

# 2022 Assessment of Oregon's Marine Reserves

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**Jess Hopf**, Oregon State University  
**Brian Erickson**, Oregon State University  
**Jennifer Caselle**, University of California, Santa Barbara  
**Stefan Gelcich**, Pontificia Universidad Católica de Chile  
**Sarah Lester**, Florida State University  
**Kerry Nickols**, California State University, Northridge  
**Jim Sanchirico**, University of California, Davis  
**Kelly Biedenweg**, Oregon State University  
**J. Wilson White**, Oregon State University

Prepared for the Scientific and Technical Advisory Committee (STAC) of the Oregon Ocean Policy Advisory Council (OPAC).

# Executive Summary

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## Background

In 2012, Oregon completed the planning and designation of five marine reserves. The implementation and management of these marine reserves is led by the Oregon Department of Fish and Wildlife (ODFW) and is based on guidance from Executive Order 08-07 (2008), House Bill 3013 (2009), Senate Bill 1510 (2012), and agency administrative rules.

The **Goals** of Oregon's marine reserves are to:

*Protect and sustain a system of fewer than ten marine reserves in Oregon's Territorial Sea to conserve marine habitats and biodiversity; provide a framework for scientific research and effectiveness monitoring; and avoid significant adverse social and economic impacts on ocean users and coastal communities.*

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

Senate Bill 1510 mandated that the ODFW Marine Reserve program complete a decadal self-assessment in 2022; as such, ODFW produced the ODFW Marine Reserve Program Synthesis Report. SB 1510 further mandated that the Synthesis Report be evaluated by a team of outside experts from an Oregon public university. This is that evaluation, termed the University Assessment Report. The **Charge** for this evaluation was, in brief, to

- A. *Assess the social, economic, and environmental factors related to the reserves.*
- B. *Recommend administrative actions and legislative proposals related to the reserves.*
- C. *Provide any other scientifically based information relevant or material to the reserves.*

## Approach

The University Assessment Report was prepared by researchers at Oregon State University, in collaboration with researchers from other universities. This team has expertise spanning the Natural Sciences (marine ecology, fisheries, oceanography) and the Social Sciences (environmental economics, psychology, and communication), with decades of combined experience in marine reserve science.

The assessment followed the evaluation framework developed by the Scientific and Technical Advisory Committee (STAC) of the Oregon Ocean Policy Advisory Council (OPAC). The university team evaluated the Synthesis Report and all accompanying appendices and supporting materials. Subsequent legislative and administrative recommendations are based on their expert judgement and current best practices in marine reserve science.

## Key Findings

- Oregon's marine reserves were, in general, effectively designed and implemented to achieve the goals and objectives set forth in legislation and OPAC recommendations.
  - It is too soon to evaluate whether some ecological goals will be met, such as whether the reserves can promote ecological resilience. Ongoing monitoring and research are needed to evaluate those goals.
  - Monitoring of social and economic effects revealed positive and adverse impacts that varied by location and social group. Adverse impacts were unevenly distributed. Overall, fewer and

less extreme adverse impacts were recorded than might have been expected. More adequately evaluating socioeconomic impacts will require developing and monitoring clearly defined social and economic indicators.

- Lessons learned over 10 years of the Marine Reserve Program (including evaluations such as this report) provide the feedback needed to:
  - Move into a phase of consistent long-term marine reserve monitoring and research.
  - Support Oregon in evaluating and potentially adjusting its marine reserve system moving forward in an adaptive management process.

## Key Recommendations

1. To support the legislated goals of conserving biodiversity while avoiding adverse socioeconomic impacts, the **Oregon Legislature should consider these actions:**
  - a. Appropriate funds to allow ODFW to continue the Marine Reserves Program at the necessary capacity. This includes funding for new human resources and programmatic activities, including: management, policy, and program administration; ecological monitoring; human dimensions monitoring; and outreach and community engagement.
  - b. Provide a mandate that supports the development of an Adaptive Management plan (as described below) for the ongoing management and evaluation of the marine reserves program.
  - c. Define a detailed collaborative process through which social monitoring data can be interpreted to affect policy decisions. This process should include steps for decision making, conflict management, and clarity on who the state of Oregon is concerned with impacting (through the Marine Reserve Program), and in what ways. The Magnuson-Stevens Act could serve as an example for describing such a process.
2. To fulfill the goals of conserving marine habitats and biodiversity while avoiding adverse socioeconomic impacts, ODFW should develop an **adaptive management plan** for the Oregon Marine Reserve Program that includes clear objectives, defined decision-making criteria and timelines, and stakeholder engagement processes. **This will require ODFW to:**
  - a. Develop specific, measurable, achievable, relevant, and time-oriented objectives for ecological and socioeconomic monitoring and research, including a timeline for adaptive decision-making.
  - b. Develop consistent measurable indicators of social impacts.
  - c. Implement efficient and consistent ecological sampling protocols.
  - d. Assess the capacity for the marine reserves to enhance ecological resilience to environmental disturbances. This requires longer time-series of data and evaluation of how well the reserves operate as a network.
  - e. Develop defined goals for outreach and engagement, including with Tribes, and undertake assessments to evaluate the effectiveness in achieving these goals.

The adaptive management plan should include criteria for determining whether modifying existing reserve boundaries or the number of marine reserves and marine protected areas is needed to meet legislative objectives. The plan should include details for a community-engaged process for planning and implementing any changes

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# Acronyms & Abbreviations

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<b>CPUE</b>	Catch per Unit Effort
<b>FTE</b>	Full-time equivalent (employees)
<b>MPA</b>	Marine Protected Area
<b>MR</b>	Marine reserves
<b>NOAA</b>	National Oceanographic and Atmospheric Administration
<b>ODFW</b>	Oregon Department of Fish and Wildlife
<b>OPAC</b>	Ocean Policy Advisory Council
<b>OSU</b>	Oregon State University
<b>ROV</b>	Remote Operated Vehicle
<b>SMURF</b>	Standard Monitoring Unit for the Recruitment of Reef Fishes
<b>STAC</b>	Scientific and Technical Advisory Committee

# Introduction

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## *Oregon's Marine Reserves*

In 2012, Oregon completed the planning and designation of five marine reserve sites in state waters (0-3 nautical miles from land): Cape Falcon, Cascade Head, Otter Rock, Cape Perpetua, and Redfish Rocks. Each of the five sites contains a marine reserve that prohibits all extractive activities, including fishing and ocean development. Some sites also have Marine Protected Areas adjacent to the reserve; these prohibit ocean development but allow some fishing.

The **Goals** of Oregon's marine reserves are to:

*Protect and sustain a system of fewer than ten marine reserves in Oregon's Territorial Sea to conserve marine habitats and biodiversity; provide a framework for scientific research and effectiveness monitoring; and avoid significant adverse social and economic impacts on ocean users and coastal communities.*

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

To help guide the siting, development, and implementation of Oregon's marine reserves, the **Objectives** of the Reserves are to:

- 1. Protect areas within 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 fewer than ten marine reserves and design the system in ways that are compatible with the needs of ocean users and coastal communities. These marine reserves, individually or collectively, are to be large enough to allow scientific evaluation of ecological effects, but small enough to avoid significant adverse social and economic impacts on ocean users and coastal communities.*
- 4. Use the marine reserves as reference areas for 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 nearshore resource management and adaptive management of marine reserves.*
- 5. Although marine reserves are intended to provide lasting protection, individual sites may, through adaptive management and public process, later be altered, moved, or removed from the system, based on monitoring and reevaluation at least every five years.*

Oregon's marine reserve sites are managed as a system by the State of Oregon, with the Oregon Department of Fish and Wildlife (ODFW) as the lead management agency.

In 2009, Oregon State Legislature created the ODFW Marine Reserves Program (**'the MR Program'**) to oversee the designation, management, and scientific monitoring of the marine reserve system. The Marine Reserves Program's **overarching mandates**, which derive from [Executive Order 08-07 \(2008\)](#), [House Bill 3013 \(2009\)](#), [Senate Bill 1510 \(2012\)](#), and agency administrative rules, are (in summary) to:

- develop and implement site management plans,
- conduct ecological research (including baseline data collection) and monitoring,
- conduct human dimensions research,
- engage communities and provide information to the public, and
- support compliance and enforcement of the sites.

These mandates encompass the Marine Reserve Goals and Objectives, as well as the Planning and Implementation Principles and Guidelines set out in the [Oregon Marine Reserve Policy Recommendations \(OPAC, 2008\)](#). See [Appendix 1](#) for detailed mandates.

In 2022, ODFW released an extensive [Synthesis Report](#) providing a comprehensive overview of the Marine Reserves Program and the first 10 years of implementation of Oregon's marine reserves. Chapter 5 of the [Synthesis Report](#) provides a detailed overview of how the marine reserve mandates have been executed.

### *2022 Marine Reserve Assessment*

This Assessment Report provides a scholarly assessment of the Marine Reserves Program and outcomes from 2008-2020, as detailed in ODFW's [2022 Synthesis Report](#) and accompanying [Appendices](#). This report was prepared by researchers at Oregon State University, in collaboration with researchers from Pontificia Universidad Católica de Chile, Florida State University, California State University Northridge, University of California Santa Barbara and University of California Davis. This assessment team was chosen by STAC in September 2021 after a competitive selection process that evaluated the expertise of the team and their proposed assessment approach. This team has expertise spanning the Natural Sciences (marine ecology, fisheries, oceanography) and the Social Sciences (environmental economics, psychology, and communication), with decades of combined experience in marine reserve science. Funding for the assessment process was provided by a grant from Oregon Ocean Science Trust Fund, via the Oregon State University Foundation.

In 2021, the Scientific and Technical Advisory Committee (STAC) of the Oregon Ocean Policy Advisory Council (OPAC) tasked the authors of this report with undertaking a legislatively-mandated assessment of Oregon's marine reserve system. As directed by Senate Bill 1510 (2012), this report includes an assessment and recommendations as set forth in Section 4(2)(b):

- A. *An assessment of social, economic, and environmental factors related to the reserves and protected areas; and*
- B. *Recommendations for administrative actions and legislative proposals related to the reserves and protected areas; and*
- C. *Any other scientifically based information related to the reserves and protected areas that the public university described in this subsection deems relevant or material.*

Informed by [OPAC's Oregon Marine Reserve Policy Recommendations \(2008\)](#), STAC developed Criteria ([Appendix 1](#)) to guide this assessment of the Marine Reserves Program. The Assessment Criteria are binned into seven categories: Marine Reserve Design, Marine Reserve Baseline Assessment, Ecological Factors, Socioeconomic Characteristics, Level of Community Engagement, Governance, and Enforcement.

### *How to use this report*

In this report, we directly address each of the Assessment Criteria developed by STAC ([Appendix 1](#)), as well as overarching questions posed by STAC about the Marine Reserves Program. In a few cases we have reorganized the criteria outlined by STAC to support a more cohesive report, making note of where this occurs. We provide a technical summary that includes overarching conclusions and recommendations, and summaries and recommendations for each Criteria. Detailed responses to each Criteria are found in the main body of the report.

Throughout this report, we make recommendations towards future inclusions and changes to ODFW's Marine Reserves Program.

Following ODFW's [Synthesis Report](#), this report focuses primarily on the marine reserve portion of the five sites, although Marine Protected Areas (and the seabird protection area at Cape Perpetua) are implicitly included in the Marine Reserve Design, Level of Community Engagement, Governance, and Enforcement sections.

Links to relevant ODFW documents stored publicly on [Google Drive](#) are provided throughout the document.

# Technical Summary

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## Overarching Comments

The following overarching questions were outlined by the Scientific and Technical Advisory Committee (STAC) of the Oregon Ocean Policy Advisory Council (OPAC) in their formal Request for Proposals for a University Team to undertake this report. We answer these here as overarching conclusions to the report, based on more detailed analyses of specific aspects of the Marine Reserves Program in our full report below.

- A. Were Marine Reserves and associated MPAs effectively designed and implemented to achieve the goals and objectives set forth in OPAC's 2008 Oregon Marine Reserve Policy Recommendations?

In our expert judgement, Oregon's marine reserves were, in general, effectively designed and implemented to achieve the stated goals and objectives. Oregon Department of Fish and Wildlife (ODFW) has undertaken extensive ecological and human dimensions research and monitoring over the last 10+ years, a period spanning the planning, implementation, and monitoring of the reserves. ODFW's research has been scientifically robust and follows best practices for long-term monitoring and marine reserve science.

The five marine reserves in Oregon protect multiple marine habitats and ecosystems from direct human pressures (i.e., fishing and ocean development). ODFW's ecological research generally supports the premise that these areas can contribute to the conservation of habitats and biodiversity. However, we identify two key objectives that are not possible to completely evaluate at this time: 1) whether the reserves are ecologically significant (as defined by OPAC in their [2008 Policy Recommendations](#)) as a whole (STAC's Assessment Criteria do not explicitly consider this; [Appendix 1](#)), and 2) whether the reserves will enhance the resilience of Oregon's nearshore social-ecological systems (this is currently a topical question for marine reserves globally).

The known social and economic impacts of Oregon's marine reserves are complex and span across multiple social groups, including ocean users and coastal communities. Critically, these impacts occur heterogeneously across social groups and what is considered 'significant' to one group may not be to another. ODFW's human dimensions research was extensive and found both adverse and positive impacts associated with Oregon's marine reserves, as well as no impacts in socioeconomic areas that might have been expected to be adversely affected. Future human dimension research would benefit from clearly defined social (in particular) and economic indicators that would 1) better inform whether the impacts experienced are more substantial than expected, 2) clarify the context or scale at which impacts should be evaluated, and 3) support the on-going monitoring of social and economic impacts.

Critically, the last 10 years of reserve planning, implementation, research, and monitoring have been an extensive learning opportunity for Oregon. The lessons learned by ODFW's Marine Reserves Program - and evaluations of the Program such as this assessment report - provide the feedback needed to 1) support ODFW in moving the Marine Reserves Program into a phase of consistent long-term monitoring and research, and 2) support the state of Oregon in evaluating and potentially adjusting its marine reserve system moving forward. This feedback is crucial to supporting an adaptive management framework, as are continued iterations of monitoring, research, and evaluation (Williams et al. 2009). The biggest limitation to adaptive management is taking the time to learn from experiences and subsequently modify strategies; Oregon is now at a pivotal stage, engaging in this critical aspect of the adaptive management process.

B. Did ODFW successfully execute the legislative mandates set forth regarding Marine Reserves implementation?

In our expert judgement, and based on the Criteria set by STAC, ODFW generally executed the legislative mandates through their Marine Reserves Program. The Marine Reserves Program included the planning and implementation of the reserves, ecological and human dimensions research and monitoring, community outreach and engagement, and support for compliance and enforcement.

This assessment report details how the Marine Reserves Program has addressed the mandates and outlines key lessons from ODFW's experience. Of particular note to the marine reserve objectives, we assess 1) the extent to which ODFW's current ecological and human dimensions research aligns with the marine reserve objectives in Question [3.8](#), and 2) whether the current Ecological and Human Dimensions Monitoring Plans address the marine reserve objectives in Question [0](#).

Critical to undertaking an assessment such as this is defining the questions that will be the most useful for the Program and the assessment. STAC developed extensive Criteria ([Appendix 1](#)) to guide the assessment. However, two overarching questions were not explicitly included in the Marine Reserves Program or the STAC Criteria; in our view these would be critical to evaluating any reserve program:

1. What outcomes and impacts (ecological, social, economic, etc.) were expected from the marine reserves, and did these occur?
2. Were there any unexpected impacts from the marine reserves?

These questions form a framework that applies broadly and specifically across multiple research domains. For example, what socioeconomic impacts were expected (broad)? Or what type of biodiversity (species, ecosystem, genetic. etc.) is expected to be affected (specific)?

Explicitly considering these questions would help guide future research and future assessments of the Marine Reserves Program.

C. Recommendations for administrative actions and legislative proposals related to the reserves and protected areas.

Based on this 2022 assessment of the Marine Reserves Program, our key recommendations are the following:

1. To support the legislated goals of conserving biodiversity while avoiding adverse socioeconomic impacts, the **Oregon Legislature should consider these actions:**
  - a. Appropriate funds to allow ODFW to continue the Marine Reserves Program at the necessary capacity. This includes funding for new human resources and programmatic activities, including: management, policy, and program administration; ecological monitoring; human dimensions monitoring; and outreach and community engagement.
  - b. Provide a mandate that supports the development of an Adaptive Management plan (as described below) for the ongoing management and evaluation of the marine reserves program.
  - c. Define a detailed collaborative process through which social monitoring data can be interpreted to affect policy decisions. This process should include steps for decision making, conflict management, and clarity on who is the state of Oregon is concerned with impacting (through the Marine Reserve Program), and in what ways. Magnuson Stevens could serve as an example for describing such a process.
2. To fulfill the goals of conserving marine habitats and biodiversity while avoiding adverse socioeconomic impacts, ODFW should develop an **adaptive management plan** for the Oregon Marine Reserve Program that includes clear objectives, defined decision-making criteria and timelines, and stakeholder engagement processes. **This will require ODFW to:**
  - a. Develop specific, measurable, achievable, relevant, and time-oriented objectives for ecological and socioeconomic monitoring and research.
  - b. Develop consistent measurable indicators of social impacts.
  - c. Implement efficient ecological sampling protocols that remain consistent over time and space.
  - d. Assess the capacity for the marine reserves to enhance ecological resilience to environmental disturbances. This requires longer time-series of data and evaluation of how well the reserves operate as a network.
  - e. Develop defined goals for outreach and engagement, including with Tribes, and undertake assessments to evaluate the effectiveness in achieving these goals. Critically, the Program requires the human resources capacity (at least one full-time equivalent position) to fully support the Outreach and Communication Program.

The adaptive management plan should include criteria for determining whether modifying existing reserve boundaries or the number of marine reserves and marine protected areas is needed to meet legislative objectives. The plan should include details for a community-engaged process for planning and implementing any changes.

## Responses to Assessment Criteria

The following sections provide technical summaries for each of the Assessment Criteria develop by STAC ([Appendix 1](#)). See the Full Report for further details.

### 1. Marine Reserve Design

*\* As these questions relate to outcomes from the initial planning and design of the marine reserves, we do not provide any recommendation. See Section 3 onwards for specific recommendations.*

#### 1.2. Were areas of high natural biodiversity identified as part of the planning process? (O1)

Areas of potentially high natural biodiversity were identified for proposed reserve sites, primarily through habitat mapping (as a proxy for biodiversity) and expert opinion. This is consistent with best practices in marine spatial planning.

However, biodiversity along the whole Oregon coast was not explicitly considered and it is unclear whether identified areas support higher biodiversity than the rest of the Coast.

#### 1.3. Do the Marine Reserves protect areas of special natural features? (O1)

*a. Were special natural features identified as part of the planning process? (O1)*

*b. What special natural features were identified? (O1)*

A range of special natural features along the Oregon coast - including emergent rocks, deep reef complexes, and upwelling sites - were identified during the planning process and encompassed in Oregon's reserves. The reserves, however, can only directly protect natural features that predominately reside within their boundaries from restricted activities (ocean development and fishing). Features identified, but not included within any marine reserve included estuaries, sea caves, littoral cells, and the Columbia River Plume.

#### 1.4. Did the design of the Marine Reserves system incorporate community interest? (O3)

The design of Oregon's marine reserves incorporated community interest primarily by providing opportunities for public involvement throughout the planning processes. There is not enough information to assess whether this approach succeeded in actually incorporating community interests.

1.5. Were less than 10 sites established as part of the Oregon Marine Reserves? (O3)

Five reserve sites were established along the Oregon coast as part of the Marine Reserves Program: Otter Rock (established 2012), Redfish Rocks (2012), Cascade Head (2014), Cape Perpetua (2014), and Cape Falcon (2016).

## 2. Marine Reserve Baseline Assessment

\* *Baseline questions ([Appendix 1](#)) have been duplicated for the ecological and human dimensions monitoring programs.*

\*\* *As these questions relate to baseline data, which can no longer be altered, we do not provide any recommendation. See Section 3 onwards for specific recommendations.*

### ***Ecological Monitoring***

2.1. Were baseline data obtained at each site prior to closure (IPG7)?

2.2. What baseline data were obtained at each site? Were methods designed and carried out so that change could be detected (IPG7)?

2.3. Did the nature of the baseline data differ among sites, and were these differences reflected in the subsequent monitoring decisions (IPG7)?

\* *These three questions (2.1-2.3) are answered together in this report*

ODFW's Ecological Monitoring Program collected baseline ecological data - including species diversity, abundance, size, and cover - in all reserve and comparison sites at least once during the two years prior to closure.

The methods used and variables collected for the baseline ecological data varied by site and year ([Table 2.3.1](#) & [Table 2.3.3](#)).

Based on the lessons learned during baseline data collection, ODFW's monitoring approach adapted over time, with individual monitoring approaches developed for each site.

The baseline data collected are limited to detecting change between data collected with comparable sampling methods, and among sites sampled with the same method.

2.4. Was the timing of sampling driven by the objectives and sampling designs planned for each site, given information available at the start of the Marine Reserves process (IPG7)?

The sampling timing was informed by the reserve objectives, the baseline data collection, and the logistical/financial constraints of the Marine Reserves Program.

In general, sampling was done in fewer years than was planned, due to 1) funding, 2) logistical, and 3) COVID-19 pandemic difficulties (in that order of importance).

- 2.5. Were the methods of data collection appropriate for each site, given information available at the start of the Marine Reserves process, and driven by the planned objectives and sampling designs (IPG7)?

The ecological sampling methods used were appropriate for each site and driven by the planned objectives, given the information available at the start of the marine reserve process, which included baseline data and Ecological Monitoring workshops.

### *Human Dimensions Monitoring*

- 2.6. Were baseline data obtained at each site prior to closure (IPG7)?

Human dimensions data were obtained in the years leading up to and during designation and implementation of the reserves. This included data for areas proximate to reserves and comparison areas.

While substantial data collection occurred, it is not clear which data will be monitored on an ongoing basis.

The reserve designation process was underway before some initial baseline data could be collected. It is therefore important to consider the contemporary socioeconomic context of the baseline when interpreting and comparing data.

- 2.7. What baseline data were obtained at each site? Were methods designed and carried out so that change could be detected (IPG7)?

Baseline human dimensions data included:

- a. the attitudes, knowledge, and perceptions of different social groups on the reserves and the Marine Reserves Program,
- b. the social characteristics of communities,
- c. the economic characteristics of communities, and
- d. the direct uses of reserve areas.

The methods used to collect these baseline data were designed and carried out to allow for the detection of change over time. In some cases, continued data collection will require on-going collaboration with external partners.

Some surveys used different language in their questions, making direct comparisons between studies and findings difficult.

- 2.8. Did the nature of the baseline data differ among sites, and were these differences reflected in the subsequent monitoring decisions (IPG7)?

Most baseline human dimensions data were compiled or collected for all sites, rather than site-by-site. Some sites had individual studies often led by partners; these data can be seen as baseline data for the specific site only.

Baseline data varied from study to study ([Table 2.6.1](#)).

It is unclear if or how additional human dimensions monitoring data has informed subsequent monitoring from the information provided.

- 2.9. Was the timing of sampling driven by the objectives and sampling designs planned for each site, given information available at the start of the Marine Reserves process (IPG7)?

The initial human dimensions monitoring schedule included planned monitoring activities developed based on the Reserve objectives. This schedule lacked exact monitoring timelines but included expected monitoring intervals. Subsequent human dimensions monitoring plans did not outline timing schedules.

- 2.10. Were the methods of data collection appropriate for each site, given information available at the start of the Marine Reserves process, and driven by the planned objectives and sampling designs (IPG7)?

The methods of data collection used in the human dimensions project were appropriate, given the information available at the start of the Marine Reserves Program and driven by the reserve objectives.

### 3. Ecological Factors

#### *Planning/Site Evaluation*

- 3.1. Are the reserves in areas with a strong likelihood of high species, habitat, community, functional, and/or genetic diversity? (O1)

*\*We assume this question is phrased using the colloquial meaning of 'likelihood' rather than referring to actual statistical likelihood calculations.*

The reserve siting process identified locations that are likely to have high biodiversity. However, ODFW's monitoring and research have not been sufficient to quantitatively assess whether the reserves are in highly biodiverse areas compared to the rest of the Oregon Coast.

#### **Recommendation**

- a. Ground-truth the habitat-surrogate approach used to estimate biodiversity during the planning process by comparing habitat type to observed biodiversity.
- b. Compare observed biodiversity in reserve sites to the rest of the Oregon coast, if there is a desire to confirm that the reserves are in higher-than-average biodiversity locations.

- 3.2. Do the Marine Reserves protect representative key habitats? (O2)

*a. Were key types of marine habitat in multiple locations identified? (O2)*

*b. Are there important key habitats that were not included in the locations chosen? (O2)*

Collectively, Oregon's marine reserves encompass all the representative key habitat defined during the planning stages. The reserves provide protection to these habitats against fishing and ocean development.

No reserve encompasses all key habitat types. Except for shallow rocky reef with kelp, all habitat types are represented in multiple reserves.

Estuaries are an important key habitat not identified during the planning stage or included in any marine reserve, possibly due to the high economic impact of prohibiting fishing in these areas. However, the mouth of the Salmon River is located within the Cascade Head Marine Protected Area.

### **Recommendation**

- a. Assess whether the ratios of key habitat types (as define in [Table 3.2.1](#)) within the reserves are representative of the whole coast.
- b. Consider assessing habitat with more nuanced classifications that are important to biodiversity, such as further dividing subtidal rocky habitats by the degree of vertical relief or complexity.

### 3.3. Do the sites provide a potential for enhanced resilience to human-caused or natural perturbations? (O2)

Oregon's marine reserves have features that may lead to increased ecological resilience, especially to perturbations that occur at the spatial scale of individual reserves and for harvested species. This is based on the current understanding of reserve effects and how these effects may lead to resilience, rather than proven resilience mechanisms.

Direct evidence for reserves enhancing ecological resilience is lacking, and difficult to obtain ([Table 3.3.1](#)). ODFW has a valuable opportunity to contribute to this relatively new and challenging field of scientific study.

### **Recommendation**

In future ecological research plans, include long-term studies directly assessing the resilience capacity of marine reserves in Oregon's nearshore systems. See also Question [3.7](#).

### 3.4. Were ecological size and spacing considerations included in the development of the Marine Reserves system? (O3)

- a. *Are the Marine Reserves of sufficient size and spacing to detect statistically significant differences between Marine Reserves and control areas? (O3)*

Ecological size and spacing considerations were included in the planning and design stages of the marine reserves, primarily through engagement with experts.

Not all size and spacing criteria were met by the reserves as ecological considerations were balanced against adverse socioeconomic impacts.

There is not enough information to assess whether the reserves are of sufficient size and spacing to detect statistically significant differences between reserves and comparison areas, and the framing of that question is problematic.

A more pertinent question is whether the expected effects of reserve protection in Oregon are large enough to detect using appropriate comparisons. This requires more research to answer.

## **Recommendation**

Evaluate the expected detectability of reserve effects in Oregon's reserves. This is a possible area where ODFW could collaborate with external researchers, recognizing that ODFW's resources are limited.

### ***Program Evaluation***

- 3.5. Has species diversity been documented by appropriate quantitative sampling and statistics? (O1)

Species diversity was sampled in all sites using all ODFW's major ecological sampling methods. However, each sampling method used can only sample a portion of the community and, therefore, cannot give a complete picture of biodiversity by itself.

Diversity was quantified using appropriate diversity metrics (Hill numbers) and analysis (rarefaction-extrapolation curves).

The current sampling frequency was not sufficient to give an accurate estimate of diversity over time but pooling over years provided sufficient sample sizes to estimate diversity at each site for each method. No comparison of observed diversity among sampling methods was made.

## **Recommendation**

- a. Continue monitoring species diversity, possibly increasing frequency if there is logistical scope.
  - b. Add species completeness/coverage to analysis to better assess whether more sampling is required.
  - c. Compare and pool diversity among methods to obtain a more complete picture of biodiversity for each site.
  - d. Consider complementary biodiversity assessment approaches, such as eDNA metabarcoding, if establishing a complete picture of biodiversity in reserves is important.
- 3.6. Have appropriate methods been used to sample the abundance of key species? (O1)

Appropriate ecological sampling methods have been used, including hook and line sampling, longline sampling, Remotely Operated Vehicle (ROV) surveys, SCUBA surveys, and video lander surveys.

