17/2011 from

<http://www.leg.state.or.us/09reg/measpdf/hb3000.dir/hb3013.a.pdf>

²³ Learn, S. 2009. Oregon Senate approves state's first marine reserves. The Oregonian (July 17). Retrieved 11/18/2011 from

http://www.oregonlive.com/environment/index.ssf/2009/06/oregon_senate_approves_states.html.

²⁴ ODFW. 2010. Marine Reserves WorkPlan. November 2009. ODFW. Retrieved 11/17/2011 from

http://www.oregonocean.info/index.php?option=com_docman&task=doc_download&gid=7&Itemid=19

²⁵ Learn, S. 2010. Oregon ocean panel endorses three new marine reserves. The Oregonian (Dec 7). Retrieved 11/15/2011 from <http://www.conservationleaders.org/marine.reserves.htm>.

²⁶ Kitzhaber, J., and Brown, K. News release: Oregon's Marine Reserves Moving Forward. 2011. Retrieved 11/23/2011 from <http://us2.campaign-archive2.com/?u=41b11f32beefba0380ee8ecb5&id=f9c8c53ce0&e=0ed6e94fcf>.

²⁷ Harvest Restrictions Redfish Rocks Marine Reserve and Marine Protected Area, and Otter Rock Marine Reserve. 6/12/2012. ODFW.

²⁸ Oregon Ocean information website:

http://www.oregonocean.info/index.php?option=com_content&view=article&id=419&Itemid=138, retrieved 11/20/2012.

²⁹ Personal email communication with Cristen Don, Nov. 17th, 2012.

³⁰ Laferriere, A., and Matteson, K. 2011. Biological Monitoring Progress Report Otter Rock and Redfish Rocks Pilot Marine Reserves. ODFW. Document provided by first author. 10/05/2011. http://www.oregonocean.info/index.php?option=com_docman&task=doc_download&gid=941&Itemid=19

³¹ Personal interview with Alix Laferriere, Marine Reserves Research Project Leader. ODFW. 11/21/2011.

³² Lafferriere, A. 2012. Marine Reserve Monitoring Workshop Summary. ODFW. Newport, Oregon.

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- ³³ LaFerriere, A, et al. April 2012. Oregon Marine Reserves Ecological Monitoring Plan. Oregon Department of Fish and Wildlife, Marine Resources Program. Newport, OR.
- ³⁴ Murphy, M. 2011. Human Dimensions Monitoring Progress Report Oregon Marine Reserve Implementation at Otter Rock and Redfish Rocks Pilot Marine Reserves. ODFW. Retrieved on 11/19/2011 from http://www.oregonocean.info/index.php?option=com_docman&task=doc_download&gid=940&Itemid=19.
- ³⁵ Murphy, M. et al. 2012. Oregon Marine Reserves Human Dimensions Monitoring & Research Plan. ODFW. Newport, Oregon.
- ³⁶ Hesselgrave, et al. 2011. Shoreside Economic Analysis for the Oregon Territorial Sea Plan Final Report. Ecotrust. Portland, Oregon.
- ³⁷ Personal interview with former POORT member Alicia Billings.
- ³⁸ Don, C, et al. April 2012. Redfish Rocks Site Management Plan. ODFW, MRP. Newport, Oregon. Retrieved from www.oregonocean.info/marinereserves 11/20/2012.
- ³⁹ Table retrieved on 11/30/2011 from <http://library.state.or.us/repository/2010/201003031600243/index.pdf>.
- ⁴⁰ Billings, A., and Golden, J. 2008. PORT ORFORD STEWARDSHIP AREA PROPOSAL. POORT and Golden Marine Consulting. Document provided by first author.
- ⁴¹ Cobb et al. 2007. PORT ORFORD: IMPLEMENTING COMMUNITY-BASED OCEAN MANAGEMENT ON THE OREGON COAST. Proceedings of Coastal Zone 07, Portland Oregon. Retrieved 11/25/2012 from http://www.csc.noaa.gov/cz/CZ07_Proceedings/PDFs/Thursday_Abstracts/3125.Cobb.pdf.
- ⁴² Map retrieved from Oregon Ocean Information website. http://www.oregonocean.info/index.php?option=com_content&view=article&id=419&Itemid=138.
- ⁴³ Roberts, C.M. and J.P. Hawkins. 2000. Fully-Protected Marine Reserves: a Guide. WWF Endangered Seas Campaign, Washington, DC, and USA and Environment Department, University of York, York, UK.
- ⁴⁴ Dickens, L.C. et al. 2011. Quantifying Relative Diver Effects in Underwater Visual Censuses. PLoS ONE 6(4): e18965. doi:10.1371/journal.pone.0018965
- ⁴⁵ Korman, et al. 2002. Effects of observer efficiency, arrival timing, and survey life on estimates of escapement for steelhead trout (*Oncorhynchus mykiss*) derived from repeat mark–recapture experiments. Canadian Journal of Fisheries and Aquatic Sciences. NRC Research Press.