The details of the sampling methods evolved over time as ODFW responded to challenges and logistical constraints. While the evolution of methods is consistent with an adaptive management approach, it limits the use of the data collected to comparing between comparable methods and among sites sampled with the same method.

The power analysis ODFW conducted is extremely valuable in revealing which sampling methods are most effective at detecting patterns of ecological change.

We agree with ODFW that their focal species approach used in the analysis may have not been the best approach as it resulted in data with many zeros for some species and overlooked other abundant species, limiting analysis.

### **Recommendation**

- a. Continue ecological monitoring and research.
  - b. Use the experiences of the last 12 years of monitoring to set future sampling protocols that will remain consistent across space (where possible) and time. Continued monitoring workshops would aid in finalizing decisions.
  - c. Specific recommendations for each sampling method are outline in [Table 3.6.1](#).
  - d. Adopt the widely-used approach of analyzing the most abundant species that occur in the datasets, as a replacement for the previous approach using predetermined focal species.
  - e. Based on the power analysis, consider a cost-benefit analysis to evaluate the most cost-effective sampling methods to detect changes in abundance or size of commonly occurring species.
- 3.7. Have appropriate methods been developed for eventually determining the role of reserves in resilience of nearshore ecosystems? (O2)
- a. *Was the monitoring system designed to pick up specific kinds of perturbations that might be expected? (O2)*

The ecological monitoring methods developed by ODFW are currently insufficient for eventually determining the ecological resilience role of marine reserves in Oregon's nearshore system. This is due to 1) a lack of a clear definition of 'resilience' and 2) a lack of a clear resilience research plan by ODFW.

The long-term ecological and oceanographic monitoring undertaken by ODFW does, however, provides a solid foundation to build upon to understand the resilience roles of Oregon's reserves.

### **Recommendation**

- a. Develop a clear hypothesis-driven, research and monitoring agenda for understanding the resilience roles of marine reserves in Oregon waters, including:
- b. developing a working definition for 'resilience',
- c. continuing long-term monitoring of oceanographic and ecological variables (primarily focusing on species most affected by reserves and disturbances),
- d. analyzing combined oceanographic and ecological data to evaluate changes inside and outside reserves during a perturbation, and

- e. developing partnerships with external research groups to understand the mechanisms through which reserves could confer resilience at the community-ecosystem level.
- f. Focusing the reserve-resilience monitoring and research on at least two reserve-comparison site pairs (we suggest Cascade Head, Cape Perpetua, and Redfish Rocks) would make the best use of limited resources.

3.8. Has research been conducted by ODFW at the Marine Reserves in alignment with stated goals and objectives in Marine Reserves management plans? (O4)

*\*Note that while this question is in the Ecological Factors section, we have addressed both ecological and human dimensions research here.*

In general, the ecological and human dimension research aligns with the stated goals and objectives of the reserves.

**Recommendation**

Continue, revise, and improve the Ecological and Human Dimension Research Programs.

3.9. Have existing research efforts addressed the effects of natural (e.g., climate change) and human-induced (e.g., resource use, anthropogenic input) stressors? (O4)

Existing research efforts have partially addressed the effects of fishing and other stressors (e.g., heat waves, hypoxia events, rising ocean acidification, pathogen, increasing plastics pollution, marine noise pollution, and ocean development) through monitoring for changes in ecosystems and oceanographic conditions.

However, research understanding the mechanisms driving the response to non-fishing stressors is currently lacking. This is important to inform mitigation approaches as part of adaptive management.

**Recommendation**

- a. At a minimum, continue monitoring ecological and oceanographic conditions. Where possible, increase the resolution of sampling to ensure baseline and disturbance events are captured.
- b. Explicitly evaluate the linkages between fishing pressure and reserve effects in future assessments.
- c. Seek collaborations with research organizations to develop targeted research program exploring the mechanisms underpinning the responses of organisms and ecosystems to global change.

3.10. Does a database of research exist? If so, can the data be accessed? (O4)

*\*Note that while this question occurs in the Ecological Factors section, we have addressed both ecological and human dimensions research here.*

ODFW's [2022 Synthesis Report](#) and a database of ecological data can be accessed via a public [Google Drive Folder](#). Preliminary ecological results were shared via the [ODFW](#)

[Data Dashboard](#) (launched 2020). No public database exists for the Human Dimensions Program.

### **Recommendation**

All data continue to be uploaded and made publicly available, where possible.

#### 3.11. Has the Oregon Marine Reserves program adapted their sampling based on lessons learned? (O4)

ODFW and collaborators have extensively considered the limitations and challenges of their ecological sampling methods and adapted the methods accordingly.

### **Recommendation**

Using the lessons learned in the past 12 years, limit future adaptations of methods to support consistent, long-term data collection.

## 4. Socioeconomic Characteristics

#### 4.1. Were criteria established to measure significant adverse social and economic impact? (O3)

Criteria to measure social and economic impacts (adverse or otherwise) of Oregon's marine reserves were not clearly established. Rather, ODFW adopted a multi-domain 'unit of analysis' approach, collecting data on several socioeconomic variables across different social groups. This is an excellent approach to explore heterogeneity of impacts. For the most part, however, data are presented in an aggregated format which should be interpreted with caution by legislators because aggregation can hide important findings for specific social groups.

A critical impediment to answering this question is the lack of a clear working definition for 'significant'. Scientifically, measures of significant impacts can be quantitative, tested for by statistical significance, and qualitative, based on the research subject's determination of causality. Both approaches have limitations. Reporting on socioeconomic indicators using both quantitative and qualitative metrics, as is done by ODFW, is important to representation, and defining significance for future work must incorporate this. Ultimately, in this context, the determination of significance is a political one, rather than scientific, and will require a collaborative process to interpret the relevance of socioeconomic monitoring data to legislative concerns around who experiences adverse impacts and in what ways.

### **Recommendation**

- a. Continue human dimensions monitoring and research.
- b. Adopt a strategic planning framework to establish defined criteria/indicators for regular monitoring of social and economic impacts (adverse or otherwise), based on the past decade of social impacts and wellbeing research.

- c. Clearly define a collaborative process through which socioeconomic data can be interpreted for evaluating the Marine Reserves Program. This process should identify key steps for decision making and conflict resolution, and outline a definition of significant impacts based on holistic assessment frameworks that account for quantitative and qualitative heterogeneity across social groups and types of socio-economic impacts (e.g., employment, cultural identity, inter-group conflict).

4.2. Is there evidence (qualitative and/or quantitative) for significant social and economic impacts on ocean users and coastal communities due to the establishment and management of marine reserves? (IPG6)

*\*Note that Questions 1a and 1b from the Socioeconomics Assessment Criteria ([Appendix 1](#)) have been folded together into this question*

There is evidence for both positive and adverse social and economic impacts from the planning and implementation of Oregon's marine reserves. Critically, the impacts of Oregon's reserves occur heterogeneously across social groups and what is considered 'significant' to one group may not be to another.

Based on qualitative interviews with people who self-identified as being impacted by the reserves, adverse social impacts included increased social conflicts and loss of relationships, increased perceived competition for space and risky travel, increased misconceptions about fishermen's motives, and increased concern or uncertainty for the future. Clear positive social impacts included an increased opportunity for dialogue for fishermen.

Fishermen who self-identified as impacted by the Marine Reserves Program reported experiencing adverse economic impacts including increased fishery operating and travel cost, increased displacement of recreational and commercial fisheries, and no realization of suggested economic benefits such as increased tourism, fishery productivity or equitable distribution of research contracts.

There was no change found in several socio-economic areas where there was concern that the reserves would have adverse impacts, suggesting that there was no impact these areas. These included reliance, engagement, and employment in the fishing industry, shifts in recreational or commercial fishing effort, charter CPUE and demand, and fisheries landings, earned income, and profitability. While it is difficult to say with certainty that there was no impact on these metrics, ODFW's sampling procedure that looked at data before and after in ports near and away from reserves is the best design for evidence of limited impact.

Across the sampled populations, positive attitudes and beliefs regarding the reserves and the Marine Reserves Program have increased over time.

### **Recommendation**

Continue human dimensions monitoring and research, including developing a clear plan that:

- a. Streamlines and systemizes the social and economic indicators to be used in on-going monitoring, informed by baseline data and the human dimensions monitoring literature.

- b. Outlines timelines for surveys and sampling.
- c. Continues a mix of qualitative and quantitative studies.
- d. Ensures that anticipated or concerning impacts are monitored in communities of place or interest where impacts are expected.
- e. Continues collaborations with external researchers, prioritizing building on existing baseline data.
- f. Considers alternative assessment criteria to assess the Human Dimensions Project, such as asking 'what positive and negative social and economic impacts are expected from the reserves, and did these happen?' in addition to 'were there any unexpected positive or negative impacts?'

## 5. Level Of Community Engagement

### 5.1. A General note on effective outreach and communication

The questions posed by STAC in this section primarily focus on whether outreach and community engagement happened or not. It is also important to ask whether that outreach and engagement was effective. We have commented on effectiveness where possible, but there is little information around effectiveness in the [Synthesis Report](#).

#### **Recommendation**

Further assessment of outreach and engagement to evaluate its effectiveness, including evaluating strategy, appropriateness of approaches, quality, and outcomes.

### 5.2. Has the public (including ocean users, coastal communities and other stakeholders) been involved in the proposal, selection, regulation, monitoring, compliance and enforcement of marine reserves (PPG1)?

Individuals who represent ocean users and coastal communities have, to varying degrees, been involved throughout the Marine Reserves process. However, it is not clear the extent to which these individuals were particularly knowledgeable of potential impacts and opportunities associated with the reserves.

While Tribal members were studied as part of ODFW's research program and engagements were discussed with OPAC's tribal representative, it is also unclear whether Tribal consultation occurred or that Tribal representatives were included in proposal development, site selection or any of the following management steps.

#### **Recommendation**

- a. Collaboratively engage in a stakeholder and rightsholder analysis to identify those most likely to be impacted materially, culturally, or emotionally from the reserves. Find ways to incorporate those not previously engaged in the Marine Reserves process.
- b. Allocate resources towards engaging Tribes and Tribal interests in the Marine Reserves process.

5.3. Was outreach and public engagement an ongoing part of the Marine Reserves planning process (PPG2)?

Outreach and public engagement were an ongoing part of the Marine Reserves Program. ODFW implemented a strategic approach to outreach and engagement in 2014, in response to growing concerns about misinformation and lack of awareness.

There is not enough information to comment on the quality, comprehensiveness, and whether target audiences were reached, but independent analysis suggests that that outreach and communication has been compliant with mandates.

**Recommendation**

Continue funding independent Communication Needs Assessments every 4-6 years.

5.4. Have researchers been accessing the Marine Reserves? (O4)

Researchers have been accessing the marine reserves and surroundings areas to undertake monitoring, research, and community projects.

**Recommendation**

None.

5.5. Have research efforts been coordinated among ODFW and external researchers? (O4)  
*a. Has cooperative and collaborative research been conducted in the marine reserves? (IPG3)*

Extensive collaborative ecological, social, and economic research has been conducted within and regarding the marine reserves.

This has primarily been with academic partners and consultants, but has been aided by fishing industry partners, non-governmental organizations, and local marine community groups.

**Recommendation**

- a. Continue collaboration with external researchers.
- b. Explore ways to cooperate with a greater diversity of fishing boats and consider community-based human dimensions research.

5.6. Have fishing vessels been used as research platforms? (IPG3)

Local commercial, charter, and recreational fishing vessels have been used as research platforms since 2010.

Some evidence suggests that contracts have not been equitably distributed.

**Recommendation**

Seek opportunities to increase the diversity of fishing vessels and captains who can obtain research contracts.

5.7. Has scientific and other information been made available to the public through outreach and websites (PPG2)?

Information about the reserves and the Marine Reserves Program has been shared through the program website and through outreach documents and events.

There is not enough information to comment on whether targeted audiences were reached or the effectiveness of the documents in communicating key messages.

Critically, the Marine Reserves Program currently lacks a full-time communication staff member.

**Recommendation**

- a. Prioritize filling the communications position, ideally with someone trained in both digital and in-person communication.
- b. Conduct an evaluation of whether scientific and outreach materials are effectively reaching diverse audiences.

5.8. Have the allowable uses of marine reserves been effectively communicated to the public and ocean users? (IPG5)

We cannot comment on whether allowable uses have been effectively communicated as there is no working definition of what is considered effective.

Outreach analysis, however, suggest that allowable uses of the marine reserves is reaching and being retained in about half the population of residents living along the I-5 corridor and in coastal Oregon communities or fewer, and that factual knowledge on allowable uses is generally increasing over time.

**Recommendation**

- a. Set clear, measurable goals for what is deemed effective communication of allowable uses.
- b. Continue conducting outreach analysis to determine if the allowable uses of Oregon's reserves are effectively reaching diverse audiences.

5.9. How have educational opportunities (formal and informal) and public engagement associated with marine reserves been encouraged? (IPG4)

Educational and public engagement opportunities associated with the marine reserves have been provided by ODFW, both for higher education students and the general public through, for example, research programs, outreach and engagement activities, and interpretive signage.

**Recommendation**

Continue with educational opportunities and public engagement initiatives.

5.10. How have economic opportunities associated with marine reserves been encouraged? (IPG4)

Economic opportunities associated with the marine reserves have been limited to research contracts with fishing vessels. It appears, however, that these contracts are limited to specific individuals and have not been broadly available and/or obtained by vessels across the impacted sites.

**Recommendation**

- a. Consider multiple pathways to enable (and thus encourage) different types of fishermen and coastal residents to engage in research-based economic activities.
- b. Consider collaborations with tourism-focused organizations to emphasize economic opportunities.

5.11. Are the educational and economic development opportunities compatible with the goal of conserving marine habitats and biodiversity? (IPG4)

*\*Originally Question 2 from the Socioeconomic Characteristics Section ([Appendix 1](#)).*

The educational and economic development opportunities are compatible with the goal of conserving marine habitats and biodiversity.

**Recommendation**

None.

## 6. Governance

### *Planning/Site Evaluation*

6.1. Are the regulations guiding marine reserve use consistent with allowing marine transit, safe harbor, and beach access? (IPG5)

The regulations guiding Oregon's marine reserve use do not include any provisions that prevent transit, safe harbor, or beach access.

**Recommendation**

None.

### *Program Evaluation*

6.2. Have short- and long-term nearshore resource management decisions considered research and monitoring data from the Marine Reserves? (O4)

The Ecological and Human Dimensions programs have collected valuable information, created new knowledge, and developed new methods that are highly relevant to management decisions. Indeed, ecological research and monitoring data from the Marine Reserves Program have been explicitly included in recent management decisions, including some beyond the state of Oregon.

## Recommendation

Continue to engage with relevant management to disseminate both ecological and human dimensions research and monitoring data. The adaptive management plan we recommend developing (see Question [3.8](#)) should include guidance on how monitoring data will inform policy decisions about the reserves themselves.

- 6.3. Does each Marine Reserve have a monitoring and evaluation plan or plan component that addresses the Marine Reserves objectives? (O4)

## Summary

Monitoring plans for the two major research streams (human dimensions and ecology) exist, but not for each individual reserve site.

Neither the Human Dimensions nor Ecological Monitoring Plans explicitly state how plan components address the marine reserves objectives, but both plans include components that address part of the objectives.

## Recommendation

Clear, explicit links between monitoring actions and the reserve objectives be included in the monitoring plans to support assessments of whether the objectives are being addressed.

- 6.4. Do the Marine Reserves as a system and each Marine Reserve have a management plan with the following?
- SMART (specific, measurable, achievable, relevant, time-oriented) objectives*
  - Standardized ecological and socio-economic monitoring protocols*
  - Compliance/enforcement plan*
  - Demonstrated long-term funding plan in alignment with objectives (IPG1)*

## Summary

- Each marine reserve site has a management plan that includes site-specific aspects and, where relevant, aspects that are inherited from the Marine Reserves Program as a whole. The objectives outlined in the plans are the marine reserve objectives, which follow some, but not all aspects of the SMART objectives' framework. No explicit objectives are outlined for management or monitoring.
- Ecological and socioeconomic monitoring protocols are outlined in the management plans and supplemented with monitoring plans.
- Compliance and enforcement plans are included in each management plan, but funding for these does not extend beyond the current Marine Reserves Program (reviewed in 2023).

## Recommendation

Include SMART objectives and standardized monitoring protocol/methods in the Ecological and Human Dimensions Monitoring Plans.

- 6.5. Have all Marine Reserves been using ecological and socio-economic monitoring protocols (and generating associated data) that support adaptive management? (IPG3)

### **Summary**

No detailed adaptive management plans currently exist for Oregon's marine reserve system. However, the Marine Reserves Program has collected ecological and social data that can be used to inform the development of a formal adaptive management plan, including set monitoring protocols with specific indicators and stated assumptions.

We are only now at a stage at which it is appropriate to take time and learn from experiences and modify strategies as a result – a critical aspect of the adaptive management process.

### **Recommendation**

Develop future monitoring and research objectives, methods, and protocols with Adaptive Management in mind.

- 6.6. Does each Marine Reserve have an adaptive management plan with clear objectives, defined decision-making points, and stakeholder engagement processes? (O5)
- a. *Do the adaptive management plans include time points to assess and consider new scientific information and monitoring data? (O5)*
  - b. *Do the adaptive management plans have clearly defined timelines and criteria for evaluation? (O5)*

### **Summary**

Neither the marine reserve system as a whole, or each marine reserve individually, have adaptive management plans beyond the mandated reassessment in 2023.

### **Recommendation**

Develop an adaptive management plan for the Marine Reserves Program that includes clear objectives, defined decision-making points, and stakeholder engagement processes.

## **7. Enforcement**

- 7.1. Does each Marine Reserve have an enforcement plan? (IPG2)
- a. *Does enforcement implementation include clearly defined enforcement procedures, including use monitoring? (IPG2)*
  - b. *Is enforcement data evaluated on a regular basis, and is the enforcement plan modified as warranted? (IPG2)*

### **Summary**

Oregon's marine reserve system has an overarching enforcement plan, which applies to each site, but no site-specific plans.

Monitoring and patrol methods are clearly defined in the Monitoring Plans, but there is no clear outline of the frequency of patrols or enforcement/use monitoring.

All agency partners are committed to meeting twice per year to review compliance and enforcement.

**Recommendation**

None.

# Full Report

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# 1. Marine Reserve Design

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\* As these questions relate to outcomes from the initial planning and design of the marine reserves, we do not provide any recommendation. See Section 3 onwards for specific recommendations.

1.1. Were areas of high natural biodiversity identified as part of the planning process?  
(O1)

## Conclusion

Through seafloor mapping and expert opinion, areas of potentially high natural biodiversity were identified for proposed reserve or MPA sites. However, as variation in biodiversity across the whole Oregon Coast was not explicitly considered, we cannot comment as to whether these areas support high biodiversity relative to the rest of the Oregon Coast.

Additionally, biodiversity was not measured directly, relying instead on habitat proxy data. That is, habitat type, derived from benthic seafloor mapping, was used as a surrogate for biodiversity in the absence of other data. This is an acceptable approach that is consistent with best practices in marine spatial planning.

## Definitions

OPAC defines **biodiversity** as “the diversity of life forms and communities that occur in a particular environment” and encompasses species diversity, ecological diversity, genetic diversity, and functional diversity in the definition ([2008 OPAC Marine Reserve Policy Recommendations](#)). We make our assessment following this definition.

What constitutes ‘**high natural biodiversity**’ was not defined by either OPAC or ODFW. Here, we understand areas with high natural biodiversity to be areas along the Oregon Coast with greater than average biodiversity.

## How ODFW measured biodiversity

During the initial planning stages of Oregon’s marine reserves, there was a lack of spatially explicit coast-wide data for marine biodiversity. In response, ecological guidance and site planning relied on identifying representative habitats across multiple depths as a proxy for biodiversity (e.g., [2008 OPAC Marine Reserve Policy Recommendations](#)).

The underlying concept for using habitat as a proxy is that habitats with high complexity and/or high productivity (e.g., rocky reefs supporting kelp forests) will have greater diversity than other habitat types, and areas with multiple habitat types will have higher diversity, relative to same-sized areas of homogenous habitat. This is based on the premise that a greater diversity of habitats and depths in an area increases the chances that a larger number of species will utilize it, presuming different species assemblages prefer different habitat types. There is an unstated tradeoff in this logic, in that larger patches of any one type of habitat tend to support more species (the species-area relationship; Lomolino 2001). As such, it is possible that an area of entirely one highly complex and productive habitat type could support more diversity than the same sized area that also

includes some less complex habitat. Nonetheless, in practice it seems reasonable that multiple habitat types would usually support greater diversity.

This habitat surrogate approach follows standard guidelines used elsewhere. For example, the design criteria developed by the Science Advisory Team for California's statewide marine protected area design process included requirements that the collection of MPAs in each ecological region include multiple representative habitat types (delineated by substrate type and depth, as in Oregon). The purpose of this was also to ensure that the MPAs protected a diversity of ecological communities and functions (Saarman et al. 2013, California Department of Fish and Wildlife 2016). Similarly, the 2004 rezoning of Australia's Great Barrier Reef adopted a 'representative areas' approach, mapping biophysically distinct 'bioregions' and protecting at least 20% of each bioregion to ensure biologically diverse representation, although this included biophysical data in addition to habitat (Fernandes et al. 2005).

### **How ODFW identified areas of high biodiversity**

ODFW used a combination of seafloor mapping and expert opinion to identify habitats (as a proxy for biodiversity) along the Oregon coast.

During the planning stage, habitat maps were developed through digitizing old bottom samples, combined with aerial kelp maps (pp. 40-41 [2008 STAC Size and spacing workshop](#); see also Lanier et al. 2007, Agapito 2008).

Expert opinion on habitats along the coast was sought through a [Request for Public Proposals](#) and during the [2008 STAC Size and spacing workshop](#). In the [Request for Public Proposals](#), applicants were asked "*what habitat type(s) are present within the [proposed] site?*", including "*special natural features or characteristics, and/or other habitat types*". Participants in the [2008 STAC Size and spacing workshop](#) were asked "*how do we identify 'special places' in nearshore Oregon, such as biodiversity hotspots, unique habitat features etc. using available habitat maps and biological information?*".

### **Were areas of high biodiversity identified?**

Identifying highly biodiverse areas (or rather, identifying areas with diverse habitats) during the planning phase focused on the [20 proposed sites](#), asking questions to ensure that reserve sites included habitats likely to support high biodiversity. In our expert opinion, this is a valid approach to capturing representative areas within reserves, given the data available at the time. However, as habitat diversity across the whole Oregon Coast was not explicitly considered (to our knowledge), we cannot definitively determine if this approach resulted in identifying areas with potentially high biodiversity *relative* to the rest of the coast. It should also be noted that long-term monitoring of biodiversity, such as that undertaken by ODFW, is required to accurately assess biodiversity, which may fluctuate over time and space, depending on disturbances and environmental variation.

See Question [3.1](#) for a discussion on whether the reserves are in areas of high biodiversity, and Question [3.2](#) for more detail on habitat classifications and representation.

- 1.2. Do the Marine Reserves protect areas of special natural features? (O1)
- a. Were special natural features identified as part of the planning process? (O1)
  - b. What special natural features were identified? (O1)

### **Conclusion**

Special features along the Oregon Coast - including emergent rocks, deep reef complexes, and upwelling sites - were identified during the planning process. Features, however, were identified primarily for areas with a proposed marine reserve or MPA site, not the entire coast. Oregon's marine reserves encompass a range of the special natural features and provide protection to those potentially impacted by ocean development or fishing.

### **Definitions**

OPAC or ODFW provide no working definition of '**special natural features**'. OPAC, however, provide examples of special natural features as "*geological formations (such as canyons or pinnacles), seafloor vents, dominant oceanographic fronts, major river plumes, ocean current eddies or jets*" ([2008 OPAC Marine Reserve Policy Recommendations](#)).

Following this, we understand special natural features to be physical and biophysical marine features that may be important to the natural diversity and abundance of marine organisms. These features may be fixed (e.g., pinnacles) or changing (e.g., river plumes) in time and space.

Marine reserves only provide the capacity to **protect** special natural features that predominately reside within their boundaries and, critically, only from the effects of prohibited activities. Special natural features within Oregon's marine reserves are directly protected from the impacts of fishing and ocean development ([Oregon Parks and Recreation Department Chapter 736](#)). Special natural features not influenced by fishing or ocean development, such as key upwelling sites or river outflows, may be enclosed within a reserve, but marine reserves have no capacity to directly protect these features from adverse change. However, those features might produce conditions favorable to certain organisms (e.g., high primary productivity due to upwelling, emergent rocks as seabird nesting habitat), and the reserves afford spatial protection to those organisms.

### **Special Features Identified**

Special natural features known to exist along the Oregon coast were identified during the [2008 STAC Size and spacing workshop](#) and in the [20 proposals](#) made by the public in 2008 (as requested in the [Public Proposal Packet](#)). The [2008 Agency Analysis](#) added to and synthesized the special natural features identified for each proposed site. Here we provide a summary of the special features identified in that process ([Table 1.2.1](#)).

ODFW's data collection methods were not comprehensive of all special natural features along the Oregon coast; only special features in proposed sites were identified ([Table 1.2.1](#)). We, therefore, cannot definitively say that the features within Oregon's reserves proportionately represent all types of special natural features found along the coast.

**Table 1.2.1** Special features along the Oregon Coast identified during the planning process, including those identified within the five Marine Reserves, and those not identified in any of the Reserves. See also [Table 3.2.1](#) & [Table 3.2.2](#) for summary of key habitat types encompassed within the Reserves.

	Special Features Identified	Reference
<b>Within the reserves</b>		
<b>Cape Falcon</b>	<ul style="list-style-type: none"> <li>- Large, rugged headlands (Cape Falcon and Neah-Kah-Nie Mountain), rocky points, sheltered coves (e.g., Short Sands Beach) and 44 offshore emergent rocks (including Gull Rocks).</li> <li>- Close proximity to Columbia River (largest freshwater flow into eastern Pacific Ocean) influences high productivity in the area.</li> </ul>	<a href="#">Public Proposal #6</a> <a href="#">Synthesis Report</a> pp. 32-33 <a href="#">Cape Falcon Management Plan (2021)</a> pp. 22-23
<b>Cascade Head</b>	<ul style="list-style-type: none"> <li>- Located immediately south of a major river (Salmon River) and its associated estuary (freshwater input).</li> <li>- Large continuous stretch of sandy beach.</li> <li>- Deep, offshore reef complexes (e.g., Siletz Reef).</li> <li>- Major upwelling center.</li> </ul>	<a href="#">Public Proposal #8</a> <a href="#">Synthesis Report</a> pp. 34-35 <a href="#">Cascade Head Management Plan (2017)</a> pp. 22-24, 26
<b>Otter Rock</b>	<ul style="list-style-type: none"> <li>- Emergent islands and rocks (inc. Gull Rock, Otter Rock, and Whale Back Rock).</li> <li>- Continuous sandy beach south of a small headland (Devils Punch Bowl).</li> </ul>	<a href="#">Public Proposal #1</a> <a href="#">Public Proposal #2</a> <a href="#">Synthesis Report</a> pp. 36-37 <a href="#">Otter Rock Management Plan (2013)</a>
<b>Cape Perpetua</b>	<ul style="list-style-type: none"> <li>- Offshore rocks, small basalt promontories (e.g., Gwynn Knoll and Brays Point), and almost continuous basalt bench intertidal area broken by sandy beaches and creeks.</li> <li>- South of multiple river and creek mouths (Yachats River, Cummins Creek, Ten Mile Creek, and Cape Creek).</li> <li>- Shoreward of banks (e.g., Heceta Bank) that cause highly dynamic current patterns. Slowed or reversed currents during the upwelling season retain nutrient-rich upwelled water, leading to higher primary productivity.</li> </ul>	<a href="#">2008 Agency Analysis</a> , p. 31 <a href="#">Public Proposal #10</a> <a href="#">Synthesis Report</a> pp. 38-39 <a href="#">Cape Perpetua Management Plan (2020)</a> pp. 22-23, 25
<b>Redfish Rocks</b>	<ul style="list-style-type: none"> <li>- Emergent rocks and islands (e.g., Redfish Rocks)</li> <li>- Mostly flat rock or rock shelf with pinnacles in the north half, with rubble, rock, and sand mixtures in the south.</li> <li>- Deep rocky reef complex.</li> <li>- Only site south of a biogeographic break (Cape Blanco).</li> <li>- Towards northern extent of the southern bioregion of the Northern Californian Current Ecosystem. Characterized by strong upwelling winds, producing nutrient rich, highly productive waters.</li> </ul>	<a href="#">Public Proposal #4</a> <a href="#">Synthesis Report</a> pp. 40-41 <a href="#">Redfish Rock Management Plan (2012)</a>
<b>Outside the reserves*</b>		
	<ul style="list-style-type: none"> <li>- Columbia River Plume</li> <li>- Littoral Cells (Clatsop Plains, Netarts)</li> <li>- Estuaries</li> <li>- Sea caves</li> </ul>	<a href="#">Public Proposals</a> <a href="#">2008 Agency Analysis</a>

\* Features identified during the planning stage that were not included in any of Oregon's marine reserves

### 1.3. Did the design of the Marine Reserves system incorporate community interest? (O3)

#### **Conclusion**

The design of Oregon's marine reserves provided opportunities for public involvement throughout the planning processes. There is not enough information to assess whether this approach succeeded in actually incorporating community interests as it is unclear that those who participated were able to represent key community interests. Moreover, participation does not always equate to inclusion.

#### **How did ODFW involve the public?**

Notable events throughout the planning process that involved the public are listed below. For details of the planning process, see Chapter 2 of the [Synthesis Report](#). See also Questions [5.1](#) & [5.2](#).

- **Sea Grant led listening & learning sessions (2008).** Mounting concerns from the public in the early stages of the planning process (2000-2007) prompted Listening & Learning sessions, which visited eight coastal communities to gather additional input and concerns on the reserves. They report finding *"mistrust (process appears unresponsive); timeline is too ambitious; there is insufficient social, economic, and biological data; and there is no funding for planning or implementation"* (p. 21 [Synthesis Report](#)).
- **Public proposals for reserves (2008).** The sites recommended for reserves were informed by a public nomination process, called for by OPAC in their [Public Proposal Packet](#). Twenty [public proposals](#) were received.
- **Agency analysis of sites (2008).** State agencies undertook an independent review of all twenty proposed sites. Criteria used by the agency to assess each potential site included consideration of community interest in the site. Specifically: *"Proposed site is large enough to allow scientific evaluation of ecological benefits, but small enough to avoid significant adverse economic or social impacts on ocean users and coastal communities", "Proposal was developed by collaborative community-based groups comprised of coastal community members, ocean users and other interested parties" and "Collectively, sites are large enough to allow scientific evaluation of ecological benefits, but small enough to avoid significant adverse economic or social impacts."*
- **Community teams refine first proposed sites (2010).** A public participatory 'community team' process was used to refine site proposals for Cape Perpetua, Cascade Head, and Cape Falcon. The first two reached fairly consensus proposals (although there is at least one dissenting vote per team), while the latter Cape Falcon final vote is contentious (pp. 25-27 [Synthesis Report](#)).

#### **Were community interests adequately incorporated?**

Public engagements and socio-economic consequences of the proposed reserve sites were consistently noted as important considerations in the planning and designated process

(e.g., [2002 OPAC Recommendation Report](#), [2008 OPAC Marine Reserve Policy Recommendations](#)). From the information provided in the [Synthesis Report](#) and associated documents, it is unclear whether these public involvement opportunities or the reserve mandates resulted in adequate incorporation of community interests. That is, it is unclear what 'community interests' are precisely, and whether these have been met in the Marine Reserve process. See also Questions [5.0](#), [5.1](#), and [5.2](#) for more detailed discussion of Community Outreach.

However, research undertaken following the 2010 Marine Reserve Community Team process, found that the majority of those involved with the process felt their experience was good or great (Bird and Conway 2012). Positive experiences included participants feeling that they had contributed meaningfully to the process and that the decision making was fair, although this was not consistent across locations, stakeholder groups, and form of service (representative or alternate). Criticisms included: 1) feelings that decisions were not reached or not committed to, 2) concerns over the composition and balance of community teams, and 3) a sense that useful information was communicated but not all participants were heard.

1.4. Were less than 10 sites established as part of the Oregon Marine Reserves? (O3)

#### **Conclusion**

Five reserve sites were established along the Oregon coast as part of the Marine Reserve Program: Cape Falcon, Cascade Head, Otter Rock, Cape Perpetua, and Redfish Rocks (ordered from North to South). Two sites (Redfish Rocks and Otter Rock) began harvest restrictions in 2012, two sites (Cape Perpetua and Cascade Head) began harvest restrictions in 2014, and one site (Cape Falcon) began harvest restrictions in 2016 (pp. 30-43 [Synthesis Report](#)).

## 2. Marine reserve baseline assessment

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\* *Baseline questions ([Appendix 1](#)) have been duplicated for the ecological and human dimensions monitoring programs.*

\*\* *As these questions relate to baseline data, which can no longer be altered, we do not provide any recommendation. See Section 3 onwards for specific recommendations.*

### *Ecological Monitoring*

- 2.1. Were baseline data obtained at each site prior to closure (IPG7)?
- 2.2. What baseline data were obtained at each site? Were methods designed and carried out so that change could be detected (IPG7)?
- 2.3. Did the nature of the baseline data differ among sites, and were these differences reflected in the subsequent monitoring decisions (IPG7)?

\* *These three questions (2.1-2.3) are answered together here*

### **Conclusion**

In the two years prior to reserve implementation, baseline ecological data - including species diversity, abundance, and cover - were collected at each of the five marine reserve sites and their comparison areas as part of the ODFW Ecological Monitoring Program. However, these baseline data were not collected consistently over time or space:

1. Initial surveys found that each site had unique characteristics and presented unique challenges. ODFW's monitoring approach subsequently adapted: individual monitoring approaches were developed for each site, with the methods used and variables collected varying by site and year ([Table 2.3.1](#) & [Table 2.3.3](#)).
2. Individual monitoring methods also evolved over time, due to 1) funding limitations, 2) logistics, and 3) COVID-19 pandemic difficulties, all compounded by the challenges of sampling in Oregon's nearshore waters (Question [3.6](#)). As such, the baseline data collected are limited to detecting change between comparable sampling methods and among sites sampled with the same method.

Limited baseline data were also collected for projects undertaken with research partners.

### **What baseline data were collected where and when?**

For ecological data collected under the ODFW Monitoring Program, baseline data were collected at least once in the two years prior to closure in all five of the marine reserve sites and their comparison areas ([Table 2.3.1](#)).

ODFW used five key sampling methods: hook and line sampling, longline sampling, Remotely Operated Vehicle (ROV) surveys, SCUBA surveys, and video lander surveys (see Question [3.6](#) for a detailed discussion on methods). Due to insufficient funding/staffing, logistical challenges, and the COVID-19 pandemic (in that order), as well as challenges associated with each reserve and comparison site, not all ODFW's methods were used consistently across all sites ([Table 2.3.1](#)). For example, baseline video lander surveys were consistently undertaken at Otter Rock, Redfish Rocks, and Cascade Head in both reserve

and comparison sites, but only once in Cape Perpetua (in 2012) and Cape Falcon (in year of closure: 2016) due to poor weather and visibility, and limited rocky reef (Cape Perpetua) ([Video Lander Methods](#)). The variables collected also differed across the five sampling methods used, although all methods collected baseline data on diversity, community composition, and measures of abundance or benthic cover for some species ([Table 2.3.3](#)).

For ecological data collected in collaboration with research partners, baseline data were also collected inconsistently across sites: juvenile fish monitoring (using standardized monitoring units for the recruitment of fishes, SMURFs) occurred at Otter Rocks in 2011 and 2012 ([SMURF Methods](#)), and intertidal monitoring, predominately sea star transects, occurred at Cape Perpetua in 2012-15 ([Intertidal Methods](#)). Limited baseline oceanographic data were also collected in the two years prior to closure at all reserve sites except for Cape Falcon, however the same baseline oceanographic variables were not always collected for reserve and comparison sites ([Oceanographic Methods](#)), and there were changes in sensor configurations that affected comparisons.

### How did monitoring differ at each site?

Initially, ODFW planned to apply a ‘one-size-fits-all’ monitoring approach to ecological monitoring. Initial monitoring methods - video lander, video sled, Remote Operated Vehicle (ROV) and SCUBA surveys, hook and line sampling, and oceanographic monitoring - were planned to be used at all sites. Multiple comparison areas (i.e., scientific controls) were also initially planned for each site to allow for a robust before-after-control-impact (BACI) assessment approach ([2012 Ecological Monitoring Plan](#)).

**Table 2.3.1** Baseline ecological data collected in reserve sites, and their associated comparison sites, prior to (2yrs and 1yr), and during the year of (0yr), closure. Colors denote data sampling years.

		Otter Rock (2012)		Redfish Rocks (2012)		Cascade Head (2014)		Cape Perpetua (2014)		Cape Falcon (2016)	
		2yrs	1yr	2yrs	1yr	2yrs	1yr	2yrs	1yr	2yrs	1yr
ODFW	<a href="#">Hook &amp; Line</a>	Too shallow									
	<a href="#">Longline</a>	NA				NA		NA		NA	
	<a href="#">ROV</a>	Too shallow								Too shallow	
	<a href="#">SCUBA</a>							Too deep			
	<a href="#">Video Lander</a>								Limited Reef		
Collaborations	<a href="#">SMURF</a>										
	<a href="#">Intertidal Monitoring</a>								*		
	<a href="#">Oceanography</a> **	T, S, DO, C	T, S, DO, C	T, S, DO, C	T, S, DO, C		T, S, DO, C	T, S, DO, pH, C	T, S, DO, pH, C		

\* Only sea star belt transects (2012-2014) and biodiversity surveys (2013).

\*\* T = Temperature, S = Salinity, DO = Dissolved Oxygen, C = Chlorophyll. This is for the reserve sites: the same oceanographic variables were not always collected in the same year in the comparison areas.

Sampling for baseline data highlighted to ODFW that each site is unique in its characteristics and challenges for monitoring. Consequently, not all methods could be used at all reserve and comparison sites (Table 2.3.1), and multiple suitable comparison areas could not be found for all of the reserves (2015 Ecological Monitoring Plan). A unique monitoring and management approach was therefore designed for each reserve and used moving forward (Table 2.3.2; Management Plans; Ecological Monitoring Plans). Monitoring plans were revised in 2015 and 2017 based on the baseline data collected.

**Were methods used that allow change to be detected?**

Best practices for detecting ecological impacts of management actions such as marine reserve establishment is the use of Before-After/Control-Impact monitoring designs, in which trajectories of change are compared between ‘impacted’ sites (reserves) and hypothetically unimpacted control (or ‘comparison’ sites; Schmitt and Osenberg 1996). This approach is challenging in the context of marine reserves, because a) ‘before’ data may not be collected until after the impact begins, b) reference sites are not statistically independent from reserves due to larval spillover and shifts in fishing effort, c) post-reserve population and fishery yield trajectories exhibit time lags and considerable fluctuations (White et al. 2013, Moffitt et al. 2013, Hopf et al. 2016, Ovando et al. 2021). Nonetheless BACI comparisons remain the best opportunity for informed assessment of reserve effects (Hopf et al. 2022).

**Table 2.3.2** *The number of comparison areas for each reserve site and the monitoring approach taken based on ecosystem and fishing pressure characteristics (Management Plans).*

<b>Reserve Site</b>	<b>Number of Comparison Areas</b>	<b>Monitoring Approach</b>
Otter Rock (2012)	2	<b>BACI</b> approach, testing how species and communities respond to closure. Pilot sites.
Redfish Rocks (2012)	2	
Cascade Head (2014)	3	<b>BACI</b> approach, testing how species and communities respond to closure.
Cape Perpetua (2014)	1*	<i>*Reserve site covers a deep isolated rocky reef and there are no similar areas for comparison. Comparison area is a shallower nearby rocky reef.</i> <b>Before-after comparison</b> looking at community and species changes over time, and inside-outside comparison to shallower reef.
Cape Falcon (2016)	7*	<i>*Reserve site had low fishing pressure prior to closure, relative to nearby areas.</i> <b>Spatial comparison</b> across a gradient of fishing pressures, using multiple small rocky reefs (with varying fishing pressures) as comparison areas.

**Table 2.3.3** Baseline (and ongoing) variables collected by each method used in the ecological monitoring program, based on the [Ecological Monitoring Appendix](#) and Ecological Monitoring Plans ([2015](#), [2017](#)). RR = Redfish Rocks.

	Habitats Targeted	Diversity				Community composition	Abundance*					Benthic characteristics	
		species richness	unique, common & rare species	diversity indices	diversity through time		CPUE	BPUE	size	density	%cover	MaxN	Substrate type
<a href="#">Hook &amp; Line (fish)</a>	Rocky Reefs (10-40m)	x	x	x	x	x (catch)	x	x	x				
<a href="#">Longline</a>	Rocky Reefs (10-40m)	x	x	x	x	x (catch)	x	x	x				
<a href="#">SCUBA (inverts)</a>	Shallow Rocky Reefs (10-20m)	x	x	x	x	x (density)				x			
<a href="#">SCUBA (fish)</a>		x	x	x	x	x (density)			x <sup>+</sup>	x			
<a href="#">SCUBA (habitat)</a>		x	x (benthic cover)	x (benthic cover)	x (benthic cover)	x (benthic cover)					x	x	x
<a href="#">ROV (invert)</a>	All (20-50m)	x	x	x	x	x (density)				x			
<a href="#">ROV (fish)</a>		x (RR only)	x (RR only)	x (RR only)	x (RR only)	x (density)			x <sup>+</sup>	x			
<a href="#">Video Lander</a>	All (5-20m)	x	x	x	x	x (mean MaxN)					x		

\* Note that abundance was collected for all species but analysis was only conducted on a subset of focal species, see Question [3.6](#).

<sup>+</sup> Size data were collected but were not used due to high measurement error ([SCUBA methods](#)), or analysis of size data were not yet complete ([ROV methods](#))

ODFW acknowledged these realities and accordingly attempted to follow a BACI approach. However, due to the adaptations made in the Ecological Monitoring Program not all sites have a robust BACI monitoring approach, nor are all sampling methods used or used consistently across all sites ([Ecological Monitoring Plans](#)). This creates challenges in detecting and attributing change; however, in our expert opinion the Ecological Monitoring Program has appropriately incorporated this variability into their monitoring approaches for each reserve ([Table 2.3.2](#)).

For example, low fishing pressure prior to closure at Cape Falcon means that the predicted effects of protection at that site are minimal changes in species and communities. ODFW has recognized this and have adapted their monitoring goals for Cape Falcon to evaluating how different levels of fishing influence change in rocky reef communities. This is achieved by comparing the reserve area (no fishing pressure) to seven other comparison sites that span a range of fishing pressures ([Cape Falcon Management Plan](#)). Additionally, a [Moving Beyond BACI Workshop](#) was hosted in 2015 to specifically address the challenges of not having suitable fished comparison sites for all the reserves.

Ecological survey and sampling methods have also evolved over the past 12 years as ODFW underwent extensive learning and adapting in response to the unique characteristics of each site and the challenges of sampling in Oregon's nearshore waters (Question [3.6](#)). Some tools were modified to be more efficient (e.g., SCUBA, ROV, Video Lander surveys) and others were retired from use at certain sites (e.g., Video Lander at Cape Perpetua). These modifications were incorporated into subsequent monitoring approaches. As such, the monitoring program lacks fully standardized sampling methods, complicating the ability of analyses to detect change over time. This also limits the broad comparability of the data collected to places and times with comparable sampling methods, as each sampling method documents different species/communities. Similarly, changes over time in oceanographic instrumentation and calibration make it difficult to quantify trends and change over time.

2.4. Was the timing of sampling driven by the objectives and sampling designs planned for each site, given information available at the start of the Marine Reserves process (IPG7)?

### **Conclusion**

Timings for sampling (i.e., years completed and planned to occur) at each site are outlined in both the [2015](#) and [2017](#) Ecological Monitoring Plans. These timings were informed by the baseline data collection, objectives of the Marine Reserves Program (primarily Objective 4: *"Use the marine reserves as reference areas for conducting ongoing research and monitoring..."*), and logistical/financial constraints of the Marine Reserves Program.

Presumably, due to weather, Covid-19, and other constraints, the years sampling was undertaken did not perfectly align with those planned. In general, sampling was done in fewer years than was planned. See Questions [3.8](#) and [0](#) for discussion on whether the Ecological monitoring program met the reserve objectives.

2.5. Were the methods of data collection appropriate for each site, given information available at the start of the Marine Reserves process, and driven by the planned objectives and sampling designs (IPG7)?

### **Conclusion**

Given the information available at the start of the reserve process, including baseline data and Ecological Monitoring workshops in [2010](#), [2012](#), and [2015](#), the methods used were appropriate for each site and driven by the planned objectives.

See Questions [3.8](#) and [0](#) for discussion on whether the Ecological monitoring program met the reserve objectives, and Question [3.6](#) for discussion on the ecological sampling methods.

### *Human Dimensions Monitoring*

2.6. Were baseline data obtained at each site prior to closure (IPG7)?

### **Conclusion**

Baseline human dimensions data, including data relevant to areas proximate to reserves and comparison sites, were obtained in the years leading up to and during designation and implementation of the reserves ([Table 2.6.1](#)). While substantial data collection occurred, it is not clear which data will be monitored on an ongoing basis.

Because some baseline data were collected after reserves were established, it is important to interpret results of all 'baseline' data within the context of how respondents were reacting to program-wide reserve creation at the time data were collected.

### **Where/when was baseline data collected?**

Initial human dimensions data were collected from 2009 to 2016, prior to any reserve implementations and continuing through the designation and implementation process ([Table 2.6.1](#)).

Data were collected both specific to the Marine Reserves Program as a whole and compiled from existing sources, including from a NOAA community profiles project and the U.S. census and American Community survey. Units of analysis included individuals, towns, businesses, and fisheries proximate to the reserve and comparison sites along the coast, and, for perceptions data, individuals within Oregon.

Critically, while substantial data collection occurred prior to and during the early stages of Oregon's reserve designation and implementation, it is not clear from the [Synthesis Report](#) or associated documents (including the [Human Dimensions Monitoring Plans](#)) which data are to be monitored on an on-going basis.

### **What is considered baseline data?**

ODFW or OPAC provide no working definition of what constitutes baseline data for the human dimensions research. Initially, ODFW recognized that it is *“crucial to collect at least two years of baseline data and information prior to the implementation of any site prohibitions”*

([2012 Human Dimensions Monitoring Plan](#)), but data collected later - "*during the designation and implementation process of all five marine reserves*" - were also considered baseline data ([2017 Human Dimensions Monitoring Plan](#)).

This can influence the interpretation of certain data. Ideally, baseline data would be collected before the event occurred, but it can be challenging to define what the event is. For economic data, such as fisheries catch and permit data, the implementation of a reserve is the event, and these data are unlikely to be affected by the spatial fishing closure before it is enacted. For social data such as perceptions and beliefs, the political process and conversations around the marine reserves began years prior to reserve implementation. In this context, the reserve creation process may have impacted perceptions and beliefs before any spatial closures occurred. However, it may be difficult to collect certain social data on an event until it is underway; for example, people may not have opinions on reserves in their local waters until they exist.

We recognize that it is not always feasible or possible to collect all baseline data well ahead of an event. Additionally, ODFW has faced funding and staffing challenges (only one full-time ODFW staff member was employed to undertake the human dimensions work). Data collected at some point is better than none and substantial useful data collection did occur. However, we raise the issue of defining 'baseline' to note that the social and economic climate at the time of data collection is critical to interpretation, and that consistent long-term monitoring (i.e., more than two points in time), as well as in depth qualitative exploration are needed to elucidate trends in the data.

**Table 2.6.1** Human dimensions studies that include baseline data, defined as collected pre-reserves or during implementation/designation. Studies were conducted in the years highlighted or the data used spans those years. Studies sharing a row are related. Colors indicate the primary research category (the study may also cover other categories): *Attitudes, knowledge, and perceptions of reserve implementation and management* (including non-market values; yellow), *social and economic characterization of reserve-proximate areas* (green), and *direct use of reserve areas* (blue).

\*OSU = Oregon State University, UMich = University of Michigan

Pre-2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
			Otter Rock & Redfish Rocks Implemented		Cascade Head & Cape Perpetua Implemented		Cape Falcon Implemented						
								Umich* Case Studies of Coastal Community Resilience ( <a href="#">Ackerman et al. 2016</a> , <a href="#">Fischer 2018</a> )					
				OSU* Baseline Regional Surveys: Coastal Residents ( <a href="#">Needham et al. 2013</a> )					OSU Baseline Regional Surveys: 15 Residents ( <a href="#">Needham et al. 2016a</a> , <a href="#">2016b</a> )				
								PSU Statewide Survey Research ( <a href="#">Manson et al. 2021</a> )					
			Marine Reserve Visitor Surveys ( <a href="#">Swearingen et al. 2016</a> , <a href="#">2017a</a> , <a href="#">2017b</a> , <a href="#">2019</a> )										
												OSU Comparison Regional Surveys ( <a href="#">Needham et al. 2022</a> )	
												Marine Reserve Visitor Surveys ( <a href="#">Fox et al. 2022b</a> )	

Pre-2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
							Whales & Marine Reserves: <b>Education &amp; Awareness Project</b> (American Cetacean Society 2016, 2017, 2018, 2019, 2020, 2021)					
							2016 ODFW <b>Coastwide Visitor Intercept Study of Ocean Awareness</b> ( <a href="#">Epperly et al. 2017a</a> )					
	ODFW & Sea Grant <b>Ecosystem Services Surveys</b> ( <a href="#">Freeman et al 2011</a> )											
	ODFW <b>Business Owner Surveys</b> ( <a href="#">Epperly et al. 2017b</a> )				ODFW <b>Business Owner Surveys</b> ( <a href="#">Epperly et al. 2017b</a> )							ODFW <b>Business Owner Surveys</b> ( <a href="#">French et al. 2022</a> )
OSU & ODFW <b>Community Profiles</b> ( <a href="#">Package &amp; Conway 2010a, 2010b, 2010c, Hall &amp; Murphy 2013, Murphy &amp; Hall 2013</a> )		OSU & ODFW <b>Community Profiles</b> ( <a href="#">Eardley &amp; Murphy 2013</a> )										
Quantitative Time Series Analyses of <b>Coastal Region Census Data</b> ( <a href="#">Fox &amp; Swearingen 2021</a> )												
	Coast Regional & Community Characterization ( <a href="#">Epperly et al. 2018</a> )											

Pre-2010	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NOAA Indices of <b>Fishing Engagement &amp; Reliance</b> ( <a href="#">NOAA 2020</a> )												
Time Series Analyses of <b>Recreational Fishing Data</b> ( <i>Fox et al. in review</i> )												
	Preliminary Study of <b>Anticipated Fishing Effort Shift</b> ( <a href="#">Swearingen et al. 2017b</a> )											
						Pilot Study Related to <b>Perceived Impacts on the Fishing Community</b> ( <a href="#">Marino 2015</a> )	OSU Coastwide Study of <b>Perceived Fisheries Impacts: 2015 - 2017</b> ( <a href="#">Marino 2020</a> )					
			Time Series Analyses of <b>Commercial Fisheries Data</b> (described as pre-post reserve, but dates unknown) ( <i>internal ODFW analysis</i> )									
			<b>Catch Per Unit Effort (CPUE) on Charter Fishing Trips</b> ( <i>internal ODFW analysis</i> )									
			<b>Economic Data</b> related to Marine Reserve Effects among <b>Commercial Fisheries</b> ( <i>internal ODFW analysis</i> )									
			Time Series Analysis of <b>Commercial Fishing Employment Data</b> ( <i>internal ODFW analysis</i> )									
		<b>Economic Impact of Marine Recreational Fishing: Oregon Pilot Survey</b> ( <a href="#">TRG 2013b</a> )										
Port Orford Marine Research & Management <b>Economic Impact Study</b> ( <a href="#">TRG 2013a</a> )												
<b>Commercial Nearshore Groundfish Permit Data</b> related to Port Groups ( <a href="#">TRG 2018a</a> ) <b>Turnover in Permits over Time</b> ( <a href="#">TRG 2018a</a> )												
<b>Fisheries Economic Importance</b> ( <a href="#">TRG 2021a</a> )												

2.7. What baseline data were obtained at each site? Were methods designed and carried out so that change could be detected (IPG7)?

### **Conclusion**

Baseline data were collected on 1) the attitudes, knowledge, and perceptions of different social groups on the marine reserves and Marine Reserves Program; 2) the social characteristics of communities; 3) economic characteristics of communities and 4) the direct uses of the reserves. These data were generally collected as part of the system-wide human dimensions monitoring program, rather than at each reserve site.

The methods used to collect these data followed standard best practices, and were designed and carried out in a manner that allows change to be detected over time. However, this requires continued collaboration with external partners, who undertook the majority of the human dimensions research. Critically, surveys across studies used different language in their questions, making direct comparisons difficult.

### **What baseline data were obtained?**

Human dimensions baseline studies, as defined by ODFW as studies done prior to and during the reserve designation and implementation process (pre-2017), covered three broad categories ([Table 2.6.1](#)):

- 1) **Attitudes, knowledge, and perceptions** of reserve implementation and management, including non-market values of the reserves. These data were collected to understand the initial knowledge, attitudes, and beliefs of stakeholders towards the reserves and the Marine Reserves Process (monitoring and research, management, and enforcement), as well as to identify the non-market values connected to the sites. Data were collected from a random sample of coastal residents, I5 corridor residents, and statewide residents as well as visitor surveys and coastal community case studies. These data were collected during the reserve implementation process (2012-2016), well after conversations of the reserves had begun in communities (Question [2.6](#)).
- 2) **Social and economic characterization** of reserve-proximate communities and comparison sites Demographic and community economic data were disaggregated and compiled from the U.S. census or American Community Survey for each year from 2010 until the year prior to establishment of the reserves (2014-2016) for median household income, natural resource and tourism income, social security income, vacant second home rates, median age, earned income, unemployment rate, SNAP benefits, and poverty rates for coastal communities living near and further away from proposed sites. Additionally, data on fishing industry engagement and reliance were compiled from a NOAA coastal community project. Perceived impacts to local business owners were collected via survey (Question [2.6](#)).
- 3) **Direct uses** of Oregon's marine reserves. These data were collected to understand the current use of the reserve sites by commercial fisheries, recreational fisheries, and non-consumptive ocean users. Research included analysis of secondary data (e.g., census data, fishing engagement and reliance indices, and fisheries landing and

permit/license data), and boat and fisherman surveys. Commercial fishing employment, fishery landings, and groundfish permit departures, entries and turnover were summarized from statewide data. CPUE on charter fishing was summarized from ODFW's recreational boat survey. Recreational fishing license sales were also compiled. Baseline data for these studies (often time-series analysis) generally started 1-2yrs prior to the implementation of the pilot reserves in 2012 (Question [2.6](#)).

These data were collected as part of the overarching human dimensions project, focused to the extent possible, on communities and industries near reserve and comparison sites.

### **Were methods used that allow change to be detected?**

Six research methods were used across the human dimensions research: individual interviews; surveys (mixed methods surveys, intercept surveys, internet surveys); pressure counts (observational surveys); economic modeling and related data aggregation; community studies (ethnographies, community case studies); and analyses of secondary data (time series analyses) ([2017 Human Dimensions Monitoring Plan](#); [Human Dimensions Technical Appendix](#)). All these methods follow best scientific practice, but there are always methodological limitations that must be considered when interpreting the data. We note these limitations here, not as a critique of ODFW but as considerations for interpretation:

- A large portion of the economic research (focusing on direct uses of reserve areas; [Table 2.6.1](#) & [Table 4.2.1](#)) evaluated secondary data in an internal ODFW analysis. These analyses used a robust before-after-control-impacted (BACI) design to detect changes over time in reserve-proximate areas, comparing to areas far from the marine reserves to control for state-wide trends. However, assigning causality to observed changes is challenging.
- The social and economic characterization and attitudinal research used interviews, surveys, and community studies, all of which can be (and, in some cases have been) repeated to detect change. The surveys, in particular, used random sample designs that can be replicated for statistical analyses of change across the same populations. The caveat to this is that some of the surveys used different language in their questions to measure knowledge or support for the reserves, making direct comparisons difficult. Importantly, however, the combination of quantitative and qualitative methods allows for more rigor in interpreting causality of trends.
- The majority of the human dimensions research was undertaken in collaboration with external research partners. As such, this is not an internal program that can be replicated by ODFW. Consequently, the continued ability to replicate past studies and to detect change in social and economic dimensions requires maintaining the capacity for human dimensions research within ODFW and fostering ongoing collaborations with external partners.

2.8. Did the nature of the baseline data differ among sites, and were these differences reflected in the subsequent monitoring decisions (IPG7)?

**Conclusion**

Most baseline human dimensions data were compiled or collected for all sites, rather than site-by-site. While some sites had individual studies often led by partners (e.g., Port Orford), these data can be seen as baseline data for the specific site only. Importantly, baseline data varied from study to study ([Table 2.6.1](#)).

From the information provided, it is unclear if or how initial monitoring data has informed subsequent monitoring.

2.9. Was the timing of sampling driven by the objectives and sampling designs planned for each site, given information available at the start of the Marine Reserves process (IPG7)?

**Conclusion**

An initial monitoring schedule was developed for the human dimensions project ([2012 Human Dimensions Monitoring Plan](#)). This schedule included planned monitoring activities that were developed based on the reserve objectives (Question [2.4](#)), as well as expected monitoring intervals. However, it did not include exact timing or timing relative to reserve establishment (i.e., no dates were included).

The monitoring schedule was also not site-specific. See Question [0](#) for discussion on whether the Human Dimensions monitoring program met the reserve objectives.

Later human dimensions monitoring plans ([2017](#)) did not outline timing schedules.

2.10. Were the methods of data collection appropriate for each site, given information available at the start of the Marine Reserves process, and driven by the planned objectives and sampling designs (IPG7)?

**Conclusion**

The methods of data collection used in the human dimensions project (Question [2.6](#)) were appropriate given the information available at the start of the Marine Reserves Program, followed standard scientific practices, and driven by the reserve objectives (Question [0](#)).

## 3. Ecological Factors

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### *Planning/Site Evaluation*

3.1. Are the reserves in areas with a strong likelihood\* of high species, habitat, community, functional, and/or genetic diversity? (O1)

*\* We assume this question is phrased using the colloquial meaning of 'likelihood' rather than referring to actual statistical likelihood calculations.*

### **Conclusion**

During the planning process, habitat type was used as a surrogate for biodiversity to ensure that Oregon's marine reserves included habitats likely to support high biodiversity (Question [0](#)). This approach followed best practices in the field (Foley et al. 2010, McHenry et al. 2017), and a broad range of habitat types were included within the reserves (Question [3.2](#)).

However, we conclude that the monitoring and research undertaken by ODFW has not been sufficient to quantitatively assess whether the reserves are in highly biodiverse areas, compared to the rest of the Oregon Coast.

### **Recommendation**

If determining whether the reserves are in locations with higher-than-average biodiversity, is important to the Marine Reserves Program, we recommend 1) ground-truthing the habitat surrogacy approach, which may be possible with the current data collected, and 2) comparing diversity in the reserve sites to a sample of areas (stratified by habitat) along the Oregon coast. We recognize that this may not necessarily be feasible for ODFW, given funding and logistical limitations.

### **Assessing diversity**

We see three challenges in clarifying if the marine reserves are in areas naturally high in biodiversity:

1. 'High' biodiversity assumes that the reserves occur in areas with naturally higher biodiversity than found elsewhere. For example, biodiversity within the reserves could be compared to the average biodiversity found along the Oregon coast. However, the current ecological monitoring design, with carefully selected comparison sites, cannot test this. Comparison sites test the efficacy of reserves; i.e., how well fishing closure affects local marine ecosystems. By design, they are the same as, or as close as possible to, reserve sites in all but fishing pressure. Indeed, the comparison sites chosen for Oregon's marine reserves generally have similar biodiversity to their local reserve site (Chapter 5.2 [Synthesis Report](#)). Consequently, if it is desirable to assess whether biodiversity is naturally high in the reserves relative to the coast as a whole, this would require additional sampling across the coast.

2. The Ecological Monitoring Program focused on species diversity and community compositions ([Ecological Monitoring Appendix](#)). Biodiversity also encompasses genetic and functional diversity - as recognized in OPACs definition of biodiversity (Question 0; [2008 OPAC Marine Reserves Policy Recommendations](#)). As per the [Synthesis Report](#), neither of these have been explicitly considered in the ecological monitoring. It has been brought to our attention, however, that ODFW explored both genetic and functional biodiversity but *“the path forward for sustainable long-term monitoring in both of these monitoring areas has yet to be determined”* (pers. comms. ODFW). We note that areas high in species diversity are also likely to be high in genetic and functional diversity (Tilman 2001, Vellend and Geber 2005). It is likely that an indication of functional diversity could be assessed with the ecological data already in hand, by classifying species into functional groups or guilds. Genetic diversity across species would require considerably greater sampling effort and molecular biology resources (e.g., eDNA metabarcoding, see Question [3.5](#)).
3. Diversity can be measured using a range of different methods. As discussed in Question [3.5](#), ODFW assess species diversity using a variety of measures, including Hill number and frequencies of rare and common species. They considered diversity between individual reserves and their paired comparison sites, and among reserves (e.g., Cape Falcon generally had low fish and invertebrate diversity and few rare species compared to other reserves; [Ecological Monitoring Appendix](#)).

3.2. Do the Marine Reserves protect representative key habitats? (O2)

a. Were key types of marine habitat in multiple locations identified? (O2)

b. Are there important key habitats that were not included in the locations chosen? (O2)

### **Conclusion**

Oregon’s marine reserves encompass the eight defined representative key habitats in multiple locations along the coast ([Table 3.2.1](#)). No single reserve, however, encompasses all the key habitats identified in the planning stages ([2008 OPAC Marine Reserves Policy Recommendations](#)). Estuaries are an important key habitat that was not identified during the planning stage, nor included in any of the chosen reserve locations, possibly due to the high economic impact of prohibiting fishing in these areas. The mouth of the Salmon River, however, is located within the Cascade Head Marine Protected Area.

At a coarse habitat scale, Oregon’s marine reserves collectively over-represent rock and gravel/mix and under-represent soft-sediment habitats ([Table 3.2.2](#)). Habitat representation at a finer habitat scale (e.g., high vs. low relief rocky reefs) was not documented, limiting assessment at this scale.

Presuming that habitats are protected by virtue of being in a marine reserve, we agree that a range of key habitats (as defined below) are protected within Oregon’s marine reserves. This protection is only directed against fishing and ocean development.

### **Recommendation**

If establishing whether the reserves protect representative key habitats is important to the Marine Reserves Program, we recommend assessing whether the ratios of key habitat types (as defined in [Table 3.2.1](#)) within the reserves are representative of the whole coast, as was done at a coarse habitat scale. This assessment would include estuarine habitats, which are used during portions of the life cycle of many species that inhabit existing marine reserves as adults.

Assessing the coverage of key habitats would also benefit from considering more nuanced habitat classifications that are important to biodiversity, such as further dividing subtidal rocky habitats by the degree of vertical relief or complexity, as that aspect of habitat quality has a strong influence on species assemblages (Easton et al. 2015).

### **Definitions**

Prior to the implementation of any of the marine reserves, OPAC identified **four representative key habitats** in their recommendations report ([2008 OPAC Marine Reserves Policy Recommendations](#)): rocky intertidal, rocky subtidal without kelp, rocky subtidal with kelp, and soft bottom subtidal. Key habitats were further divided into shallow (extreme low tide to 25 m depth) and deep (greater than 25 m depth), except for rocky intertidal. These habitat categories align, but are fewer and broader than those used for reserve designation in other temperate near-shore systems (e.g., California; as discussed in the [2008 STAC Size and spacing workshop](#)).

Marine reserves directly **protect** habitats from prohibited activities – here, fishing and ocean development ([Oregon Parks and Recreation Department Chapter 736](#)). Protection against other impacts, such as heatwaves, hypoxic events, plastics, and disease outbreaks, is indirect at best. Evidence for indirect protection is sparse (see also Questions [3.3](#) & [3.7](#)).

### **How ODFW identified/mapped habitats (ODFW's methods)**

Seafloor mapping was undertaken by the Active Tectonics and Seafloor Mapping Lab at Oregon State University, between 2009-2011. This survey mapped ~48% of Oregon's territorial seafloor, including ~80% of the rocky habitat ([2012 Ecological Monitoring Plan](#)).

Various habitats (including and beyond the four identified by OPAC) were also identified for multiple candidate locations through [proposals submitted by the public](#) in 2008. The [2008 Agency Analysis](#) added to and synthesized the habitats identified for each proposed site.

### **Key habitats located within the reserves**

Based on the habitat mapping of Oregon's marine reserves (Chapter 3 [Synthesis Report](#)), all the pre-defined representative key habitats were included in multiple reserve locations ([Table 3.2.1](#)). Only shallow soft bottom subtidal habitat occurs in all five reserves, and no reserve encompasses all key habitat types. Canopy kelp habitat only occurs in two of Oregon's reserves and is only abundant at Redfish Rocks.

**Table 3.2.1** Key representative habitats protected by Oregon’s Marine Reserves, as per the [Synthesis Report](#) (Chapter 3). Habitat types were defined by OPAC in the [2008 OPAC Marine Reserves Policy Recommendations](#).

Reserve	Max Depth	Rocky Subtidal Habitat (without Kelp)			Rocky Subtidal Habitat w/canopy Kelp		Soft Bottom		
		Intertidal*	Shallow*	Deep**	Shallow	Deep	Intertidal	Shallow	Deep
Cape Falcon	56m	Y (small, isolated)	Y (isolated)	N	N	N	Y	Y	Y
Cascade Head	58m	Y (around Roads End only)	Y	Y (<40m)	N	N	Y	Y	Y
Otter Rock	14m	Y (north of Devils Punch Bowl only)	Y	N	Y (patchy)	N	Y	Y	N
Cape Perpetua	53m	Y (extensive)	N	Y (patchy)	N	N	Y	Y	Y
Redfish Rocks	40	N	N	Y	Y	Y	Y	Y (patchy)	Y

\* Intertidal is defined as extreme high tide line to the extreme low tide line

\* Shallow is defined as the extreme low tide line to 25 m depth

\*\* Deep is defined as greater than 25m depth

### **Important habitats not within the reserves**

None of Oregon’s marine reserves encompassed estuarine (or river mouth) habitat. Estuaries can be an important recruitment habitat for harvested species, such as black rockfish, *Sebastes melanops* (Gallagher and Heppell 2010), and protecting the entire life-cycle of species can enhance biodiversity protection (White 2015).

Estuaries were suggested in the original [2002 OPAC recommendations](#) as a key habitat type (p. 7) and were identified in sites [proposed by the public](#), as summarized by the [2008 Agency Analysis](#): for example, Three Arches Rock (Public Proposal [#7](#) and [#16](#)). We speculate that omission of estuarine habitat from any of the reserves may be due to the high economic impact of prohibiting fishing within these habitats. We note that the mouth of the Salmon River is located within the Cascade Head MPA though not within the marine reserve.

While rocky intertidal and subtidal habitats were identified as a key habitat, not all rocky areas are equally used by different species (Kane et al., In Review). Consideration of this diversity within rocky habitats was also reflected in the recommendations by the [2008 STAC Size and spacing workshop](#) (p. 42), which further divided rocky habitat into low and high relief. The more diverse the habitats and depths in an area, the greater the chances

that a larger number of species will use it. It is also known that some rockfish species, in particular, have greater abundance in high relief rock areas (e.g., Easton et al. 2015).

Without a finer scale delineation of rocky habitats, we cannot fully assess how well Oregon’s reserves encompass the full range of key habitats important to diverse species.

**Do the reserves protect representative key habitats?**

As there is no public access to the comprehensive seafloor mapping along Oregon’s Coast, we are unable to fully assess if the ratios of key habitat types (as defined above) encompassed within the reserves is representative of the coast. ODFW, however, provided a [summary of habitat representation](#) at a coarse habitat level ([Synthesis Report](#)), summarized here in [Table 3.2.2](#).

Of the three coarse categories of benthic habitat types, reserves along the Oregon coast collectively over-represent rock and gravel/mix and under-represent soft-sediment habitats. This is especially true south of Cape Blanco, where 56% of the habitat in Redfish Rocks Reserve is rock or gravel/mixed, versus 15% in all of Oregon’s waters ([Table 3.2.2](#)).

**Table 3.2.2** Summary of habitat representation within Oregon’s Marine Reserves, at a coarse habitat level.

		Habitat Type		
		<b>Rock</b>	<b>Gravel / Mixed</b>	<b>Soft Sediment</b>
<b>Total</b>	In Oregon Waters	7%	3%	90%
	In reserves	9%	9%	83%
<b>North of Cape Blanco</b>	In Oregon Waters	6%	3%	91%
	In reserves	7%	8%	85%
<b>South of Cape Blanco</b>	In Oregon Waters	13%	2%	85%
	In reserves	35%	21%	44%

3.3. Do the sites provide a potential for enhanced resilience to human-caused or natural perturbations? (O2)

**Conclusion**

Oregon’s marine reserves have features that may lead to increased ecological resilience, especially at the local reserve scale and for harvested species. Sites that protect local populations from moderate to high fishing pressure, cover a moderate area (5-10 km along-shore), or both, have a greater capacity for rebuilding harvested populations: specifically, Cascade Head, Cape Perpetua and Redfish Rocks. The larger, healthier populations in these reserves are more likely to have greater resilience to a variety of

perturbations than unprotected populations. Whether this would also lead to greater resilience of the entire ecosystem is less clear, however.

Direct evidence for marine reserves enhancing resilience is lacking in general and we make our conclusion based on hypothesized resilience mechanisms, informed by the current knowledge of reserve effects.

### **Recommendation**

The resilience role of marine reserves is a relatively new and challenging field of study. Given enhancing ecological resilience is a key goal of Oregon's marine reserves, we recommend that long-term studies directly addressing resilience questions be included in future ecological monitoring plans (see Questions [3.7](#) for suggestions).

### **Definitions**

In the 2008 Policy recommendations, OPAC define ecological **resilience** as "*the amount of natural or manmade disturbance an ecosystem can absorb while retaining the same function, structure, and feedbacks*" (p. 6 [2008 OPAC Marine Reserves Policy Recommendations](#); Walker and Salt 2012). This is challenging to quantify: to measure resilience, the concepts of structure, function, and feedbacks need specific definitions and baselines, and specific measurable variables need to be defined (Hofmann et al. 2021; Questions [3.7](#)).

Resilience will also vary based on the type of disturbance and the function or structure being measured (e.g., White et al. in review), and resilience in one species/system may look very different in another. Here, we use reduced mortality and morbidity in the face of disturbance as an indication of resilience, assuming that larger, healthier populations will retain ecosystem function, structure and feedback.

We consider **enhanced resilience** to mean that placing a reserve increases resilience of the local ecosystem *relative to* if that same site had not been designated a reserve, or *relative to* non-reserves areas with similar habitats and fishing pressure histories. By this definition, reserve areas may not have enhanced resilience relative to non-comparable habitats. For example, placing a reserve in a pristine habitat is not enhancing the resilience of that area, rather, it is preserving resilience relative to a counterfactual in which it is allowed to be fished or developed. Thus, goals related to resilience 'enhancement' could be revised to reflect that possibility.

We consider **perturbations** to refer to relatively acute, localized events, such as coastal hypoxia events, pathogen outbreaks (e.g., sea star wasting disease), and heatwaves, rather than longer-term, wide-spread climate change pressures such as ocean acidification and rising average sea surface temperatures. See also our comments on Questions [3.7](#).

### **Marine reserves & resilience background**

The resilience role of marine reserves against disturbance and perturbations is a relatively new and challenging field of study.

There is now strong evidence that marine reserves support larger populations with more old, larger individuals than surrounding fished waters, especially for species targeted for

harvest (reviewed by Lester et al. 2009). There is also mounting evidence that rebuilding populations of previously harvested species can promote more intact food webs and ecosystems (e.g., Eisaguirre et al. 2020).

The mechanisms through which reserve benefits can promote resilience to human-caused or natural perturbations have been hypothesized but evidence supporting them is sparse or non-existent (see Hofmann et al. 2021).

Considering this, assessing whether Oregon's marine reserves provide a potential for enhanced resilience is challenging. Our approach is to first discuss the proposed mechanisms through which reserves may support enhanced resilience. We then link these mechanisms to reserve design and features and use this as a framework for assessing the potential of Oregon's reserves to enhance resilience.

### **Placing Oregon's marine reserves in context of the best available science**

Here, we have considered those reserve effects with modest to strong empirical support, and the possible disturbance resilience mechanisms that those effects could lead to ([Table 3.3.1](#)). Importantly, many of these resilience benefits of reserves are hypothesized based on our understanding of ecology, physics, and socioeconomics: they are not yet fully documented by empirical studies, although we have noted where evidence does exist. We have also focused only on resilience mechanisms against human-caused or natural perturbations (rather than longer-term climate change pressures; Hofmann et al. 2021).

We have considered how reserves may lead to resilience at three scales: 1) the individual reserve, 2) multiple reserves along a coast, and 3) multiple reserves that have been designed as a network of connected sites (through larval or adult connectivity). While Oregon's marine reserves were designed as a collection of independent reserves, rather than as a connected reserve network, we have still considered the network scale, as spatial refugia and rescue effects are important resilience mechanisms that only occur if the reserve system is functioning as a network. This may be important in future discussions of the resilience roles of Oregon's reserves and considerations of adding reserves to create a connected network.

It is important to note that the potential for enhanced resilience is greatest for those individual species that are directly affected by reserve protection, that is, harvested species (e.g., Black Rockfish). Flow-on effects from rebuilding populations of these species will depend heavily on the strength of their linkages to other trophic levels. The best-documented example of this in temperate reef systems is in the California Channel Islands, where protection of large predatory fish (e.g., California Sheephead) inside no-take marine reserves provided functional redundancy to the loss of predatory sea stars during the wasting disease epizootic. Those large fish maintained suppression of sea urchins, preserving kelp forest habitats. Outside reserves, kelp habitat was lost due to urchin grazing (Eisaguirre et al. 2020). However, we note that we are not aware of similar potentially positive indirect effects in the food webs of Oregon coastal ecosystems.

### **The potential of Oregon's marine reserve sites to enhance resilience**

At the individual reserve level, all of Oregon's marine reserves (except Otter Rock, due to its relatively small size) have features with the potential to enhance resilience. This is especially true for those species that were moderately to heavily fished prior to reserve implementation ([Table 3.3.1](#)). For example, all reserve sites (except Otter Rock) had either moderate to high fishing pressure prior to closure, cover a moderate area (5-10km along-shore), or a combination of both (Chapter 3 [Synthesis Report](#)). These attributes provide the greatest scope for harvested populations to rebuild (White et al. 2011, Hofmann et al. 2021).

Supporting more, larger individuals is likely to be the key reserve effect that promotes resilience within Oregon's reserves, given that the reserves primarily removed extractive activities for these areas. Through rebuilding population size and structure, individuals and populations may have an increased capacity to resist and recover from disturbances (e.g., Micheli et al. 2012). In general, this is because larger populations are less likely to be locally eradicated by a single disturbance, and larger organisms have a higher per capita reproductive output. If harvested species play important ecosystem roles, then recovering those populations may also promote ecosystem and habitat resilience, through top-down control or increased trophic linkages (Peterson et al. 1998), although evidence for the potential for those mechanisms to be present is currently lacking in Oregon.

Otter Rock and Redfish Rocks experienced moderate to high fishing pressure for red urchin prior to reserve closure (Chapter 3 [Synthesis Report](#)). Urchins are a key herbivore that can mediate kelp and algae growth, especially in degraded habitats (Randell et al. 2022, Rennick et al. 2022). At a first order level, reducing fishing pressure on urchins may reduce ecosystem resilience through increased herbivory of algal habitat. However, evidence suggests that the presence of urchins is not necessarily indicative of ecosystem decline or reduced resilience. Recent research in California kelp (*Macrocystis pyrifera*) forests suggests that kelp loss due to urchins depends on complex interplays of habitat complexity, drift kelp production, and urchin behavior (Randell et al. 2022, Rennick et al. 2022, Smith and Tinker 2022). Consequently, further work is required to better understand how reduced fishing pressure on urchins impacts resilience in reserves, and whether findings from *Macrocystis* kelp forests apply to *Nereocystis* kelp forests in Oregon.

As a collective set of reserves, Oregon's reserves cover a wider range of habitats than any individual reserve. This provides a greater chance that reserve effects, and associated resilience mechanisms, will affect more species. Furthermore, multiple reserves provide redundancy in the face of localized disturbances. However, we are unable to assess Oregon's marine reserves capacity to provide refugia and rescue effects as quantifying such effects depends on detecting a disturbance to which the ecosystems in the reserves respond. Thus, it is impossible to plan such an evaluation in advance. Moreover, actual quantification would require evaluating the counterfactual response in which the reserves are not in place. Such evaluation would require a mandate to examine network-scale effects and would likely necessitate simulation modeling as well as empirical evaluations.

For further discussion of the mechanisms through which reserve effects can enhance resilience, including the current state of evidence for those mechanisms, see Hofmann et al. 2021.

**Table 3.3.1** Summary of the potential for Oregon’s Marine Reserves to enhance resilience against perturbations, based on expected marine reserve effects, the associated possible mechanisms for resilience and the reserve features that would likely support those mechanisms. Colors indicate **Strong supporting evidence (green)**, **Modest supporting evidence (yellow)**, **Emerging supporting evidence (purple)**, and **No supporting evidence found (grey)**, based on Hofmann et al. 2021.

Scale	Reserve effects	Possible resilience mechanisms	Reserve features that may enable mechanisms*	Applicable to Oregon’s Marine Reserves
Single Reserve	<ul style="list-style-type: none"> <li>Increased biogenic habitats (kelp/macroalgae, seagrasses, and salt marshes)</li> </ul>	<ul style="list-style-type: none"> <li>Increased species vital rates (though intact habitat)</li> </ul>	<ul style="list-style-type: none"> <li>Areas with strong trophic links between harvested predators and biogenic habitat.</li> <li>Moderate to high pre-closure direct habitat destruction (e.g., via trawling).</li> </ul>	<ul style="list-style-type: none"> <li><b>Cascade Head, Cape Perpetua &amp; Redfish Rocks:</b> moderate to high pre-closure fishing pressure for predatory groundfish, like Cabezon and Lingcod.</li> <li>No reserve had habitat-compromising activities pre-closure</li> </ul>
		<ul style="list-style-type: none"> <li>Increased resistance to ocean acidification and hypoxia.</li> </ul>		
		<ul style="list-style-type: none"> <li>Buffering against physical stressors (e.g., storms and surges)</li> </ul>		
	<ul style="list-style-type: none"> <li>Larger/older individuals<sup>+</sup></li> </ul>	<ul style="list-style-type: none"> <li>Greater reproductive output supports faster recovery.</li> <li>Increased organismal tolerance to environmental stress among larger individuals</li> </ul>	<ul style="list-style-type: none"> <li>Moderate to high pre-closure fishing pressure.</li> <li>Larger reserve size<sup>++</sup>.</li> </ul>	<ul style="list-style-type: none"> <li><b>Cape Falcon:</b> moderate pre-closure fishing pressure (crab only), moderate reserve size (7.5km along-shore).</li> <li><b>Cascade head:</b> moderate-high pre-closure fishing pressures (high for groundfish), small to moderate reserve</li> </ul>
<ul style="list-style-type: none"> <li>Complete/fuller age-structure<sup>+</sup></li> </ul>	<ul style="list-style-type: none"> <li>Storage effect (less vulnerable to a series of poor reproductive years)</li> </ul>			

	<ul style="list-style-type: none"> <li>• Larger population sizes<sup>+</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Higher probability of reproductive success supports faster recovery.</li> <li>• Increased resistance to stochastic demographic loss.</li> </ul>		<p>size (5.1km along-shore).</p> <ul style="list-style-type: none"> <li>• <b>Cape Perpetua:</b> moderate-high pre-closure fishing pressure, moderate reserve size (6.5km along-shore).</li> <li>• <b>Redfish Rocks:</b> High pre-closure fishing pressure (groundfish and urchins).</li> </ul>
	<ul style="list-style-type: none"> <li>• Maintenance of trophic linkages via large body sizes of predators<sup>+</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Functional redundancy in the face of loss of some members of the food web</li> </ul>	<ul style="list-style-type: none"> <li>• Moderate to high pre-closure fishing pressure.</li> <li>• Areas with strong trophic links between harvested predators and ecosystem.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Cascade Head, Cape Perpetua &amp; Redfish Rocks:</b> moderate to high pre-closure fishing pressure for predatory groundfish, like Cabezon and Lingcod.</li> </ul>
<b>Multiple Reserves</b>	<ul style="list-style-type: none"> <li>• Increased taxonomic and functional diversity across space and depth</li> </ul>	<ul style="list-style-type: none"> <li>• Increased portfolio effect (resistance and recovery via differential responses)</li> <li>• Increased insurance against coastwide impact</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple reserves across varying habitat types and depth ranges.</li> <li>• Redundancy in habitat and depth across reserves.</li> </ul>	<ul style="list-style-type: none"> <li>• Whole Marine Reserve system (multiple habitat types represented across system, with replication of habitats in multiple reserves)</li> </ul>
<b>Reserve Network</b>	<ul style="list-style-type: none"> <li>• Connectivity exporting reserve benefits</li> </ul>	<ul style="list-style-type: none"> <li>• Increased meta-population resistance and recovery through spatial refugia and rescue effect</li> </ul>	<ul style="list-style-type: none"> <li>• Reserve network designed with connectivity in mind</li> </ul>	<ul style="list-style-type: none"> <li>• Unknown, but not implausible. The reserves were not designed or assessed with connectivity in mind.</li> </ul>

\* Relative to pre-reserves or outside reserves

+ This is expected primarily for harvested species.

\*\* The benefits of reserve size vary by location and species. In general, the number of species that can achieve their natural densities and size structure increases with the size of a protected area. In the [2008 STAC Size and spacing workshop](#), a minimum reserve size of 5-10km and preferably 10-20km (along-shore length) was recommended based on species movement and dispersal rates from similar nearshore systems. We are using this as our guide in assessing reserve size.

3.4. Were ecological size and spacing considerations included in the development of the Marine Reserves system? (O3)

*a. Are the Marine Reserves of sufficient size and spacing to detect statistically significant differences between Marine Reserves and control areas? (O3)*

### **Conclusion**

Ecological size and spacing considerations were included in the planning and design stages of the marine reserves, primarily through engaging with experts in a [2008 STAC Size and spacing workshop](#) and through state Agency Analysis and Workshops ([2008](#), [2010](#)). As ecological considerations needed to balance against adverse socioeconomic impacts, not all size and spacing criteria were met by the reserves.

We were unable to assess whether the reserves are of sufficient size and spacing to detect statistically significant difference between the reserves and the comparison areas. A more pertinent question is whether the expected reserve effect size is large enough to be able to detect, given the characteristics of the reserves, comparison sites, and focal species. This requires more research to answer.

### **Recommendation**

To set realistic expectations, we recommend ODFW evaluate the detectability of reserve effects in each of Oregon's marine reserves (see Perkins et al. 2021 for an example of the type of analysis that could be undertaken). This is a possible area where ODFW could collaborate with external researchers, recognizing that ODFW's resources are limited.

Understanding when and where reserve effects are likely to be greatest can also inform future monitoring design and data analysis.

### **Size and spacing considerations**

The [2008 Executive Order](#) dictates that the reserve sites, "*individually or collectively, are large enough to allow scientific evaluation of ecological benefits*". To obtain guidance on meeting this objective, OPAC and STAC convened a [2008 STAC Size and spacing workshop](#) that produced specific guidelines for the size, spacing, and configuration of the reserves ([Table 3.4.1](#)). These guidelines informed the size, spacing and placement criteria used in the [2008 Agency Analysis](#) of the 20 initial reserve [site proposals](#), and the [2010 Agency Analysis](#) further evaluating sites proposed at Cape Falcon, Cascade Head and Cape Perpetua. The [2010 Agency Analysis](#), in particular, details clear and explicit criteria used in their assessment of proposed reserve sites ([2010 Agency Analysis: Appendix 1](#)), which derive from the guidelines developed during the [2008 STAC Size and spacing workshop](#).

Size and spacing considerations were also included in the initial [2008 Public Proposal Packet](#) for proposed sites and the [2010 Community Teams evaluations](#) of Cape Falcon, Cascade Head and Cape Perpetua, with community members explicitly asked questions regarding the size, shape, location, and the habitat features of the proposed site.

As the ecological objective also dictated that reserves be "*small enough to avoid significant economic or social impacts*" ([2008 Executive Order](#)), a balance needed to be struck between ecological outcomes (which are often greater with larger reserves) and adverse

socioeconomic impacts (which are commonly minimized with smaller reserves). Consequently, not all reserves met the ecological size and spacing guidelines developed during the [2008 STAC Size and spacing workshop](#) (Table 3.4.1).

### **Detecting reserve effects**

We are unable to assess whether the reserves are sized and spaced sufficiently to detect statistically significant differences between reserves and control areas. This is due to the following reasons:

1. Statistical significance is not always a measure of biological significance. For marine reserves, a more pertinent question is whether the reserve effect size is likely to be large enough to detect (Kaplan et al. 2019, Nickols et al. 2019).
2. Spacing between reserves and comparison sites will more strongly influence the ability to detect a reserve effect (comparing inside to outside), than spacing between reserves (Moffitt et al. 2013). Spacing between reserves is relevant to assessing reserve network effects, which are not an objective of Oregon's reserves ([2008 OPAC Marine Reserves Policy Recommendations](#)).
3. Detecting reserve effects depends on the characteristics and histories of the reserves and the comparison sites, as well as the life-history traits of the species of focus. This is because the spatial and temporal scales of population responses to reserves is affected by relationships between reserve area size, larval and adult movement distances, species generation time, and current and historical fishing pressure, as well as the ability to detect change among temporal and spatial variation (Moffitt et al. 2013, Kaplan et al. 2019, Nickols et al. 2019, Hopf et al. 2022).

We can, however, comment that we agree with ODFW's conclusions that 1) any reserve effects are not likely to be detectable until a minimum of 10-15 years (longer for longer-lived species) after reserve implementation (p. 15 [Synthesis Report](#)); and 2) that reserve effects are most likely to be detectable in Redfish Rocks and Cascade head, based on their habitats, moderate to larger areas, and pre-closure fishing pressures (p. 17 [Synthesis Report](#)).

**Table 3.4.1** Condensed summary of size, spacing, and placement guidelines used to develop criteria assessing Oregon’s proposed marine reserve sites, based on recommendations developed during the [2008 STAC Size and spacing workshop](#). See also [2010 Agency Analysis: Appendix 1](#).

	<b>Suggested Guideline</b>	<b>Guideline Met</b>	<b>Additional Comments</b>
<b>Size</b>	Minimum size guideline of 5-10km alongshore distance, preferably 10-20km	Mostly.	Cape Falcon, Cascade Head, and Cape Perpetua extend 5-10km alongshore. Otter Rock and Redfish Rocks extend <5km alongshore (Chapter 3 <a href="#">Synthesis Report</a> ).
	Western boundary to follow state boundary (i.e., extend to deep, offshore waters)	Rarely.	Only Cape Perpetua extends to the state boundary. Cape Falcon, Cascade Head, and Redfish Rocks have MPAs west of the reserve sites. Otter Rocks extend 1.2km offshore with no adjacent MPA (Chapter 3 <a href="#">Synthesis Report</a> ).
	Large enough to encompass home ranges or typical movement areas of species of interest	Mostly.	See species table in the <a href="#">2008 STAC Size and spacing workshop</a> (pp. 51-53), and the <a href="#">2010 Agency Analysis</a> .
<b>Spacing</b>	Sites distributed along the full Oregon coast and in each biogeographical region.	Yes.	Four sites are located north of the Cape Blanco biogeographic demarcation. Redfish Rocks occurs in the southern region (Chapter3 <a href="#">Synthesis Report</a> ).
	Sites spaced no more than 50-100 km apart.	Mostly.	All reserves are within 100km of another reserve, with the exception of Redfish Rocks that occurs 170km south of Cape Perpetua ( <a href="#">System-wide Agency Analysis, 2010</a> ).
<b>Placement</b>	Individual sites placed to maximize the habitat and depth ranges within their boundaries.	Mostly.	See Questions <a href="#">3.2</a> & <a href="#">1.2</a> .
	Seafloor types and depth ranges, and their relative proportions, are representative of the general region where the site is located.	Mostly.	
	Sites collectively represent habitat types within their biogeographical region and include areas of high biological diversity and special natural features.	Yes.	

## *Program Evaluation*

3.5. Has species diversity been documented by appropriate quantitative sampling and statistics? (O1)

### **Conclusion**

Species diversity in both comparison and reserves sites was sampled using all ODFWs major ecological sampling methods (Hook, line and longline, SCUBA, ROV, and video lander). It is important to note that each sampling method used can only sample a portion of the community and, therefore, cannot give a complete picture of biodiversity by itself.

Diversity was quantified using appropriate diversity metrics (Hill numbers) and analysis (rarefaction-extrapolation curves).

Rarefaction-extrapolation curves based on sample number suggest that the current sampling frequency was not sufficient to give an accurate estimate of diversity over time but pooling over years provided sufficient sample sizes to estimate diversity at each site for each method. No comparison of observed diversity among sampling methods was made.

### **Recommendation**

We recommend that diversity sampling continue. If there is funding and logistical scope, increasing sampling frequency would allow for better-resolved comparisons over short time horizons, which is critical if assessing diversity changes before-after reserve establishment is an objective of the Marine Reserves Program.

If establishing a complete picture of biodiversity in reserves is important, we also suggest comparing and pooling diversity across sampling methods. Alternative and complementary biodiversity approaches (e.g., environmental DNA metabarcoding) might also be worth considering (Ruppert et al. 2019, Valdivia-Carrillo et al. 2021).

We also suggest that sample coverage (a measure of how complete the sampling is) be analyzed (this requires no extra sampling). Compared to the effective number of species (used in ODFW's analysis), sample coverage is better able to quantify the magnitude of the differences in richness among communities and can indicate whether more sampling is required (Hsieh et al. 2016).

### **Definition**

OPAC define **species diversity** as "*the variety and abundance of species in an ecosystem*" (p. 4 [2008 OPAC Marine Reserves Policy Recommendations](#)). This can be quantified different ways (discussed below).

### **ODFWs sampling and analysis of species diversity**

Species diversity was sampled in reserve and comparison sites using a range of sampling methods. We comment on the general appropriateness of ODFWs sampling methods in [Table 3.6.1](#).

Critically, every method used samples only a portion of the community, as none were designed as true biodiversity monitoring techniques. For example, [hook and line](#) sampling

will only give an indication of biodiversity for certain fished species, as is exemplified by the need to add [longline fishing](#) to the Ecological Monitoring Program (Question [3.6](#)). Likewise, divers undertaking the [SCUBA monitoring](#) focused on a predefined list of invertebrate and algae species to ensure that they completed the required number (two) of replicate transects per dive. This is important if measuring 'true' biodiversity of the whole community is an objective of the Marine Reserves Program. However, ODFW's approach is appropriate if the objective is to evaluate biodiversity of those communities most likely to be affected by reserve protection (i.e., harvested species and those that directly interact with them). The approach taken by ODFW is standard practice in long-term reserve monitoring program (Caselle et al. 2015).

Our comments here are made based on the [Synthesis Report](#). It has been brought to our attention, however, that [ODFW are also currently trialing](#) Autonomous Reef Monitoring Structures (ARMS), combined with genetic sampling, for use in evaluating the diversity of small or cryptic invertebrates, which are currently overlooked in the sampling methods.

For each sampling method, species diversity at a given site, and among sites, was quantified using four concepts. All are appropriate to document species diversity (recognizing the limitation that each method can only sample a subset of the community):

1. *Species richness*. Total observed and estimated number of species, pooled across all years. To estimate richness, standard rarefaction and extrapolation techniques were used (Hsieh et al. 2016).
2. *Unique, common and rare species*. Frequency of occurrence across all samples (pooled across all years) for a site. Rare species had frequency occurrence of  $\leq 10\%$ , and common species  $> 50\%$ .
3. *Diversity indices*. The first three Hill numbers (effective number of species): species richness, Shannon diversity and Simpson Diversity. Incidence data, pooled across all years is used and presented as rarefaction and extrapolation curves (standard tools in biodiversity analysis; Chao et al. 2014). These curves overcome the common issue of discarding data to compare between different sampling efforts (Chao et al. 2014, Hsieh et al. 2016). By plotting the diversity indices rarefaction and extrapolation curves, comparisons between sites with different sampling efforts are appropriate (but see comment below regarding sample completeness).
4. *Diversity through time*: The current sampling frequency (approximately every 1-2 years) was not sufficient to compare diversity over time, as indicated by rarefaction-extrapolation curves based on sample number. An analysis of variance (ANOVA) was used to test transect diversity (pooled across all years).

No comparison of quantified diversity among sampling methods is made in the [Synthesis Report](#) or associated documents. This is critical given that each sampling method used by ODFW samples only a portion of the community. Comparing and pooling across techniques would aid in establishing a fuller picture of biodiversity relevant for marine reserves.

We believe that pooling data across years was an acceptable approach to overcoming low sampling numbers year-by-year. As more data is collected over time, binning across multiple years may be possible to evaluate diversity changes over time.

For pooled data, rarefaction and extrapolation curves (number of species vs number of sampling units) for each site by method are at an asymptote, or closely approaching one. This partially suggests that enough sampling was undertaken across sites and methods to provide an accurate estimate of diversity (as measured by Hill numbers) at this level of analysis, recognizing that the methods used are unable to provide estimates of biodiversity of the whole ecosystem.

Estimating sample completeness (measured by sample coverage), in addition to the effective number of species, would also be helpful in providing a more complete picture of species diversity (Chao et al. 2014, Hsieh et al. 2016); it was not included in ODFW's analysis. Sample coverage is defined as the total relative abundances of observed species, and effectively estimates the proportion of the total individuals in the assemblage that belong to undetected species (Chao et al. 2014). Critically, sample coverage vs number of sampling units curves can indicate whether more sampling is required to obtain completeness in sampling (Hsieh et al. 2016).

If estimating biodiversity at a broader taxonomic scale is important to the Marine Reserves Program, alternative and complementary biodiversity approaches – such as environmental DNA (eDNA) metabarcoding – may be of value to ODFW. It is important to recognize that eDNA metabarcoding is relatively new and still in development, especially for marine systems (Ruppert et al. 2019, Valdivia-Carrillo et al. 2021), and the cost-effectiveness of these techniques will need to be considered. Work is currently underway in California that might provide insight to the applicability of these methods to Oregon (Valdivia-Carrillo et al. 2021).

3.6. Have [appropriate methods](#) been used to sample the abundance of key species?  
(O1)\*

### **Conclusion**

The sampling methods used to quantify the abundance of key species (and other variables, such as density and benthic cover) evolved over time as the ODFW Ecological Monitoring Program responded to challenges met in each of the reserve sites. The nature of this change varied by sampling method. This is consistent with an adaptive management approach; however, it limits the use of the data collected to only comparable sampling methods and among sites sampled with the same method.

Assessment of methods used to analyze the data is outside the scope of this question, however, we would like to comment on two data analysis aspects relevant to sampling of key species: the [focal species approach](#), and the power analysis ([Ecological Research Appendix: Power Analysis](#)). We agree with ODFW that their focal species approach used in

the analysis may have not been the best approach (p. 105 [Synthesis Report](#)) as it limited analysis.

That conclusion was supported by the power analysis, which is a very valuable tool for evaluating the relative effectiveness of different sampling methods for detecting ecological changes. Coupling an evaluation of power with an assessment of the costs per sample of different methods could be useful in developing monitoring plans.

### **Recommendation**

We recommend that ODFW use the experiences of the monitoring program to immediately set sampling protocols that will remain consistent moving forward, recognizing the limitation of long-term monitoring programs (e.g., funding and personnel). Analysis of the relative costs of sampling and relative statistical power of different methods could guide decisions. Continuing to hold monitoring workshops will aid in finalizing monitoring decisions.

Specific recommendations for each of ODFW's sampling methods are outlined in [Table 3.6.1](#).

For future analysis of data, we recommend adopting the accepted approach of analyzing the top abundant species that emerge from the data, rather than a predetermined focal species approach.

### **Field Methods**

ODFW used five key sampling methods: hook and line sampling, longline sampling, Remotely Operated Vehicle (ROV) surveys, SCUBA surveys, and video lander surveys. The variables collected varied across the five sampling methods used, although all methods collected baseline data on diversity, community composition, and a measure of abundance or benthic cover ([Table 2.3.1](#) & [Table 2.3.3](#)).

ODFW ecological monitoring methods have undergone an extensive learning and adapting process (see also Questions [2.1-2.3](#)). Initially set out to sample with consistent methods across all reserves and comparison sites, the ecological monitoring program quickly learned and adapted to unique characteristics for each site and each sampling method. For example, ODFW collaborators (commercial fishermen) noticed that hook-and-line surveys were not capturing the full range of species caught commercially out of Port Orford. Subsequently, longline fishing was introduced to supplement sampling at Redfish Rocks ([Longline methods](#)). SCUBA surveys faced the greatest challenges - including poor visibility, challenging currents, poor weather, and safety concerns - and methods have changed multiple times over the years.

Given the limitations and challenges of each sampling method, surveys with all methods have only occurred at one reserve-comparison site pair (Redfish Rocks) and no single sampling method has been used across all sites. This limits comparisons between reserve sites as well as challenges in detecting emergent effects of the set of five Oregon reserves, as each sampling method captures different species/communities.

## **Relevant Data Analysis**

### *Focal species approach*

In their analysis and reporting, ODFW focused on a select number of focal species, due to logistical constraints (time, fundings, resources). These [focal species](#) were selected based on their ecological or economic importance, and their potential to show a response, or change within a marine reserve over time. However, identifying focal species based on these criteria, rather than abundance, resulted in limited analysis and reporting. For example, some focal species (e.g., Yelloweye Rockfish, the California Sea Cucumber, and Woody-stemmed Kelp) were not abundant, resulting in zero-heavy data (p. 105 [Synthesis Report](#)). Consequently, analyses were also performed on non-focal species that were found to be highly abundant, which improves statistical power and follows common practice for analysis of survey data (White et al. 2021).

Importantly, all species encountered during surveys are being recorded by the Ecological Monitoring Program - only the analysis is limited to certain species. We pre-emptively recommend against limiting sampling to a certain number of species as this does not save time or resources. In fact, it compromises future-proofing the data; at the moment there is scope to analyze less abundant species in the future, even if they are not analyzed now.

### *Power analysis*

The power analysis undertaken by ODFW ([Ecological Research Appendix: Power Analysis](#)) was extremely thorough and a valuable tool for evaluating the relative effectiveness of different methods in detecting change in different species across sampling locations. The overall Monte Carlo approach using simulated negative-binomial-distributed data and applying a GLM is an appropriate and standard approach (Johnson et al. 2015).

The power analysis also called attention to the value of analyzing change in the most abundant species, rather than pre-determined focal species. Further, if the cost per sample were known for different sampling methods, this analysis could be used to identify the most cost-effective sampling tools for detecting changes in reserves. Additionally, the power analysis correctly notes that the power to detect change depends on the degree of change expected. Some approximate guidance on that expected change is available; for example, White et al. (2013) showed that as a first approximation the proportional increase in abundance inside a reserve should eventually be  $1 + F/M$ , where  $F$  is the fishing mortality rate prior to reserve enforcement, and  $M$  is the natural mortality rate of the species. In well-managed fisheries,  $F$  is typically kept less than  $M$ . Thus, very extreme increases in abundance (e.g., 6x) are likely to be uncommon, except perhaps as a result of large recruitment events (see e.g., Hopf et al. 2022). That type of approximation could guide the level of expected change when interpreting the power analyses.

**Table 3.6.1** Summary table of field methods used by ODFW, including our assessment of appropriateness\* of the methods, comments, and recommendations. Method names link to method documents.

	Sampling Method	Summary of Application	Appropriateness*	Comments	Recommendations
ODFW Marine Reserves Ecological Monitoring Program	<a href="#">Hook &amp; Line</a>	<p><i>Species:</i> fish  <i>Metrics:</i> diversity, CPUE/BPUE, size  <i>Habitat:</i> rocky reef (10-40m)  <i>Number of reserves:</i> 4</p>	High	<ul style="list-style-type: none"> <li>• Methods changed in 2013 to match California Collaborative Fisheries Research Program (CCFRP). Care required when considering data pre-2013.</li> <li>• Has potentially high social value by forming relationships between fishermen and researchers.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue with current program.</li> <li>• Collaboration with CCFRP may yield joint research or funding opportunities.</li> </ul>
	<a href="#">Longline</a>	<p><i>Species:</i> fish (targeting demersal sedentary fish species)  <i>Metrics:</i> diversity, CPUE/BPUE, size  <i>Habitat:</i> rocky reef (20-40m)  <i>Number of reserves:</i> 1</p>	High	<ul style="list-style-type: none"> <li>• Low additional cost to supplement data not collected by hook and line (demersal fish species).</li> </ul>	<ul style="list-style-type: none"> <li>• Continue with current program</li> </ul>
	<a href="#">SCUBA</a>	<p><i>Species:</i> fish, invertebrates, benthos  <i>Metrics:</i> diversity, density, % cover  <i>Habitat:</i> shallow rocky reef (non-kelp) (10-20m)  <i>Number of reserves:</i> 4</p>	Moderate	<ul style="list-style-type: none"> <li>• Fish size proved difficult to measure (due to poor conditions). This is problematic as size and size structure are key indicators of reserve effects.</li> <li>• No sampling occurred in kelp, due to safety concerns, precluding any conclusions about effects in kelp habitats.</li> <li>• Inconsistencies in survey frequencies due to poor weather/covid.</li> <li>• Changes between fixed and random transects.</li> </ul>	<ul style="list-style-type: none"> <li>• Adopting a community-based volunteer program like ReefCheck (California) may broaden the volunteer pool and align protocols with those used in other nearshore systems.</li> <li>• Current methods across all 4 sites may be too costly for the limited data obtained. Focusing efforts on limited sites (as ODFW plan to do) may yield more useable data.</li> <li>• ODFW have detailed method considerations moving forward (including addressing the lack of</li> </ul>

				<ul style="list-style-type: none"> <li>• Mid-water and canopy fish surveys discontinued.</li> <li>• Methods changed multiple times.</li> </ul>	diving in kelp), which we agree will be beneficial.
	<a href="#">Remotely Operated Vehicle (ROV)</a>	<i>Species:</i> fish, invertebrates, benthos <i>Metrics:</i> diversity, density <i>Habitat:</i> all (20-50m) <i>Number of reserves:</i> 3 (data for 2)	Extremely high	<ul style="list-style-type: none"> <li>• Minor changes and development during initial field testing, but methods follow standard ROV protocols.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue with current program</li> </ul>
	<a href="#">Video Lander</a>	<i>Species:</i> fish, benthos <i>Metrics:</i> diversity, MaxN <i>Habitat:</i> all (5-20m) <i>Number of reserves:</i> 4 (data for 2)	Moderate to Low	<ul style="list-style-type: none"> <li>• Very low (50%) useability found.</li> <li>• In later years, landers only deployed alongside SCUBA, nullifying their usefulness in deep waters.</li> </ul>	<ul style="list-style-type: none"> <li>• Assess whether continuing with the program is cost effective and provides sufficiently novel data, beyond that collected by other methods.</li> </ul>
Collaborations	<a href="#">SMURE</a>	<i>Species:</i> larval fish <i>Metrics:</i> settlement rate <i>Number of reserves:</i> 1	Extremely high	<ul style="list-style-type: none"> <li>• Procedures are standardized to most other SMURF projects (e.g., in California)</li> </ul>	<ul style="list-style-type: none"> <li>• Continue with current program and collaborations.</li> <li>• Consider expanding to more MPAs, although there are trade-offs as this is a destructive sampling technique.</li> </ul>
	<a href="#">Intertidal Monitoring</a>	<i>Species:</i> sea stars, mussels, and benthic community <i>Metrics:</i> diversity, size, density, % cover <i>Habitat:</i> <i>Number of reserves:</i> 3	Extremely high	<ul style="list-style-type: none"> <li>• Surveys undertaken in response to sea-start wasting disease outbreak, but continue to present.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue with current program and collaborations.</li> <li>• Links between intertidal habitats and MPA effectiveness is indirect, but this method supports monitoring of the health of Oregon's coastal habitats</li> </ul>

\*Appropriateness scale considers how appropriate the sampling method is, relative to best practice and other case studies, as well as the degree to which the method changed/developed over time. It does not take into account the monetary costs relative to benefits.

**Extremely High:** The method is appropriate and has not had major changes over time.

**High:** The final method is appropriate but has had a major change over time. Considerations of method changes are required in analyzing associated time series data.

**Moderate:** The final method is somewhat appropriate but has one or more notable flaws or has had multiple major changes. Considerations of method changes are required in analyzing associated time series data.

**Low:** The method is still in development or not appropriate.

- 3.7. Have appropriate methods been developed for eventually determining the role of reserves in resilience of nearshore ecosystems? (O2)
- a. Was the monitoring system designed to pick up specific kinds of perturbations that might be expected? (O2)*

### **Conclusion**

The ecological monitoring methods developed by ODFW are currently insufficient for eventually determining the resilience role of marine reserves in Oregon's nearshore system. Fundamentally, 1) 'resilience' lacks a clear working definition in the context of monitoring and research, and 2) the exact resilience roles of reserves, and mechanisms through which reserves may influence resilience, have not been discussed (see also Question [3.3](#)). These deficits lead to a lack of clear and appropriate research goals and monitoring methods for determining reserve-resilience effects.

The long-term ecological and oceanographic monitoring undertaken by ODFW, however, provides a solid foundation to build upon. The comprehensive monitoring of multiple species through multiple survey approaches over the past decade provides critical data required for detecting and understanding disturbances (aka perturbations) experienced by Oregon's nearshore ecosystems.

### **Recommendation**

We recommend that ODFW develop a clear hypothesis-driven research agenda for understanding the resilience roles of marine reserves in Oregon waters, including, but not limited to; 1) developing a working definition for 'resilience', 2) continuing the current long-term monitoring of oceanographic and ecological variables, 3) analyzing combined oceanographic and ecological data to evaluate changes inside and outside reserves during a perturbation, and 4) developing partnerships with external research groups to understand the mechanisms through which reserves could confer resilience at the community-ecosystem level.

If OPAC and ODFW continue to be interested in resilience in nearshore ecosystems, then we suggest focusing on species most affected by reserve closures and known to respond to expected disturbances (as these are more likely to show reserve-resilience effects).

We also suggest ensuring that paired reserve-comparison sites are used to elucidate effects. Focusing reserve-resilience monitoring and research on at least two site pairs would best support the efforts, given potential funding and logistical limitations moving forwards. We suggest Cascade Head, Cape Perpetua, and Redfish Rocks, which are the most likely to show any resilience effects (largely due to higher fishing pressure prior to closure; Question [3.3](#), [Table 3.3.1](#)), and span the two biogeographical regions. Each site has its positives and challenges that will need to be considered alongside targeted research questions: Cape Perpetua, for example, lacks a similar comparison area ([Table 2.3.2](#)) but has long-term oceanographic monitoring ([Table 2.3.1](#)).

We outline more detailed recommendations below.

## **Definition**

In the 2008 Policy recommendations, OPAC define **resilience** as “the amount of natural or manmade disturbance an ecosystem can absorb while retaining the same function, structure, and feedbacks” (p. 6 [2008 OPAC Marine Reserves Policy Recommendations](#); Walker & Salt 2006). Here, we work within this definition but make note that it is insufficient in its current form. See also Question [3.3](#).

## **Framework for determining resilience role of reserves**

To understand the California Current Large Marine Ecosystem (CCLME) and its response to impacts and change (anthropogenic or natural), PISCO developed a research platform based on three components: 1) quantifying oceanographic conditions over time, 2) undertaking a long-term, field-based monitoring program to detect human and natural disturbances on ecosystems, and 3) conducting ‘process’ studies to understand the mechanisms driving dynamics (across all sub-organismal to community levels) (Menge et al. 2019).

Here, we use an adaptation of these components to help frame our assessment of whether appropriate methods been developed for eventually determining the resilience role of Oregon’s marine reserves.

Enhancing resilience is an explicit part of Oregon’s marine reserve objectives (O2: “Protect key types of marine habitat ... to enhance resilience of nearshore ecosystems to natural and human-caused effects”; [2008 OPAC Marine Reserves Policy Recommendations](#)). As such, we expand component 2 to include monitoring for resilience in ecosystems. Overarching this framework is the need to assess the roles that the reserves may play in enhancing resilience (or not), i.e., testing the effect of reserves on measured resilience variables.

We discuss the need for each of these components in the context of assessing resilience in reserves, what is or may be involved (this is based on our expert knowledge, and not comprehensive), and whether ODFW’s Ecological Monitoring Program currently includes all or part of these components. We also suggest ways ODFW may move forward using this framework, recognizing that this is an idealistic framework and that ODFW’s resources are limited.

**Component 1:** *Quantifying oceanographic conditions over time, in both reserve and comparison sites.*

### **Why:**

To understand the disturbance/perturbation impacting an ecosystem, ODFW need to know ‘how much’ disturbance/perturbations occurred, as well as when and where it happened. Achieving this also requires quantifying baseline conditions to compare against. Critically, to understand the resilience capacity of reserves specifically, ODFW needs to understand if reserves and comparison sites are/were impacted differently.

Quantifying oceanographic conditions is primarily to account for confounding factors when assessing reserve-resilience effects. It is not to test if reserves changed local oceanographic conditions, as this is unlikely. For example, at a coast-wide scale we would expect Redfish

Rocks to experience different oceanographic conditions to reserves north of the oceanographic demarcation at Cape Blanco (Rivas and Samelson 2011). But we would not expect Redfish Rocks reserve to experience different conditions from an equally impacted comparison site by virtue of it being a marine reserve.

How:

To ensure baseline values, long-term trends, and short-term perturbations are captured, long-term and consistent monitoring of oceanographic conditions at both reserve and comparison sites is required. The timescale of monitoring needs to match the disturbance events of concern. For example, over the last two decades, major disturbance events along the Oregon Coast have included hypoxic events (durations on the order of days), marine heatwaves (durations on the order of months to years), and disease (including SSWD). The variables measured also need to match the types of disturbances expected; for example, sea surface temperature and dissolved oxygen.

ODFW, in conjunction with PISCO, has monitored key variables (temperature, salinity, dissolved oxygen, chlorophyll and pH) at all sites, over the past 10 years. We believe this to be an extensive, though not comprehensive range of oceanographic variables to monitor. Due to sampling challenges, including a lack of equipment and budget constraints, ODFW have not consistently or simultaneously monitored all variables at all sites (Oceanographic methods; Barth et al. 2021). Remotely sensed oceanographic variables are increasingly available, and in some cases, may be more cost-effective and at appropriate scales, than in situ measurements.

The value of long-term, consistent oceanographic monitoring is exemplified by the detection of anomalously warm, fresh, high-DO water from offshore in Cape Perpetua Reserve (which has 18 years of consistent interannual data for all variables) during the late summer of 2015, as the Warm Blob sat offshore ([Barth et al. 2021](#)). Detecting this event allowed for ODFW to combine oceanographic and ecological data to better understand how the ecosystem responded to this event. However, oceanographic data is not available for the Cape Perpetua comparison site(s), thereby limiting the use of this data in elucidating any reserve effects although the Warm Blob is likely to have encompassed both areas.

Recommendation:

We recommend that ODFW continue long-term monitoring of variables at all sites (prioritizing reserve-comparison pairs), as consistently as logistically possible. This would be of particular value to the Ecological Monitoring Program.

We support ODFW's efforts to explore the best ways to address continued oceanography capacity issues ([Ecological Research Appendix: Oceanography Report](#)). Moving forward, and recognizing logistical constraints, we suggest that ODFW:

1. develop priority oceanographic monitoring objectives that reflect the need to understand the resilience roles of Oregon's reserves,

2. explore the possibility of prioritizing efforts in the reserve sites likely to demonstrate the strongest reserve effects (e.g., Cascade Head, Cape Perpetua, and Redfish Rocks; [Table 3.3.1](#)),
3. continue to maximize oceanographic data collection efforts by building on opportunistic collaborative research projects (as they have done previously; [Ecological Research Appendix: Oceanography Report](#)),
4. consider alternative sources for data and data products (e.g., satellite data, oceanographic modelling; Barth et al. 2019), and
5. consider that consistent recording of low-cost data streams (e.g., water temperature) as a high priority, as variables such as temperature can sometimes be used as proxies for other types of oceanographic disturbances (e.g., exposure to low-DO upwelled water) that are more challenging to measure consistently.

**Component 2:** *Undertaking a long-term, field-based monitoring program to detect human and natural disturbances and measure resilience in ecosystems, in both reserve and comparison sites.*

Why:

Understanding the resilience role of reserves requires understanding what aspect of an ecosystem was affected, how it was impacted and how it recovered, and whether this was different between reserves and comparison sites. Long-term, field-based monitoring is essential to achieving this, especially as impacts can be unpredictable.

How:

As long-term monitoring is expensive and logistically demanding, it is important that clear objectives and goals be established. In the context of understanding the resilience roles of reserves, how to best capture these reserve-resilience effects needs to be considered.

Monitoring for disturbance and resilience is at the forefront of marine science and no case studies exist to draw from. Here, we suggest possible ways forward to monitoring for resilience, noting that this is a starting point based on our expertise and not comprehensive:

1. Resilience monitoring and analysis should *prioritize species that are the most impacted by reserve protection and by the expected disturbance*, such as fishery targeted species with smaller home ranges. Resilience benefits from reserves (if present) are most likely to be present in species that have the strongest response to reserves protection (see Question [3.3](#) and [Table 3.3.1](#)). This also depends on the disturbance expected; for example, ocean acidification primarily affects calcifying organisms, so monitoring fish species is not applicable here. In general, for Oregon's marine reserves, groundfish, crab, and urchins are possible candidates, all of which are being monitored across ODFW's different survey methods.

To inform the selection of candidate species, ODFW has a wealth of experience and data to draw on. For example, ODFW learned that their [focal species approach](#) to reporting may not have been the best as certain species were often zero heavy (e.g., Yelloweye Rockfish; p. 105 [Synthesis Report](#)); however, this is informative moving forward.

2. Working definitions of 'resilience' and 'disturbance', targeted research questions, and specific measurable variables need to be developed. Baseline conditions should also be established, where possible.

OPAC's current definition of resilience – *"the amount of natural or manmade disturbance an ecosystem can absorb while retaining the same function, structure, and feedbacks"* - is vague and not a suitable working definition moving forward. This definition follows a resistance framework, focusing on how much impact an ecosystem can withstand before significant change occurs (Ingrisch and Bahn 2018). A resistance approach is challenging to quantify. We suggest a definition be developed that focuses on both impact and recovery (sensu Ingrisch and Bahn 2018), as this allows for measurable ecosystem response such as magnitude of impact, recovery times, and increased temporal variance (Denny et al. 2009, Ingrisch and Bahn 2018, White et al. in review). Furthermore, possible reserve rescue effects could be tested for by assessing these variables at varying distances from reserve boundaries (Moffitt et al. 2013).

Resilience will also vary based on disturbance, system, and species; different types of disturbances may elicit different types of resilience, or the same disturbance may elicit different responses in different species/systems (see Question [3.3](#)). Consequently, defining resilience for monitoring also requires careful thought about what disturbances are expected along Oregon's coast and how they may affect candidate species (i.e., fishery targeted species as discussed above). The oceanographic and ecological data collected by ODFW's ecological monitoring program may be able to inform this.

A clear working definition for resilience can inform, and be informed by, targeted research and monitoring questions. These are currently lacking in ODFW's monitoring for reserve-resilience effects. Reserve-resilience questions can also be informed by observed reserve effects (in Oregon and elsewhere) and by hypothesized resilience mechanisms for ecosystems within reserves that are relevant to Oregon (Question [3.3](#)). Targeted research reserve-resilience questions are already being developed for California's MPAs (Table A-3 in Hofmann et al. 2021) and collaborative efforts may prove resource-efficient.

3. *Monitoring needs to be long-term, consistent, and frequent* enough to detect the types of disturbances expected and to establish baseline conditions. Due to sampling challenges and logistical constraints, all of Oregon's marine reserve and comparison sites have not been sampled by all survey methods every year since monitoring began. As funding and logistical constraints may prevent ODFW increasing sampling

frequency, it is important to recognize that acute disturbances may be missed. It may be prudent to assess what types of disturbances are likely and whether the current, or on-going, monitoring frequency is sufficient to detect these. Oceanographic and ecological data collected by ODFW's monitoring program could be supplemented by modelled oceanographic data (e.g. Barth et al. 2019) and remotely sensed data to inform this.

4. Monitoring needs to *occur across paired reserve-comparison sites* to allow for teasing out reserve effects. Ideally, paired sites should match those with oceanographic monitoring. All of Oregon's marine reserves, except Cape Perpetua, have suitable comparison sites that are currently monitored using a range of methods ([Ecological Monitoring Plans](#)), laying the groundwork for inside-outside reserve comparisons.

ODFW's monitoring of Oregon's sea star populations in response to the outbreak of Sea Star Wasting Disease (SSWD) exemplifies how a monitoring program can detect disturbances and resilience. ODFW recognized a threat to an important species, joined forces with an established long-term monitoring program (PISCO), and asked clear research questions to understand the impact of SSWD. Their findings suggest that intertidal sea star populations in Oregon were resilient to the outbreak. Resilience was defined as a speedy population recovery ([Intertidal Sea Star Monitoring Report](#)). ODFW also found that SSWD had no noticeable implications for the intertidal community (measured as no encroachment by mussel beds; [Mussel Bed Dynamics Report](#)). Monitoring was done in both reserves and comparison sites and suggested no reserve-resilience effect: populations within reserves were no less impacted nor recovered faster than those outside. However, this is not surprising given that sea stars are not directly impacted by reserve protection (e.g., they are not a harvested species). While the SSWD study answers other important questions and provides an example of how monitoring can detect disturbance and recovery, it is not – strictly speaking – helpful in understanding the potential resilience roles of reserves *per se*.

*Recommendation:*

We recommend that ODFW develop a 1) clear working definition of 'resilience', and 2) targeted monitoring objectives for elucidating the resilience effects of reserves, considering the specific needs and limitations of Oregon's marine reserves. This would be of particular value if understanding the resilience effects of Oregon's reserves is of importance to the Marine Reserves Program.

To ensure limited ODFW resources are allocated effectively, we suggest that priority monitoring objectives for understanding the resilience effects of reserves be developed through working groups with experts and managers (for example, see Appendix C in Hofmann et al. 2021).

**Component 3:** *Conducting 'process' studies to understand the mechanisms driving observed dynamics.*

*Why:*

The resilience mechanisms potentially enhanced by reserves are theoretical with little to no supporting evidence, as discussed in Question 3.3. Therefore, understanding these mechanisms at a sub-organismal, organismal, population, and community level can inform targeted monitoring and set expectations for management.

How:

As with component 2, process studies will require clear research questions and studies that are targeted at understanding resilience effects that are reserve- and Oregon-specific.

For example, a clear ecological effect of reserves is the increased density of larger-bodied individuals (Lester et al. 2009) that may be more resilient against extreme oceanographic changes. Evidence for this exists for pink abalone (*Haliotis corrugata*) in Baja California (Micheli et al. 2012). Pink abalone do not occur in Oregon, but red abalone (*H. rufescens*) do, although in very low densities and they are not currently fished (due to ongoing temporary closure of abalone fisheries in Oregon). Consequently, this resilience benefit of reserves is unlikely to be seen in Oregon's abalone. Rather, Oregon could focus on understanding whether this resilience effect (larger size promotes individual resilience) occurs in different groundfishes or crabs, both of which occur in sufficient densities in Oregon's waters and are fished.

Currently, ODFW have no clear process-based studies outlined for understanding the resilience mechanisms that may be enhanced by reserves. This is understandable given that this research question is relatively new in the context of marine reserves.

Recommendation:

We recommend that ODFW fosters research partnerships with external organizations, or leverages current partnerships, to support process studies to understand the resilience mechanisms that may be enhanced by reserves.

Given the limited resources and funding available to ODFW, we suggest that ODFW acts as a sounding board for research ideas and as a collaborator, rather than leading process studies. For example, some of this work may be well-suited to be funding priorities for Oregon Sea Grant.

3.8. Has research been conducted by ODFW at the Marine Reserves in alignment with stated goals and objectives in Marine Reserves management plans? (O4)

*\*Note that while this question occurs in the Ecological Factors section, we have addressed both ecological and human dimensions research here.*

**Conclusion**

In general, the ecological and human dimension research aligns with the stated goals and objectives of the reserves (Table 3.8.1). Both research programs, however, have notable gaps. We summarize these below and direct you to other sections of the report where more details can be found (if applicable).

## **Recommendation**

We recommend that ODFW continue, revise, and improve their Ecological and Human Dimension Research Programs. Specific recommendations can be found in the relevant sections outlined in Table 3.8.1.

## **Reserve goals**

The stated goals of Oregon's marine reserve are ([2008 OPAC Marine Reserve Policy Recommendations](#)):

*To protect and sustain a system of fewer than ten marine reserves in Oregon's Territorial Sea to conserve marine habitats and biodiversity; provide a framework for scientific research and effectiveness monitoring; and avoid significant adverse social and economic impacts on ocean users and coastal communities.*

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

The stated reserve objectives are outlined in [Table 3.8.1](#).

## **Notable gaps in current research**

- No ecological research directly considers whether Oregon's marine reserves are *ecologically significant as a whole*. OPAC defines 'ecologically significant' as "*contributing to biodiversity, resilience of the system and its populations and ecological communities*" ([2008 OPAC Marine Reserves Policy Recommendations](#)). While research is underway to assess diversity (but only species diversity; Questions [3.1](#) & [3.5](#)) and abundance within reserve and comparison sites (aligning with Objectives 1 & 4; [Table 3.8.1](#)), this research does not consider whether the reserves contribute to the biodiversity and populations/communities along the whole Oregon Coast, beyond reserve boundaries. Furthermore, there is current no research plan directly evaluating where the reserves enhance resilience within or beyond their borders (not meeting Objective 3.2; [Table 3.8.1](#))(Questions [3.3](#) & [3.7](#)).
- Significant ecological monitoring and research has been conducted assessing changes within reserves and comparison sites (aligning with Objectives 1-5; [Table 3.8.1](#)) (Questions [3.5](#) & [3.6](#)). However, long-term research and monitoring plans are required to fully assess reserve effectiveness (to meet Objective 4; [Table 3.8.1](#)). Furthermore, the ecological research is not supported by any work exploring whether the effects expected to occur within Oregon's reserves are large enough to detect (Questions [3.4](#)).
- A broad range of social and economic monitoring and research has been conducted, however to fully assess whether the reserve planning and implementation has minimized adverse impacts requires developing a detailed and strategic research plan for the Human Dimensions Program that, critically, has defined, measurable indicators of impacts (to better align with Objective 3) (Questions [4.1](#) & [4.2](#)).

**Table 3.8.1** Stated Marine Reserve objectives ([2008 OPAC Marine Reserves Policy Recommendations](#)) and assessment of whether the current ecological and human dimensions research align with these objectives.

Objective	Current Research Alignment	Comments on the Marine Reserves Program	Relevant Questions/Answers
1. Protect areas within 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.	Moderate	<ul style="list-style-type: none"> <li>- Ecological monitoring of diversity and abundance is underway.</li> <li>- No research assessing if protected areas have higher natural diversity than the rest of the coast.</li> </ul>	Marine Reserve Design: <a href="#">0</a> , <a href="#">1.2</a> Ecological Factors: <a href="#">3.1</a> , <a href="#">3.5</a> , <a href="#">3.6</a>
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.	Low	<ul style="list-style-type: none"> <li>- No clear ecological research plan directly testing whether reserves enhance resilience.</li> </ul>	Ecological Factors: <a href="#">3.2</a> , <a href="#">3.3</a> , <a href="#">3.7</a>
3. Site fewer than ten marine reserves and design the system in ways that are compatible with the needs of ocean users and coastal communities. These marine reserves, individually or collectively, are to be large enough to allow scientific evaluation of ecological effects, but small enough to avoid significant adverse social and economic impacts on ocean users and coastal communities.	Moderate/ High	<ul style="list-style-type: none"> <li>- Evaluation of ecological effects is underway, but the expected detectability of ecological effects is currently unclear.</li> <li>- Human dimensions research is underway assessing the socio-economic impacts of the reserves.</li> </ul>	Marine Reserve Design: <a href="#">1.2</a> , <a href="#">1.3</a> Marine Baseline Assessment: <a href="#">2.1-2.5</a> Ecological Factors: <a href="#">3.4</a> Socioeconomic Characteristics: <a href="#">4.1</a> , <a href="#">4.2</a>
4. Use the marine reserves as reference areas for 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 nearshore resource management and adaptive management of marine reserves.	Moderate/ High	<ul style="list-style-type: none"> <li>- Baseline and ongoing ecological data have been collected inside and outside the reserves.</li> <li>- Current ecological research is unable to fully assess reserve effectiveness; long-term research and monitoring plans are required.</li> </ul>	Marine Baseline Assessment: <a href="#">2.1-2.5</a> Ecological Factors: <a href="#">3.8</a> , <a href="#">3.9</a> , <a href="#">3.9</a> , <a href="#">3.11</a> Level of Community Engagement: <a href="#">5.3</a> , <a href="#">5.4</a> Governance: <a href="#">6.2</a> , <a href="#">0</a>
5. Although marine reserves are intended to provide lasting protection, individual sites may, through adaptive management and public process, later be altered, moved, or removed from the system, based on monitoring and re-evaluation at least every five years.	High	<ul style="list-style-type: none"> <li>- Monitoring and evaluations are underway.</li> <li>- Ecological research and been included in the adaptation of site monitoring and management plans.</li> </ul>	Governance: <a href="#">6.6</a>

3.9. Have existing research efforts addressed the effects of natural (e.g., climate change) and human-induced (e.g., resource use, anthropogenic input) stressors? (O4)

### **Conclusion**

Existing research efforts have partially addressed the effects of natural and anthropogenic stressors through monitoring for changes in ecosystems and oceanographic conditions in both reserve and paired comparison sites. However, due to the inherent challenges faced by the monitoring program (Question [3.6](#)) the effect of some non-fishing stressors may be overlooked.

Research efforts have not yet addressed the effects of stressors to inform and support nearshore resource management and the adaptive management of Oregon's reserves. Notably, research to understand the mechanisms driving the effects of non-fishing stressors in Oregon's waters is lacking.

### **Recommendation**

We recommend that monitoring of ecological and oceanographic conditions continues, at a minimum and that ODFW explicitly evaluate the linkages between fishing pressure and reserve effects in future assessments. Where possible, we suggest increasing the resolution of sampling to ensure baseline and disturbance events (non-fishing stressors) are captured.

If undertaking management actions to mitigate the effects of stressors it is important to state agencies, we suggest seeking collaborations with research organizations to develop targeted research program exploring the mechanisms underpinning the responses of organisms and ecosystems to global change.

### **Definitions**

Oregon's coast experiences a range of **natural and human-induced stressors** that occur over varying spatial and temporal scales: heat waves, hypoxia events, rising ocean acidification, pathogen outbreaks (e.g., sea star wasting disease), increasing plastics pollution, marine noise pollution, resource use (fishing and harvesting), and ocean development.

Additionally, possible human induced stressors specific to Cascade Head, Cape Perpetua, and Cape Falcon were identified during site management plan workshops and public comment for site proposals ([Management Plans](#)). These included water quality issues, marine debris and pollution, high visitation, invasive and non-native species, failing shoreside infrastructure, and shoreline armoring.

Marine reserves interact with natural and anthropogenic stressors in two ways. First, they provide areas to test the effects of removing direct anthropogenic stressors, like fishing and ocean development. Second, they provide areas to test the impacts of other stressors in the absence of fishing and ocean development.

### **Addressing the effects of fishing and ocean development:**

ODFW is directly assessing the effects of (removing) fishing through monitoring ecological changes inside reserves and their paired comparison sites. The approach taken by ODFW varies across Oregon's reserves sites ([2017 Ecological Monitoring Plan, Table 2.3.2](#)): Cascade Head, Redfish Rocks, and Otter Rocks are all suited to a before-after-control-impact (BACI) approach to testing fishing effects, although Otter Rock is less suitable as it is a small reserve that had low fishing pressure prior to enforcement. Cape Perpetua has not suitable comparison site making it suitable only to before-after comparisons. Cape Falcon also had low fishing pressure prior to enforcement, and ODFW are using this site as one of many in the area in a spatial comparison across a fishing gradient.

To date, ODFW have not explicitly evaluated the linkages between fishing pressure and reserve effects. That is, nowhere in the [Ecological Research Appendix](#) compares the pre-reserve fishing pressures to observed reserve effects and evaluates how this varies along the Oregon coast (or across the Cape Falcon region).

ODFW is currently not directly assessing the effects of any ocean development in their Ecological Monitoring Program. No reserve site had ocean development prior to closure.

### **Addressing the effects of other stressors:**

We perceive two avenues for how the ecological monitoring program and associated research efforts could be 'addressing' the effects of natural and human-induced stressors (other than fishing and ocean development): 1) through **monitoring for the effects** of stressors to determine how Oregon's nearshore systems respond to stressors and to allow partitioning of effects (reserve vs. other) in reserve assessment, and 2) through **undertaking experimentation and research** to understand mechanistic responses to stressors to support mitigation approaches as part of adaptive reserve management.

With respect to **monitoring for the effects** of stressors, the Ecological Monitoring Program is monitoring ecosystems and ocean conditions inside and outside the marine reserves, and we believe that monitoring efforts are focusing on useful ecological (e.g., abundance, density and diversity of fish and invertebrate communities, and benthic cover) and oceanographic (i.e., temperature, salinity, dissolved oxygen, pH, and chlorophyll) variables.

However, the challenges faced by the monitoring program (pp. 98-105 [Synthesis Report](#), Question [3.6](#)) mean that these data may be limited in detecting stressors and their effects. For example, sampling efforts occur on a yearly basis at best, which may miss smaller-scale disturbances such as coastal hypoxia events. Oceanographic sampling, in particular, has not occurred consistently in all reserves nor are all oceanographic variables commonly monitored ([Oceanographic Methods](#)). Furthermore, sampling is not undertaken in kelp forests, which are a valuable and vulnerable nearshore habitat for Oregon, especially south of the biogeographic demarcation at Cape Blanco.

Nonetheless, important disturbance events have been detected by ODFW's monitoring program, namely the 2014 outbreak of sea star wasting disease ([Intertidal Sea Star](#)

[Monitoring Report, Intertidal Methods](#)) and nearshore hypoxia events at Cape Perpetua reports and Cape Falcon ([Ecological Research Appendix](#)). The monitoring program has also generated valuable research opportunities with collaborating institutions (Oregon State University and NOAA) to explore emerging marine stressor issues like microplastics in fish and marine noise pollution (pp. 100-101 [Synthesis Report](#)).

A mandated objective of Oregon's marine reserves is to provide "*reference areas for conducting ongoing research and monitoring of reserve condition, effectiveness, and the effects of natural and human-induced stressors*" ([2008 OPAC Marine Reserves Policy Recommendations](#)). As reference areas, reserves allow for the effects of fishing pressure and ocean development to be partitioned from other natural and anthropogenic stressors. ODFW have yet to use the monitoring data as such. This is understandable, however, given that with Oregon's temperate marine ecosystem (where many species are long-lived and slow to grow and reach sexual maturity) reserves effects are not expected for a minimum of 10-15 years (p. 16 [Synthesis Report](#)).

To address the effects of stressors, **experimentation and directed research** is also needed to understand the mechanisms driving responses to stress and to inform mitigation approaches as part of adaptive management. This relates to the mandated objective to "*use the research and monitoring information in support of nearshore resource management and adaptive management of marine reserves*" ([2008 OPAC Marine Reserves Policy Recommendations](#)). At this stage, ODFW have no explicit research investigating the drivers behind how nearshore systems respond to change and, therefore, limited knowledge to support mitigation actions. As demonstrated by the microplastics and noise pollution collaborations, however, ODFW are uniquely positioned to provide valuable support to research that adds new knowledge to this field for Oregon systems (pp. 100-101 [Synthesis Report](#)). See also Question [3.7](#).

3.10. Does a database of research exist? If so, can the data be accessed? (O4)

*\*Note that while this question occurs in the Ecological Factors section, we have addressed both ecological and human dimensions research here.*

**Conclusion:**

ODFW's [Synthesis Report](#) (2022) constitutes the primary database of ecological and human dimensions research done for the Marine Reserves Program. With the publication of the [Synthesis Report](#), all research and associated documents can now be accessed via a publicly shared [Google Drive folder](#). This excludes embargoed reports currently under scientific review or in preparation.

Over the course of the Marine Reserves Program, updates on ecological methods and findings were posted on the [Oregon Marine Reserves](#) website (launched 2016). Preliminary ecological results were shared via the [ODFW Data Dashboard](#) (launched 2020). Beyond published works, no public database of research from the Human Dimensions Program exists.

Raw data, however, has not been made publicly available. This limits the capacity for reproducible research (Michener 2015). Furthermore, several documents from the early planning stages (pre-2008) are no longer available publicly, since the original website for the reserve process (<http://oregonocean.org>) is no longer available.

See also Questions [5.2](#) & [5.6](#).

### **Recommendation**

We recommend that all data continue to be uploaded and made publicly available where possible.

3.11. Has the Oregon Marine Reserves program adapted their sampling based on lessons learned? (O4)

### **Conclusion**

ODFW and collaborators have extensively considered the limitations and challenges of their ecological sampling methods throughout the past decade and as part of the [2022 Synthesis Report](#). This has included Ecological Monitoring Workshops in [2010](#), [2012](#), and [2015](#) to obtain expert feedback on ODFW's current and future ecological monitoring activities.

Sampling protocols have been adapted over time (see also [Table 3.6.1](#), Question [3.6](#)) in response to lessons learned, and future changes are discussed for each method in the [sampling method documentation](#), under a 'Learning and Adapting' section. Furthermore, recommendations for future improvements are included in most sections of the [Ecological Monitoring Appendix](#).

### **Recommendation**

Using the lessons learned in the past 12 years, we recommend that ODFW limit future adaptations of methods to support consistent, long-term data collection.

## 4. Socioeconomic characteristics

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4.1. Were criteria established to measure significant adverse social and economic impact? (O3)

### **Conclusion**

Criteria to measure social and economic impacts (adverse or otherwise) of Oregon's marine reserves were not established in the [Human Dimensions Monitoring Plans](#). While socio-economic values and information needs were brainstormed during the reserve planning stages, they were never officially formalized as criteria or measurable indicators. Instead, overarching research questions were explored, with many variables and across multiple research groups. To synthesize this extensive research output, ODFW adopted a 'unit of analysis' approach (p. 113 [Synthesis Report](#)), aggregating findings at different levels from the individual to the state. We believe this exploratory approach was a productive endeavor, as it enabled the program to broadly explore the types of impacts that could happen and has created a notable database to support future work. However, without clearly defined criteria and indicators (including the populations for whom the indicator is important), the ability to answer this question will be difficult. Furthermore, by aggregating the findings, it is possible that important positive and adverse impacts were obscured or overlooked.

The lack of measurable criteria is compounded by considering whether impacts are 'significant' without a clear working definition. Significance cannot be established if it is poorly defined or if measurable criteria are not established. OPAC and STAC define significance as "*depend[ing] on context and intensity*" (STAC 2021 Request for Proposals – Oregon's Marine Reserves Assessment), but, in its current form, this definition is problematic for the purposes of reviewing the Marine Reserves Program: there is no legislative guidance on what context should be used to evaluate significance, nor what degree of intensity would be considered significant in that context. We also note that statistical significance, where used, is not always an indication of social, economic, or political significance (Rothman 2016), especially when comparing across multiple methodologies and data sets (as per the [Synthesis Report](#)). In light of this, and echoing STACs definition of significance (see below), we adopt a framework that captures a nuanced approach that considers the possibility of multiple, uneven impacts across groups and domains ([Figure 1](#), sensu Gill et al. 2019). We use this framework in our assessment in Question [4.2](#), below.

### **Recommendation**

We recommend that ODFW adopt a strategic planning framework to establish defined criteria for regular monitoring of social and economic impacts, adverse or otherwise. The work done over the past decade has created a valuable database that extends across multiple domains and social groups; we recommend that ODFW draw on this to help inform criteria selection and prioritize research moving forward. Focus, for example, could

be placed where heterogeneity in impacts have been identified for a given user group, or where aggregate findings are not consistent with the level that impact is expected to occur.

We also recommend that Oregon Legislature define a process, with clear context-specific criteria, for determining if socio-economic impacts are 'significant' for the purpose of policy modifications and adaptive management. This process should adopt a framework that recognizes heterogeneity in impacts (building on the National Environmental Policy Act's [definition of significance](#) that considered context and intensity) and work alongside the criteria framework recommended above. The federal Magnuson-Stevenson Fishery Conservation and Management Act provides a possible example of a framework with defined standards and clear steps for what parties should be involved in decision making and conflict management.

### **Definition**

In their 2021 request for proposals, STAC defines **significant** (regarding social and economic impacts) as *"The beneficial or adverse impacts of Marine Reserves and Marine Protected Areas on ocean users, coastal communities, and other communities of interest. The significance of these impacts depends on context and intensity"*, referring to the [National Environmental Policy Act \(NEPA\)](#) (see also [OR Territorial Sea Plan Appendix A](#)). Like statistical significance, this definition requires clearly defined criteria and as discussed below, we do not believe that these were established for socio-economic impacts. Critically, it is unclear from the controlling legislation in what scale and context the Marine Reserves Program should be minimizing the adverse impacts of reserves. Lacking this guidance, we have conducted our analysis without referring to 'significant' impacts (positive or negative). Until a working framework for 'significance' is developed, we recommend against using the term 'significance'. This also reflects ODFW's approach, which recognizes that *"Determination of 'significant' impacts in this context entails an element of judgement beyond a strictly scientific role related to presentation of the facts of the case"* (p. 3 [Human Dimensions Technical Appendix Executive Summary](#)).

### **ODFWs approach to assessing social and economic impact**

Socio-economic values and information needs were brainstormed during the reserve planning and implementation phases, yet they were never officially formalized as criteria or measurable indicators. This is especially true for the social, knowledge, and attitudes and beliefs research compared to the economic, where measurable criteria (e.g., catch, profit, permits) have traditionally been clearer to define in management and planning. While we have traditionally given priority to monetary and job-related impacts in our society, social impacts can be equally or more harmful as a result of marine conservation.

This lack of established criteria is despite plans to identify indicators and metrics to be monitored ([ODFW Marine Reserves Work Plan 2009](#)). For example, in 2010, Community Teams (p. 25 [Synthesis Report](#)) engaged by ODFW identified social and economic [information needs](#) to support the Community Teams' evaluation of the recommended sites. ODFW's [2012 Human Dimensions Monitoring Plan](#) also identified a Total Economic Value approach that can incorporate non-monetary social values.

Rather than key indicators within the Total Economic Value approach, the human dimensions research defined and focused on addressing six overarching research questions across four research categories, in collaboration with multiple external researchers (p. 10 [2017 Human Dimensions Monitoring Plan](#)). Each of these research questions has many indicators, resulting in a robust, complex suite of research. To synthesize this extensive human dimensions research output, ODFW adopted a 'unit of analysis' approach (p. 113 [Synthesis Report](#)). This approach aggregates findings at different social grouping levels, from the individual to the state.

While we recognize that the decisions to shift focus away from set criteria and indicators to overarching research questions may have been driven by limited resources (the Human Dimensions Project is one full-time position; p. 109 [Synthesis Report](#)) or by a desire to capture as much information as possible in the first ten years to later define the most relevant indicators, we identify a number of caveats, risks, and biases with this approach:

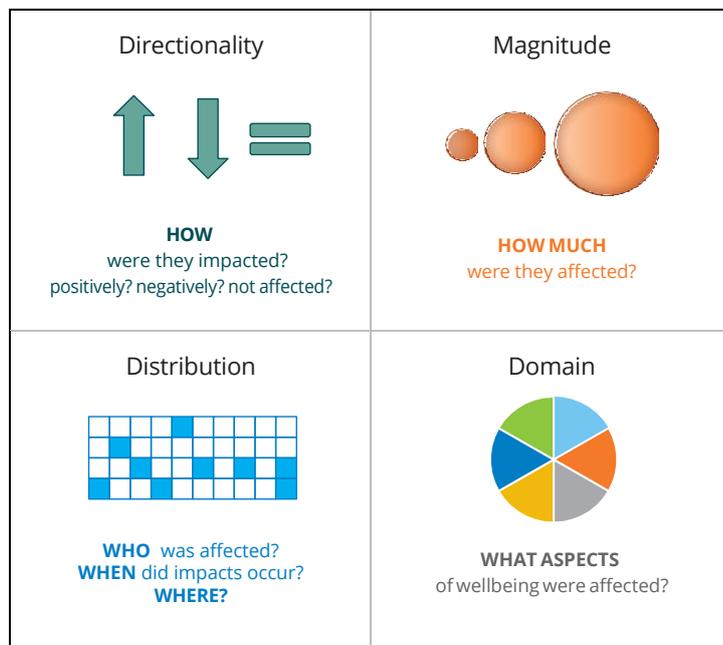
- 1) The lack of clearly defined metrics and indicators hampers consistent measuring and long-term monitoring. Multiple different measures were used across studies and sample populations, making it challenging to compare findings across social groups. For example, knowledge about the reserves was measured using multiple disparate methods: factual knowledge, perceived knowledge, awareness, and predictors thereof ([Table 4.2.1](#), [Question 4.2](#)). This is compounded by different studies asking different questions to different groups. As such, knowledge in one group, like recreational users, cannot be compared to knowledge in another, like coastal residents or fishermen. The breadth of measures and studies also makes it unclear which metrics and indicators will be used in long-term monitoring.
- 2) While extensive, the research done does not build a comprehensive picture; important social and economic aspects of reserves may have been overlooked. The lack of defined criteria may also have biased the research to focus on domains perceived to be important by researchers, rather than those important to the impacted social groups.
- 3) The aggregation of findings may obscure impacts that have occurred at fine scale (Reimer and Haynie 2018). See discussion in "The challenge of the aggregate", [Question 4.2](#).
- 4) The aggregation of findings may also overlook cumulative impacts that could be happening to specific individuals more than others, thereby resulting in disproportionate impacts. Cumulative impacts to an individual or social group may result from them experiencing multiple impacts from Oregon's marine reserves, or from reserve impacts combining with fisheries-based or other area-based management approaches. For example, fishermen who identified as affected by the reserves notes that the reserves "*are another layer of regulations that have historically caused fishers to adapt, abandon the profession, or be forced out by management*" (p. 122 [Human Dimensions Technical Appendix](#), [Robison 2022](#)).

We acknowledge that defining indicators is an extensive process, requiring ongoing engagement with relevant social groups (Biedenweg et al. 2016, Hicks et al. 2016, Jones et al. 2017). ODFW's current research is extensive, valuable and a very important step forward; we highlight these issues not as a critique but as an acknowledgement about how these data were presented in the [Synthesis Report](#). This is a call to legislature that while aggregation can provide a population level overview and aid synthesis of information, there are still people (fishermen) who self-identify as impacted and are not visible in the quantitative data.

**A heterogeneous framework**

In the absence of established criteria to assess any positive or adverse impacts of the marine reserves on Oregonians, we have chosen to examine the social impacts through a Synergies, Tradeoffs and Equity (STE) framework ([Figure 1](#); Gill et al. 2019). This framework recognizes that marine reserve impacts can vary in the direction, magnitude, and distribution, resulting in equitable or inequitable outcomes across wellbeing domains, social groups, space, time, and levels of organization. In exploring this heterogeneity, this framework explicitly recognizes that there will always be winners and losers, but who wins and who loses may vary substantially across space, time, and other scales. We use this framework in answering Question [4.2](#) below.

In assessing social and economic impacts, ODFW's [Synthesis Report](#) identifies directionality and presents results by unit of analysis (one component of Distribution). However, the monitoring lacked a definition of social domains outside of economic indicators.



***Figure 1** Framework for assessing heterogeneity in social impacts, focusing on four major dimensions of heterogeneity: directionality, magnitude, distribution, and domain. Reproduced from Gill et al. 2019.*

4.2. Is there evidence (qualitative and/or quantitative) for significant social and economic impacts on ocean users and coastal communities due to the establishment and management of marine reserves? (IPG6)\*

\* Note that Questions 1a and 1b from the Socioeconomics Assessment Criteria (Appendix 1) have been folded together into this question.

### **Conclusion**

Given the limitations outlined in Question [4.1](#), we cannot establish if *significant* social or economic impacts (adverse or positive) on ocean users and coastal communities occurred due to the establishment and management of the marine reserves. Rather, following the STE framework outlined in Question [4.1](#) (Gill et al. 2019), we conclude that there is evidence that impacts occurred for a range of relevant social groups (including fishermen, local business owners, coastal communities and state constituents), across multiple domain categories ([Table 4.2.1](#)). These impacts occurred heterogeneously across social groups and were both adverse and positive.

Due to the methods used (see Question [4.1](#)), it is challenging to ascertain the magnitude of the observed impacts and we make no comments on whether they were large or small. Importantly, the perceived direction, magnitude, and distribution of impacts may also differ substantially from objective measurements, creating disparities between researcher observations and what is experienced and reported by respondents (Gill et al. 2019).

For **social impacts**, ODFW and collaborating research teams measured several aspects that we have categorized into domains based on the wellbeing literature and our expert knowledge. These include: access, communication, conflict, demographics, identity, psychological health, safety, security, social cohesion, values, and vulnerability/resilience. We conclude that not enough data were disaggregated to determine heterogenous social impacts (across large/small commercial, nearshore/offshore, etc.). However, qualitative interviews with people who self-identified as being impacted from the reserves demonstrated evidence for some social impacts due to the reserves, including 1) psychological harm from uncertainty, 2) the depiction of fishermen as power hungry and non-stewarding, 3) loss of agency by fishermen, 4) loss of trust among fishermen and government officials, 5) conflict and loss of social relationships within fishing communities, and 6) perceived non-compliance with commitments to contract fishermen for research.

For **economic impacts**, ODFW and collaborating research teams measured several domains, including effort, employment, expenses, food security, income, industry, poverty, and shelter. Because robust design approaches (before/after, affected/non-affected) were used, we conclude that the monitoring team can be relatively confident that there were minimal positive or adverse economic impacts for most fishermen (but not all) due to the establishment and management of the reserves.

In addition to social and economic impacts, ODFW and collaborating research teams explored changes in **knowledge** (about the reserves), **attitudes, and beliefs**. These are not social or economic impacts. Rather, they are metrics of acceptability, understanding, and education. In general, attitudes and beliefs surrounding the reserves have become

more positive over time. Knowledge about the reserves is more relevant to the outreach component of the Marine Reserves Program (see Questions [5.2](#), [5.6](#), [5.7](#)).

Finally, we believe that the human dimensions team have largely identified the correct social groups to survey and collect information from. It is possible that unique data should be collected from tribal representatives, although alternative methods may be required, such as formal consultation rather than participation as research subjects (see also Question [5.1](#)).

### **Recommendations**

We recommend that ODFW continue the human dimensions monitoring and research.

- a. To better support future monitoring and research, we also recommend that ODFW develop a clear plan that:
  1. Streamlines and systemizes indicators of social and economic impacts. The baseline and research work done over the last decade, in conjunction with published social indicators and human wellbeing monitoring literature, provides valuable data to inform the development of indicators.
  2. Outlines which baseline data will be monitored on an on-going basis and outlines timelines for surveys and sampling.
  3. Continues a mix of qualitative and quantitative studies. The combination of quantitative and qualitative methods used in the Human Dimensions Project has allowed for rigor in interpreting causality of trends.
  4. Ensures that anticipated or concerning impacts are monitored in communities of place or interest where impacts are expected.
  5. Continues collaborations with external researchers, prioritizing studies that build on existing baseline data.

We also suggest that alternative assessment criteria to assess the Human Dimensions Project be considered. Examples include, ‘what positive and negative social and economic impacts are expected from reserves, and did these happen?’ in addition to ‘were there any unexpected positive or negative impacts?’

### **What is the evidence for social impacts?**

As social domain categories were not clearly defined and articulated, we believe that there is not enough information to know whether adverse or positive impacts *of a large magnitude* were experienced. That said, findings presented in the [Human Dimensions Technical Appendix Executive Summary](#) that demonstrated a social impact ([Table 4.2.1](#)) are outlined in this sub-section.

Population sampling and data collection tools followed best practices for the representative scientific fields. As such, we support the interpretation that the majority of the following adverse and positive social changes can be credibly attributed to the marine reserves. For changes in the social domain, causality is often clear as the reserve effects are

articulated by those who are meaningfully affected by them. For example, fishermen explicitly stated that they felt increased concern and uncertainty about the future due to the reserves ([Robison 2022](#)).

#### *Adverse Social Impacts*

- Reserves as an **increased source of conflict and loss of social relationships for fisheries** (domain category: conflict). A 2015-2017 OSU coastwide study of perceived fisheries impacts ([Marino 2020](#)) observed that *“the marine reserves are a contentious flash point, exacerbating tensions between fishers, managers, environmental advocates, and scientists.”* (p. XVII [Human Dimensions Technical Appendix](#)).
- **Increased perceived competition** for space (domain category: conflict) and **increased perceived risk of travel** due to effort shift (domain category: safety) in commercial fisheries. A 2017 Portland State University Effort Shift Survey ([Hudson et al. 2018](#)) found that *“Those [fishermen] who identified specific marine reserve impacts cited ... increased spatial competition (13%), and increased travel (12%).”* (p. XVI [Human Dimensions Technical Appendix](#)).
- **Increased concerns for misconceptions** about fishermen motives, including the depiction of fishermen as power hungry and non-stewarding (domain category: identity). Results from an OSU values-based investigation of affected individual fishermen ([Robison 2022](#)) *“highlighted their concerns that the reserves contribute to an inappropriate public misconception of a profession motivated by Power.”* (p. XX [Human Dimensions Technical Appendix](#)).
- **Increased concern or uncertainty for the future** by fisheries (domain category: security). An OSU qualitative research project on the perceptions of fishermen ([Robison 2022](#)) found that *“The marine reserves produce new economic and policy uncertainties for fishers, some with potential lagged effects related to catch and profitability.”* And that *“Many fishers interviewed cited apprehensions that the marine reserves introduce new economic uncertainties for fishers, a sense of uncertainty evident in the earlier studies.”* (pp. XVIII-XIX [Human Dimensions Technical Appendix](#)).

#### *Positive Social Impacts*

- An **increased the opportunity for dialogue by fishermen** (domain category: communication). A 2015-2017 OSU coastwide study of perceived fisheries impacts ([Marino 2020](#)) observed that, while the reserves have been contentious, *“they also have created the opportunity for a constructive dialogue among the various parties.”* (p. XVII [Human Dimensions Technical Appendix](#)).

#### **What is the evidence for economic impacts?**

As economic domain aspects were not clearly defined and articulated, we believe that there is not enough information to know whether adverse or positive impacts of a large magnitude were experienced. That said, findings presented in the [Human Dimensions](#)

[Technical Appendix Executive Summary](#) that demonstrated an economic impact ([Table 4.2.1](#)) are outlined in this section.

### *Adverse Economic Impacts*

As with the social aspects of these studies (see above), we believe that the following economic changes can be credibly attributed to the marine reserves.

- Increased perceived and recorded **fishery operating and travel costs** (domain category: expenses) by at least some fishermen. Fishing occupational community studies found that:

*“Those [fishermen] who identified specific marine reserve impacts cited ... increased spatial competition (13%), and increased travel (12%).”* (p. XVI [Human Dimensions Technical Appendix, Hudson et al. 2018](#)).

*“Some charter fishers in Port Orford (Redfish Rocks) and Depoe Bay (Cascade Head) were concerned that effort shift entailed substitute fishing grounds which required longer and more risky travel, with associated costs.”* (p. XVII [Human Dimensions Technical Appendix, Marino 2020](#)).

*“Fishers are spending more to remain competitive (e.g., more expensive fishing gear) and compliant (e.g., increased costs associated with traveling further), but they are catching less.”* (p. XVIII [Human Dimensions Technical Appendix, Robison 2022](#)).

- Increased **displacement of recreational and commercial fisheries** (domain category: income). Fishing occupational community studies found that:

*“Those [fishermen] who identified specific marine reserve impacts cited displacement (14%)...”* (p. XVI [Human Dimensions Technical Appendix, Hudson et al. 2018](#)).

*“Awareness of the marine reserves may have caused a small number of specialized private recreational fishers to quit fishing in the proximate areas.”* (p. XVIII [Human Dimensions Technical Appendix, Robison 2022](#)).

- **Economic benefits expected from the reserves have not yet been realized** (domain category: income & industry). In a coastwide survey of fishermen perspectives of reserves ([Robison 2022](#)), many individuals noted that *“The marine reserves have not yet provided previously suggested economic benefits, such as research contracts, increased ecotourism, or increased fisheries productivity.”* (p. XVIII [Human Dimensions Technical Appendix](#)).

The following studies used secondary long-term data to explore economic changes. We believe that the human dimensions team used the most robust approach available to them; that is, comparing time series and other data for places near and far from reserves, as well as over time (a before-after-control-impact study). Nonetheless, there have been shifting economic dependencies (from natural resource extraction to tourism and retirement) gradually occurring along the Oregon coast, making it challenging to untangle potential confounding factors. As such, we are not convinced that these adverse impacts are due solely to reserves:

- An immediate short-term **decrease in monthly commercial fishing employment** (domain category: employment) in Garibaldi/Tillamook. An internal ODFW time-series analysis of commercial fishing employment data showed *“that there was an immediate and proportional 8.5% decrease in employment post 2016 that was followed by a long-term 0.3% proportional increase in slope per month post reserve implementation”* for the Garibaldi/Tillamook treatment group (p. XV [Human Dimensions Technical Appendix](#)).
- **Decreased recreational fishing licenses** near Redfish Rocks (domain category: industry). A time series analyses of recreational fishing data (Fox et al. in review) found that *“The proportion of license sales near Redfish Rocks displayed an immediate 47.1% decrease following reserve implementation. However, the actual number of sales in this area is quite small.”* (p. XI [Human Dimensions Technical Appendix](#)).

Other adverse economic impacts were noted in the [Human Dimensions Technical Appendix Executive Summary](#), however these were clearly stated as unlikely to be due to reserve implementation. These were:

- A decrease in natural resource employment in communities near Cascade Head and Cape Perpetua post-2014 (domain category: employment), that was attributed to a sampling error (p. VII [Human Dimensions Technical Appendix](#), [Fox and Swearingen 2021](#)).
- An increase in the percentage of coastal community residents near Cape Falcon receiving Supplemental Nutrition Assistance Program (SNAP) benefits (a.k.a. ‘food-stamps’; domain category: income) post 2016, which was not corroborated by a parallel change in earned income, unemployment, or poverty (p. VII [Human Dimensions Technical Appendix](#), [Fox and Swearingen 2021](#)).
- A decrease in charter fishing CPUE (domain category: income) in Depoe Bay post implementation of Otter Rock (2012) following a decline CPUE trend that began in 2010. Otter Rock is unlikely to have contributed to the continued decline as the reserve is small (p. XII [Human Dimensions Technical Appendix](#), Internal ODFW analysis).
- An increase in the proportion of residents in the coast communities receiving social security income (domain category: income) (p. VII [Human Dimensions Technical Appendix](#)), which was not reflected in communities proximate to the reserves. Those communities saw a decrease in social security income (not reported in the [Human Dimensions Technical Appendix](#); [Fox and Swearingen 2021](#)).

### *Positive Economic Impacts*

The following studies used secondary long-term data to explore economic changes. As discussed above for these studies, we are not convinced that these positive impacts are due solely to reserves:

- A long-term **increase in monthly commercial fishing employment** in Garibaldi/Tillamook, following an immediate short-term decrease (domain category:

employment). An internal ODFW time-series analysis of commercial fishing employment data showed *“that there was an immediate and proportional 8.5% decrease in employment post 2016 that was followed by a long-term 0.3% proportional increase in slope per month post reserve implementation”* for the Garibaldi/Tillamook treatment group (p. XV [Human Dimensions Technical Appendix](#)).

- **Increased recreational fishing licenses** near Otter Rock and Cascade Head (domain category: industry). A time series analyses of recreational fishing data (Fox et al. in review) found that *“The proportion of license sales near Otter Rock and Cascade Head displayed a 0.5% proportional increase in monthly demand after implementation.”* (p. XI [Human Dimensions Technical Appendix](#)).
- **Increased commercial fishing permit entries and decreased exits**, coastwide (domain category: industry). A pre-post reserve analysis of fishing permits in port nearest to reserves ([TRG 2018a](#)) found that *“The average coastwide number of nearshore groundfish permit entries increased, and departures decreased, from the period before the marine reserves to the period after the reserves were implemented.”* (p. XI [Human Dimensions Technical Appendix](#)).

#### What is the evidence for no social and economic impacts?

There were also findings outlined in the [Human Dimensions Technical Appendix Executive Summary](#) that showed no change for several indicators of concern, suggesting that reserves have not had the potentially adverse impacts. Specifically, there was:

- **No change in the reliance** (social domain category: resilience/vulnerability) and **engagement** (economic domain category: industry) on fisheries in reserve-proximate coastal communities. Based on NOAA’s annual indices, ODFW *“used a difference-in-differences (DID) approach to investigate whether marine reserve implementation impacted fishing industry engagement and reliance in communities near the marine reserves and found no significant effects.”* (p. IX [Human Dimensions Technical Appendix](#)).
- **No change in the annual commercial fishing employment** in any port group (economic domain category: employment). An internal ODFW time-series analysis of commercial fishing employment data from 2005 to 2019 found *“no significant differences in annual employment before and after reserve implementation between treatment (proximate) and control (distant) ports.”* (p. XV [Human Dimensions Technical Appendix](#)).
- **No change in the monthly commercial fishing employment** for Newport or Port Orford (economic domain category: employment). An internal ODFW time-series analysis of commercial fishing employment data found *“no significant impacts of marine reserves on commercial fishing employment in Newport or Port Orford.”* (p. XIX [Human Dimensions Technical Appendix](#)).
- **No change in unemployment** (economic domain category: employment) or **poverty** (economic domain category: poverty) near Cape Falcon. Analysis of Census

data for coastal communities ([Fox and Swearingen 2021](#)) found that *“The percentage of the population receiving SNAP benefits in communities near Cape Falcon significantly increased post 2016. However, there was not a parallel change in earned income, unemployment, or poverty that would corroborate this observation.”* (p. VII [Human Dimensions Technical Appendix](#)).

- **No shift in recreational or commercial fishing effort**, in the majority of sites (economic domain category: income). A 2021 ODFW Statewide Survey of Recreational Fishermen (Fox et al. 2022a, Fox et al. in review) found that *“Of those aware of Oregon’s marine reserves (n = 4,372), 11.8% indicated they had changed their fishing behavior in any manner due to reserve establishment. The results indicate that most had continued to fish in the same local marine fishing grounds, or had identified alternate fishing grounds.”* (p. XIV [Human Dimensions Technical Appendix](#)). Likewise, a survey of nearshore commercial fishermen ([Hudson et al. 2018](#)) found that *“when asked directly about the impact of implementation of the marine reserve system in Oregon, a majority (63%) of the respondents said the reserves had not had any clear impact on their fishing operations in terms of profitability or fishing effort”* (p. XIX [Human Dimensions Technical Appendix](#)). See also our discussion of ‘The challenge of the aggregate’, below.
- **No change in charter fishing CPUE** in Newport, Depoe Bay, and Garibaldi/Tillamook (economic domain category: income) attributable to the reserves. An internal ODFW analysis found that *“CPUE significantly increased in Newport and Depoe Bay post 2014, the year Cascade Head was implemented, and in Garibaldi/Tillamook post 2016, the year Cape Falcon was implemented”* but did not attribute these changes to reserve establishment. Rather, the non-decline in CPUE suggest that these reserves did not have an impact on charter CPUE in these regions (p. XI [Human Dimensions Technical Appendix](#)).
- **No change in charter demand** (economic domain category: income). A survey of charter fishermen who self-identified as being affected by the reserves ([Robison 2022](#)) suggests that *“a lack of reserves awareness may be a reason why the much larger cohort of charter customers more generally has not been reduced”* (p. XVIII [Human Dimensions Technical Appendix](#)).
- **No change in earned income** in fisheries or coastal communities (economic domain category: income). The overarching results from two independent studies suggest that earned income changed little after the reserves were implemented: *“This research supported the pilot qualitative study conclusions that economic impacts were nominal because the reserves are not large and alternative fishing grounds are available.”* (p. XVIII [Human Dimensions Technical Appendix](#), [Marino 2020](#))  
*“... there was not a parallel change in earned income, unemployment, or poverty...”* (p. VII [Human Dimensions Technical Appendix](#), [Fox and Swearingen 2021](#)).

However, see also our discussion of ‘The challenge of the aggregate’, below.

- **No change in commercial fisheries landings** at the aggregate (state) level, and no evidence of negative change at the near-shore level (economic domain category: income). An internal longitudinal analysis of commercial landings data showed that *“aggregated statewide fisheries landings before and after marine reserve implementation ... indicated that economic impacts of the marine reserves on commercial fisheries could not be identified”* and time series model also *“indicated that landings were not adversely impacted by marine reserve implementation either immediately or in subsequent years.”* (pp. VI & XV [Human Dimensions Technical Appendix](#))
- **No change in commercial fisheries profitability** (economic domain category: income). A coastwide survey of fishermen perspectives of reserves ([Robison 2022](#)) reported that *“a majority (63%) of the respondents said the reserves had not had any clear impact on their fishing operations in terms of profitability or fishing effort”*, indeed *“When asked to identify drivers of fishing effort and profitability, no respondent mentioned the marine reserves as a primary determinant of effort or profitability.”* (pp. XVI & XIX [Human Dimensions Technical Appendix](#)).

### **Other human dimensions impacts**

In addition to social and economic indicators, several indicators focusing on attitudes and beliefs were reported in the [Human Dimensions Technical Appendix Executive Summary](#). In general, positive attitudes and beliefs regarding reserves and the Marine Reserves Program have increased over time ([Table 4.2.1](#)).

For example, opposition to reserves decreased, and support for reserves increased, among visitors to the area. This was especially true for those who had fished in the last 10 years, and for those who were older, more educated, and more aware of the reserves (pp. XII & XV [Human Dimensions Technical Appendix](#), [Swearingen and Epperly 2016](#), [Swearingen et al. 2017a](#), [Swearingen et al. 2019](#)).

Likewise, favorable attitudes towards reserves increased pre- to post-reserves in state constituents (coastal residents and I5 corridor residents). Beliefs that the reserves could be beneficial, and not harmful, for affected groups (businesses and fishermen), also increased over time in these respondents (p. XVIII [Human Dimensions Technical Appendix](#), [Needham et al. 2013](#), [2016a](#), [2016b](#), [2022](#)). Expectations that the reserves would have negative impacts on businesses also decreased in local business owners (p. XIII [Human Dimensions Technical Appendix](#), [Epperly et al. 2017a](#), [2017b](#), [French et al. 2022](#)).

Beyond the Human Dimensions program, there is also evidence for positive social interaction and social cohesion due to the reserves. Many local residents have become more engaged with their local coast, and the reserves have been a source of community organizing for folks involved with reserve community groups: there is a ‘friends of’ group for each reserve site (Chapter 5.4 [Synthesis Report](#)). These impacts do not appear to have been studied or measured explicitly, and they were not reported in the human dimensions research summary ([Human Dimensions Technical Appendix](#)).

## **The challenge of the aggregate**

While the Human Dimensions work, as reported in the [Human Dimensions Technical Appendix Executive Summary](#), is extensive and captures a wide range of positive and adverse impacts of the reserves, the greatest challenge in assessing the outcomes is understanding the heterogeneous impacts felt across multiple social groups at varying scales ([Figure 1](#), [Question 4.1](#)) and whether these impacts are meaningful. That is, of those impacted, how meaningful was the impact to them? And, in cases where there are differential impacts, whose impact is more important to the state?

In this sub-section we expand on example findings from the [Human Dimensions Technical Appendix](#), to demonstrate the complexity and nuance of determining overarching socioeconomic impacts of Oregon's marine reserves. This also highlights the need for a consistent framework that captures heterogeneity across all dimensions (Gill et al. 2019).

### 2017 Portland State University Effort Shift Survey ([Hudson et al. 2018](#))

In 2017, in collaboration with Portland State University, ODFW conducted a study of commercial nearshore fishing effort shift after the marine reserves had been established - a direct concern of local fishermen (pp. XVI & 116 [Human Dimensions Technical Appendix](#)). The study consisted of surveys sent out to all current permit holders in the fisheries most likely to be impacted by state nearshore marine policy.

Reported key findings of the study included:

- *"A majority of respondents [(63%)], in aggregate and across individual fisheries, said the reserves had not had any clear impact on their fishing operations."*
- *"A plurality of respondents (42%) indicated no individual reserve had affected their fishing operation."*

These findings also suggest that a notable portion indicated that the reserves did impact their fishing operations (other answers included "maybe" and "I don't know"). Indeed, 33% of the respondent thought that the reserves had impacted them negatively: *"Those who identified specific marine reserve impacts cited displacement (14%), increased spatial competition (13%), and increased travel (12%) in nearly equal proportions"* (p. 116 [Human Dimensions Technical Appendix](#)).

This survey considered fishermen in the charter, Dungeness crab, groundfish, and salmon fisheries. Disaggregating the results shows that the charter fishery was perceived to be the least impacted by reserves (21% of charter fishermen report an impact), and D. crab the most (48% of D. crab fishermen reported an impact) (p. 116 [Human Dimensions Technical Appendix](#)). Furthermore, *"those fishers in Lincoln County (Cascade Head - 30%, Cape Perpetua - 32%) and Curry County (Redfish Rocks - 69%) were ... more likely to attribute impacts to a specific marine reserve"* (p. XVI [Human Dimensions Technical Appendix](#)). As such, these data identify different levels of impact by both location and fishery, but not by the combination of the two; indeed, sample sizes may be too small for us to identify differences in impact for each fishery near each reserve.

This is a clear example of how reporting in the aggregate may overlook impacts experienced by individuals or social groups. Marine reserves are not expected to impact all fishermen, but we do anticipate it would impact some, such as those who primarily fished in a reserve area. While this Portland State University study was interpreted as little to no impact in the aggregate, a series of qualitative studies found the opposite, as demonstrated with the next example.

OSU Coastwide Study of Perceived Fisheries Impacts (2015 – 2017) (Marino 2020)

Following an earlier pilot study (Marino 2015) in conjunction with the related quantitative study (Hudson et al. 2018), ODFW collaborated with Oregon State University to qualitatively investigate commercial fishing effort shift with the reserves. The study surveyed volunteers recruited from the Hudson et al. 2018 study.

The reported key findings of the study included (p. XVII [Human Dimensions Technical Appendix](#)):

- *“This research supported the pilot qualitative study conclusions that economic impacts were nominal because the reserves are not large and alternative fishing grounds are available.”*
- *“Some charter fishers in Port Orford (Redfish Rocks) and Depoe Bay (Cascade Head) were concerned that effort shift entailed substitute fishing grounds which required longer and more risky travel, with associated costs.”*

However, the negative qualitative results found in this study may not be fully represented in the executive summary. For example, while many of the fishermen supported the pilot study (Marino 2015) findings that economic impacts were minimal, but not zero, *“there were a number of fishers who disputed that economic impacts were minimal on fishers, and some who disputed the original finding at Cape Falcon that there were minimal economic impacts”* (p. 5, [Marino 2020](#)).

Furthermore, the perceived economic implications of effort shift were great for some: *“one of the most significant impacts of marine reserves reported in the interview set is on the charter fishery out of Port Orford... Some interviewees told us that it was impossible to run a sustainable charter industry out of Port Orford because of marine reserves. One interviewee said, ‘from a business experience standpoint, without being able to fish there at Redfish Rocks, you couldn’t effectively profitably and sustainably run a charter boat business out of Port Orford.’”* (p. 6, [Marino 2020](#)).

This reiterates the challenges of assessing whether ‘significant’ adverse effects occurred. [Marino 2015](#) demonstrates that some individual fishermen perceived the social and economic effects of the reserves to be large for certain fisheries sectors (e.g., Charter) in certain areas (Port Orford and Depoe Bay), even if the collective conclusion was that impacts were minimal. Does minimal impact to many outweigh large impacts to few?

These examples highlight why monitoring domain, distribution, and direction of impact (and magnitude if possible) is critical.

### **Final comments on social and economic impacts**

Here, to the best of our abilities, we have outlined the positive and adverse impacts that have been reported in the Human Dimensions Project. A key take-home from this assessment is that the impacts of reserves occur heterogeneously across social groups and what is considered 'significant' to one group may not be to another. A statistically significant impact may not be socially meaningful and, vice-versa, a statistically non-significant impact at a larger scale may be incredibly meaningful to some individuals.

We would also like to highlight that the impacts (perceived, reported, or otherwise) that have occurred may fall within the scope of what was anticipated beforehand. Many individuals voiced concern during the [2008 Listening & Learning sessions](#), the [2010 community teams](#), and other events that the reserves would put individuals or the industry out of business. As such, a finding of no clear evidence of business collapse due to the reserves, even in aggregate, suggests this was prevented (a goal of the [2008 Executive Order](#)). Notably, those claims were most prevalent when 1) no specific sites were proposed yet, 2) a marine sanctuary was proposed for the entire coast, and 3) [20 public proposals](#) for the coast were submitted (representing much more territorial sea than the current system). That is, those concerns arose when the reserve process was young and perceived to affect a larger area. Ideally, findings should be considered in the context of what is expected, however, this add another layer of interpretation to the findings that is not always feasible.

It is also important to place the marine reserves within relevant social context. There is a known greying of the fleet and socio-cultural shift in coastal Oregon communities from fishing to retirement and tourism. There are many causal factors driving those shifts, including changing government policies (fisheries management) and shifting societal norms (Cramer et al. 2018). As such, while MPAs may not be the most direct stressor on people's lives, it is an additional stressor to those most likely to lose out (fishermen) and may exacerbate existing and growing tensions between government authorities and some fishermen. For example, *"Given the challenges of the fishing industry, and the loss of catch over the last decade, this conflation means that fishers often have negative reactions to marine reserves, despite most saying that they have minimal economic impact"* ([Marino 2020](#)).

Finally, while ODFW's Human Dimensions team seems to have largely identified the correct social groups to survey and collect information from, the absence of Native American perspectives/impacts in the [Synthesis Report](#) and [Human Dimensions Technical Appendix](#) is notable. We recognize that 'collecting' data from Tribal members is not ideal for this (and that privacy concerns are important to protect), but it is also crucial that government-to-government protocols are being followed and that Tribal Consent and Consultation be attempted. It's unclear that any of this occurred. This is not an oversight of ODFW; plans to engage Native Peoples were included in the [Human Dimensions Monitoring Plans](#), however funding and logistical constraints have not seen these realized. We advise that resources should be allocated to this.

**Table 4.2.1** Summary of changes observed in the economic, social, and opinions and knowledge domains, across key social groupings (distributions) over time. Direction of change for a given variable is categorized as decreasing (blue ↓), no change (green ~), increasing (purple ↑), or not reported (e.g., study considered a single point in time; grey •), based on findings reported in the Human Dimensions [Technical Appendix Executive Summary](#). Change does not necessarily indicate a positive or negative impact of reserve implementation. \*Indicates that change was not attributed to the reserves.

DOMAIN / Category / Variable	Visitors to area	Fisheries - Recreational	Fisheries - Charter	Fisheries - Commercial	Fisheries - Mixed	Local business owners	Coastal communities	State constituents	Mixed
<b>ECONOMIC</b>	~	~ ↑ • ↓	↑ •	↓ ~ ↑ •	~ ↑ •		↓ ~ ↑ •		•
<b>Employment</b>									
Commercial fishing employment, annual				~					
Commercial fishing employment, monthly				↓ ~ ↑					
Contribution from research and management spending								•	
Natural Resource Industry employment*							↓		•
Tourism employment							↑		•
Unemployment rate							~		
<b>Expenses</b>									
Boat damage, anticipated impact						•			
Operating expenses					↑	•			
Travel costs			↑	↑					
<b>Food security</b>									
SNAP benefits, % of population receiving*							↑		
<b>Income</b>									
Anticipated impact						•			
Charter demand					~				

DOMAIN / Category / Variable	Visitors to area	Fisheries - Recreational	Fisheries - Charter	Fisheries - Commercial	Fisheries - Mixed	Local business owners	Coastal communities	State constituents	Mixed
Concern about sustainability (impact of effort shift)						•			
Contribution from research and management spending								•	
CPUE on charter fishing trips*			↓ ↑						
Displacement		↑		↑					
Earned income					~		~		
Fisheries productivity, anticipated					~				
Fishing pressure, concern for future						•			
Fishing pressure, current estimate				•	•				
Household income									•
Landings				~	•				
Loss of income						•			
Profitability				~					
Profitability, drivers of					•				
Research contracts, anticipated					~				
Shift in fishing effort, anticipated			•			•			
Shift in fishing effort, drivers of					•				
Shift in fishing effort, reported		~		~					
Social security income*							↑		•
<b>Industry</b>									
Daily recreational fishing license sales, proportion of							↓ ↑		
Fishing industry engagement							~		
Fishing infrastructure								•	
Industry entry								•	
Nearshore groundfish permit departures				↓					
Nearshore groundfish permit entries					↑				
Nearshore groundfish permit turnover					~				

DOMAIN / <i>Category</i> / Variable	Visitors to area	Fisheries - Recreational	Fisheries - Charter	Fisheries - Commercial	Fisheries - Mixed	Local business owners	Coastal communities	State constituents	Mixed
Regional economic impact (REI)					•				
Tourism demand, anticipated					~				
Visiting ORMRs+ as motive for coast trip (tourism demand)	•								
<b>Poverty</b>									
Poverty rate							~		
<b>Shelter</b>									
Vacant second home rate									•
<b>SOCIAL</b>	•			↑ •	↑ •		~ •	•	•
<b>Access</b>									
Concern about loss of fishing grounds					•				
<b>Communication</b>									
Opportunity for dialogue					↑				
<b>Conflict</b>									
ORMR were contentious source of conflict					↑				
Spatial competition				↑					
Values misalignment					•				
<b>Demographics</b>									
Age									•
Visitor composition, seasonal	•								
<b>Identity</b>									
Anticipated impact					•				

DOMAIN / <i>Category</i> / Variable	Visitors to area	Fisheries - Recreational	Fisheries - Charter	Fisheries - Commercial	Fisheries - Mixed	Local business owners	Coastal communities	State constituents	Mixed
Community identity							•		
Fishermen expressed a strong conservation ethic						•			
Fishermen's identity						•			
Misconception about fishermen motives					↑				
<b>Psychological health</b>									
Anticipated impact						•			
Subjective well-being							•		
<b>Safety</b>									
Risk of travel (due to displacement)				↑					
<b>Security</b>									
Concern for future, Anticipated impact							•		
Concern/uncertainty for future					↑				
Familial successional planning						•			
<b>Social cohesion</b>									
Anticipated impact							•		
<b>Values</b>									
Ecosystem service values								•	
Professional motivations							•		
Security							•		
Tradition							•		
<b>Vulnerability/Resilience</b>									
Ability to adapt							•		
Commercial fishing reliance								•	

DOMAIN / <i>Category</i> / Variable	Visitors to area	Fisheries - Recreational	Fisheries - Charter	Fisheries - Commercial	Fisheries - Mixed	Local business owners	Coastal communities	State constituents	Mixed
Contributors to resilience								•	
Employment diversity								•	
Fishing industry reliance							~		
Nearshore fisheries dependence								•	
Perceived community resilience, spatial distribution								•	
Stressors								•	
<b>KNOWLEDGE</b>	↑ •	•	•	•	•	~ •	↓ •	~ ↑	
<b>Knowledge</b>									
Awareness of ORMRs	↑ •	•	•	•	•	~ •	•		
Awareness of ORMRs, predictors of									
Factual knowledge								~ ↑	
Factual knowledge, predictors of									
Perceived knowledge of ocean issues									
Perceived knowledge of ocean issues, predictors of									
Perceived knowledge of ORMRs							↓		
Perceived knowledge of ORMRs, predictors of									
Perceived level of being informed about ORMRs							↓		
Perceived understanding of ORMR purpose, role of science, role of agency								↑	
Recognition of ORMR locations		•							
Recognition of ORMR names		•							

DOMAIN / <i>Category</i> / Variable	Visitors to area	Fisheries - Recreational	Fisheries - Charter	Fisheries - Commercial	Fisheries - Mixed	Local business owners	Coastal communities	State constituents	Mixed
<b>ATTITUDES &amp; BELIEFS</b>	↓ ↑ •	•		~		• ↓ •	• ↓ ↑ •	•	
<b>Attitudes</b>									
Favorable attitudes toward ORMRs								↑	
Opposition to ORMRs	↓								
ORMR spatial preference (expand, status quo, reduce)						•	•		
ORMR spatial preference (expand, status quo, reduce), predictors of							•		
Support expansion of reserves								• •	
Support expansion of reserves, predictors of								•	
Support for ORMRs	↑	•							
Support for ORMRs, predictors of	•	•					•		
Support more scientific research						•			
<b>Beliefs</b>									
Concern about declining stocks							•		
Feel that groups could benefit from ORMRs								↑	
Feel that groups would be harmed by ORMRs							↓		
Government should do more to protect marine areas in OR								↑	
Impact on fishing behavior, reported				~					
Laws protecting marine areas are too strict							↓		
Marine areas should be protected with little/no utilization								↑	
Negative expectations of impacts on businesses						↓			

<b>DOMAIN / Category / Variable</b>	<b>Visitors to area</b>	<b>Fisheries - Recreational</b>	<b>Fisheries - Charter</b>	<b>Fisheries - Commercial</b>	<b>Fisheries - Mixed</b>	<b>Local business owners</b>	<b>Coastal communities</b>	<b>State constituents</b>	<b>Mixed</b>
Negative expectations of impacts on businesses and communities					•				
ORMRs will not be an effect fisheries management tool					•				
Perceived threat to Oregon marine areas	•								
Perceived threat to Oregon marine areas, predictors of	•								
Positive expectations of impacts on business demand, predictors of						•			
Skepticism around scientifically-driven legislative review process					•				
Support for management policies							•		
Support for sustainable fisheries regulations							•		
<b>Behavioral Intention</b>									
Support for ORMRs (Favorable hypothetical voting intentions)								↑	

\*ORMR = Oregon's marine reserves

## 5. Level of Community Engagement

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### 5.0. A General note on effective outreach and communication

A critical aspect of effective community outreach and engagement is identifying the appropriate mechanisms for the audience and objective. That is, to assess the level of community engagement undertaken during the planning, implementation, and ongoing monitoring and enforcement of Oregon's marine reserves, we ideally need to ask *how* effective the outreach and engagement was. This is somewhat overlooked in the questions posed by the STAC in this section. Instead, the questions here ask us to note whether or not communication and outreach happened. That said, there is only limited information in the [Synthesis Report](#) and associated documents to allow us to evaluate the quality of the outreach and communication done. We do, however, make note where data is available or where further investigations may be warranted.

#### **Recommendation**

If state agencies consider effective outreach and communication important, then further assessment of strategy, appropriateness of approaches, quality, and outcomes is required.

5.1. Has the public (including ocean users, coastal communities and other stakeholders) been involved in the proposal, selection, regulation, monitoring, compliance and enforcement of marine reserves (PPG1)?

#### **Conclusion**

Individuals who represent ocean users and coastal communities have, to varying degrees, been involved in the proposal, selection, regulation, monitoring, compliance, and enforcement of Oregon's marine reserves. It is not clear, however, the extent to which these individuals are able to represent the interests of stakeholders and Tribes, and to what extent they were knowledgeable of potential impacts and opportunities associated with the reserves.

Specifically, while Tribal members were studied as part of ODFW's research program and engagements were discussed with OPAC's tribal representative, it is not clear that Tribal consultation occurred or that Tribal representatives were included in proposal development, site selection or any of the following management steps.

See also Question [5.2](#), for a relevant discussion on the outreach and public engagement throughout the whole program.

#### **Recommendation**

We recommend that ODFW collaboratively engage in a stakeholder and rightsholder analysis (Reed et al. 2009) to identify those most likely to be impacted materially, culturally, or emotionally by the reserves. This analysis can be used to assess whether involvement in the reserve process is equitable and fair and identify those previously not involved.

Approaches to incorporate those previously uninvolved into future reserve processes should then be considered.

### **Public Involvement**

During the **proposal stage**, a call for [public nominations](#) for initial sites resulted in [20 proposed sites](#). Engagement with individuals and groups who submitted proposals - along with state [2008 Agency Analysis](#) - informed the 2008 recommendations of the two pilot sites (Otter Rocks and Redfish Rocks) and the three sites for further evaluation (Cape Perpetua, Cascade Head, and Cape Falcon (p. 24 [Synthesis Report](#)). The 2010 further evaluation of Cape Perpetua, Cascade Head and Cape Falcon included three [community teams](#) (with membership representation designated by OPAC), who consulted with ODFW to gather further data and local expert knowledge ([Community Teams Charter](#)). ODFW reports that Cape Perpetua and Cascade Head 2010 proposals had “*strong support from the community team*”, and that the Cape Falcon 2010 proposal had only moderate support from the community team (9 to 7 vote) which was revised based on feedback until reaching consensus. An external 2012 report found that there was disagreement around whether the community team stakeholder representation was appropriate (Bird and Conway 2012).

During the **selection process**, members of the public participated in [community teams](#) processes related to boundary adjustments for Cape Falcon, Cascade Head, and Cape Perpetua Marine Reserves. Otter Rock and Redfish Rocks reserves were nominated by community groups ([Redfish Rocks Community Team](#) and Depoe Bay Near Shore Action Team) that included fishermen support (pp. 66-67 [Synthesis Report](#)). The marine reserve legislation was developed in conjunction with conservation, and commercial and recreational fishing interests (p. 28 [Synthesis Report](#)). See also Question [1.3](#).

Public involvement during ongoing **monitoring** has primarily been through a volunteer SCUBA dive team as well as partnerships with local commercial and charter fishermen for hook and line and longline surveys. These partnerships have been critical to collecting ecological monitoring data (p. 55 [Synthesis Report](#)). The dive team has been in partnership with Oregon State University and Oregon Coast Aquarium. Public involvement in the human dimensions monitoring is limited to engagement with ODFW staff and researchers as study participants.

**Regulation, compliance, and enforcement** are undertaken by Oregon State Police in conjunction with ODFW and state agencies (p. 149 [Synthesis Report](#)). Members of the public are able to call a tip line to report suspected reserve violations, and locals and fishermen who have a strong relationship with ODFW often call in violations directly (p. 150 [Synthesis Report](#)). Otherwise, communities are not involved in the regulation, compliance, and enforcement of Oregon’s reserves.

Public user groups involved in the proposal, selection, regulation, monitoring, compliance, and enforcement of Oregon’s reserves included local commercial and recreational fishermen, conservation organizations (e.g., Oregon Surfrider), and local representative community groups (e.g., Depoe Bay Near Shore Action Team, Redfish Rocks Community Team).

The [Synthesis Report](#) does not include discussions on Tribal engagement with the Marine Reserves program due to several reasons, including protecting sensitive information. It was brought to our attention, however, that ODFW, through collaboration with researchers from Portland State University, have undertaken interviews with Tribal elders and other knowledgeable insiders. At the request of the Tribes involved, this research is not public (ODFW pers. comms.). ODFW also discussed engaging the coastal tribes with the Marine Reserves Process with the OPAC tribal representative (also a member of the Confederated Tribes of Grand Ronde). However, the OPAC tribal seat has been vacant since 2018 (ODFW pers. comms.). Consequently, it is not clear the full extent that Tribal consultation occurred or that Tribal representatives were included in proposal development, site selection or any of the following management steps. Tribal involvement should not be limited to studies, but rather a key aspect of the design, governance, and communication program. Tribal consultation is a formal process between U.S. government and Tribal government that can be pursued at the state level.

5.2. Was outreach and public engagement an ongoing part of the Marine Reserves planning process (PPG2)?

### **Conclusion**

Outreach and public engagement were an ongoing part of the Marine Reserves Program, including during planning ([Table 5.2.1](#)). Outreach and engagement have become more strategic since 2014, in response to growing concerns about misinformation and lack of awareness of the reserves.

We are unable to comment on the quality, comprehensiveness, and whether target audiences were reached. A Communication Needs Assessment ([Kearns & West 2019](#)) found that the latter years (post-2014) of outreach and communication have been compliant with Oregon's reserve mandates, and research relating to outreach and communication is ongoing.

### **Recommendation**

We recommend that funding for Communication Needs Assessments – ideally undertaken every few (4-6) years – be continued. The [Kearns & West 2019](#) assessment provided very valuable information about impacts and potential directions forward.

### **Key outreach and engagement activities**

Public engagement in the marine reserve planning process was slow to start, potentially due to the lack of clarity around who would be responsible for managing the reserves, contributing to initial concerns and distrust in the Marine Reserves Program and associated state agencies (p. 21 [Synthesis Report](#)). Following the [2008 Executive Order](#) and [Letter from the Governor](#), OPAC initiated active community engagement and outreach, seeking initial site proposals and further evaluations of sites from locals, fishermen, and community groups. State agencies worked to ensure that participants were engaged as possible in the process. For example, when there was not overwhelming community agreement regarding

the Cape Falcon Marine Reserve (in 2010), state agencies continued engagement to redesign the reserve until reaching consensus ([Cape Falcon Management Plan](#)).

It is unclear from the [Synthesis Report](#) and associated materials exactly how and through what channels state agencies initially engaged the public during the planning process. It appears that majority of the local public engagement (prior 2014) was facilitated by the community groups involved in the reserve process – an approach which can enhance engagement in some community segments. However, there is not enough information to comment on whether this was an effective communication and engagement process that reached all relevant stakeholders during the planning years.

Prior to 2014 outreach and communication was primarily focused on site planning, the development of site management plans, disseminating ecological monitoring opportunities, and compliance and enforcement (p. 133 [Synthesis Report](#)). There was little public engagement regarding the marine reserves in general, the Marine Reserves Program, the reserve sites, or the research being undertaken. To address increasing concerns about low awareness and misinformation within communities, ODFW liaised with communication consultants in 2014 to develop a strategic communication plan that runs through to 2023 (Chapter 5.4 [Synthesis Report](#)).

ODFW's outreach and communication efforts have been evaluated to a commendable extent, particularly relative to other public sector outreach evaluations with which we are familiar. An assessment of ODFW's communication and outreach needs was undertaken by [Kearns & West](#) in 2019. Notably, the needs assessment found that *"Program staff have moved forward with effective communications and outreach strategies based on knowledge of best practices and industry standards, literature reviews and interpretations of original legislative intent in policy development."* ([Kearns & West 2019](#)). Furthermore, [nine research studies](#) relating to outreach and communication of Oregon's reserves have been undertaken. Assessment of the findings of these studies is beyond the scope of this question.

See also Question [5.6](#) for discussion on outreach and engagement post-2014.

**Table 5.2.1** Summary of the outreach and engagement activities undertaken during the **Marine Reserves Program**, and notable relevant events. For details of outreach and communications post-2014 see Chapter 4 of the Synthesis Report.

		Program Activities	Notable events
Planning & Implementation		<p><b>2002-2007: Early Phases</b></p> <ul style="list-style-type: none"> <li>- No explicit outreach and engagement activities undertaken</li> </ul>	<p>2007 saw <b>mounting concerns</b> from the public about the reserve planning process (p. 21 <a href="#">Synthesis Report</a>)</p> <p>Nov 2008: <a href="#">OPAC Recommends</a> 2 pilot sites (Otter Rock and Redfish Rock), 3 sites for further review (Cape Perpetua, Cascade Head, and Cape Falcon), and further collaboration on a Cape Arago-Seven Devils site proposal</p>
		<p><b>2008: Initial Site Proposals</b></p> <ul style="list-style-type: none"> <li>- Listening and learning forums in 8 coastal communities to gather input for outreach and communication (OPAC &amp; Oregon Sea Grant)</li> <li>- <a href="#">Public proposals</a> for sites requested via a <a href="#">press release</a> and public meetings (OPAC)</li> <li>- Public meetings undertaken to provide updates on the process (Oregon Sea Grant and ODFW)</li> <li>- Workshops provided for anyone developing proposals to seek and share information and advice (Oregon Sea Grant and ODFW)</li> </ul>	
		<p><b>2009-2010: Further Evaluation</b></p> <ul style="list-style-type: none"> <li>- Community Teams members are <a href="#">called</a> and <a href="#">selected</a> for to further evaluate Cape Perpetua, Cascade Head, and Cape Falcon site boundaries (ODFW).</li> <li>- Community Teams meet 11 times, consult with ODFW to gather local expert knowledge, and finalize recommendations</li> <li>- ODFW post final recommendation on the public marine reserve planning website (no longer active)</li> </ul>	
Management, Monitoring & Research		<p><b>2010-2014: Legislative Actions &amp; Designations</b></p> <ul style="list-style-type: none"> <li>- Workshops with local fishermen and their communities to help inform the development of ecological monitoring (<a href="#">Redfish Rocks Community Team</a>, Depoe Bay Near Shore Action Team and ODFW)</li> <li>- Monitoring partnerships with fishermen began 2010 (See also Question <a href="#">5.5</a>)</li> <li>- Outreach and communication focused primarily on enforcement and compliance (see Question <a href="#">5.7</a> for details)</li> </ul>	<p>2012: <b>Pilot sites</b> (Otter Rock and Redfish Rock) in effect</p> <p>2014 saw a <b>distinctive increase in ODFW's strategic communications</b> to address increasing concerns about misinformation about the reserve sites, the Program, and research in the public (p. 133 <a href="#">Synthesis Report</a>)</p>

2014-2021: Strategic Communications Planning	<p><b>2015 - 2016: Branding &amp; Awareness Building (Phase 1)</b></p> <ul style="list-style-type: none"> <li>- <a href="#">eNewsletter</a> launched 2015 (sent to &gt;1,300 people per month)</li> <li>- <a href="#">YouTube</a> (34 videos) and <a href="#">Flickr</a> (1,722 photos &amp; videos) accounts launched 2015</li> <li>- Annual summary <a href="#">infographics</a> launched 2015</li> <li>- Official <a href="#">Marine Reserves Program website</a> launched April 2016</li> </ul>	2014-2016: <b>Remaining reserve sites</b> (Cape Perpetua, Cascade Head, and Cape Falcon) in effect
	<p><b>2017-2018: Cultivating Relationships (Phase 2)</b></p> <ul style="list-style-type: none"> <li>- Assessment of ODFW's communication and outreach needs undertaken (<a href="#">Kearns &amp; West 2019</a>)</li> <li>- Outreach and engagement targeted events and workshops began (total 76 events). These include 'Science on the Grill' and 'Slice of Science' events, open policy meetings, presentations by communities to scientific workshops, and hosting of volunteer angling and SCUBA programs.</li> </ul>	
	<p><b>2019-2021: Communication Needs Assessment (Phase 3) &amp; Human Dimensions Research Communications (Phase 4)</b></p> <ul style="list-style-type: none"> <li>- ODFW <a href="#">Data Dashboard</a> Launched Nov 2020 (1,100 page views as of Dec 2021)</li> <li>- <a href="#">Strategic Communications Overview</a> Developed</li> </ul>	
	<p><b>Other (dates unknown)</b></p> <ul style="list-style-type: none"> <li>- Infographics on <a href="#">reserve highlights</a>, <a href="#">human dimensions</a> and <a href="#">ecological monitoring</a> disseminated (annually updated)</li> <li>- <a href="#">Fish On!</a> newsletter for hook &amp; line survey volunteers emailed and posted on the website</li> <li>- <a href="#">Brochures and FAQs</a> on reserves released</li> <li>- <a href="#">Reports and publications</a> maintained on the website</li> </ul>	

### 5.3. Have researchers been accessing the Marine Reserves? (O4)

#### **Conclusion**

Researchers (ODFW staff, collaborators, and permit recipients) have been accessing the marine reserves and surroundings areas to undertake monitoring, research, and community projects.

#### **Recommendation**

None.

#### **Summary of research access**

For ecological research, take of organisms or disturbance of habitats inside reserves requires a permit from Oregon Parks and Recreation Department (OPRD) or ODFW, and is only permitted if deemed necessary ([2008 OPAC Marine Reserves Policy Recommendations](#)). A total of 45 ecological research permits were issued by ODFW (27) and OPRD (18) between 2016-2020 for monitoring projects, research projects and other surveys. Most of the permits have been for projects at Redfish Rocks, Cape Perpetua, and Otter Rocks and all have been issued to researchers from Oregon or Californian research institutions or federal agencies. Furthermore, the Department of State Lands has issued a small number of permits, primarily to ODFW, allowing long-term modifications (e.g., bolting permanent survey equipment to rock) within reserves (pp. 72-73 [Synthesis Report](#)).

Human dimensions research does not necessarily take place physically within the reserves, though often around them. For example, marine reserve visitor surveys were conducted through in-person intercept interviews of a random sample of visitors at sites adjacent to the marine reserves (Swearingen et al. [2016](#), [2017a](#), [2019](#), [Fox et al. 2022b](#)).

### 5.4. Have research efforts been coordinated among ODFW and external researchers? (O4)

*a. Has cooperative and collaborative research been conducted in the marine reserves? (IPG3)*

#### **Conclusion**

Extensive collaborative and cooperative ecological, social, and economic research – coordinated among ODFW and external researchers – has been conducted within and regarding the marine reserves. This has primarily been with academic partners and consultants, but has been aided by fishing industry partners, non-governmental organizations, and local marine community groups. ODFW staff have been particularly effective at communicating with and integrating findings from external research partners.

#### **Recommendation**

We recommend ODFW continue to collaborate with external researchers. In addition, we recommend ODFW find ways to cooperate with a greater diversity of fishing boats for ecological research, as well as consider community-based human dimensions research.

To better guide collaborative and cooperative research, we also recommend that ODFW develop a more strategic human dimensions research plan, while continuing to collaborate on non-agenda specific research with individual researcher groups.

### **Collaborative efforts and outcomes**

Both the Ecological Monitoring Project and the Human Dimensions Project have relied on research collaborations with external academic partners, private consultants, fishing industry partners, non-governmental organizations, and local marine community groups (for a list of partners see pp. 53-54 [Synthesis Report](#)). This is especially true for the Human Dimensions Project, which was limited to one full-time position with a modest budget and has relied heavily on extensive collaboration with researchers from universities and private consultants. Furthermore, over 20 ecological science and 67 socioeconomic students from various universities have obtained research experience or used the reserves in their research projects.

Collaborations between ODFW and external researchers has been led by 1) the partners, as projects supported financially and in staff by both ODFW and the partner; 2) the partners, as reserve-related projects supported predominately by the partner with some support from ODFW; and 3) ODFW, as projects contracted out to partners (p. 48 [Synthesis Report](#)). These collaborations have brought substantial additional funding, personnel, and expertise to ODFW and have resulted in several published and draft scientific journal articles (especially for academic partnerships). This has allowed ODFW to stretch a limited budget far. For more details on collaborations see Chapter 4 of the [Synthesis Report](#).

Cooperative research with local communities, fishermen, and volunteers has primarily created community science opportunities related to biophysical research, but none related to the social sciences. This is a missed opportunity by ODFW as community-based research - in which user communities help identify research needs, develop research methods, and interpret research results - can build trust, buy-in, and ensure that the questions and methods are appropriate. As such, it can be both a research and outreach tool, greatly helping the Marine Reserves Program address two of its overarching goals.

5.5. Have fishing vessels been used as research platforms? (IPG3)

### **Conclusion**

Local commercial, charter, and recreational fishing vessels have been used as research platforms since 2010. However, there is not enough information to assess whether contracts have been distributed with equity in mind.

### **Recommendation**

We recommend that ODFW seek opportunities to increase the diversity of fishing vessels and captains who can obtain research contracts.

### **Use of fishing vessels**

Fishing vessels have supported hook and line, longline, and Remotely Operated Vehicle surveys, as well as aided oceanographic mooring deployments and juvenile fish research. A total of 47 contracts have been undertaken - an average of 4.2 per year - with vessels operating out of Garibaldi, Depoe Bay, Newport, Coos Bay, Port Orford, and Gold Beach. Additionally, expert local fisherman knowledge has been incorporated into guiding strategies to engage vessels, the selection of research comparison areas, and the placement of sampling locations (pp. 67 & 139 [Synthesis Report](#)). See also Question [5.8](#).

Despite the success of these partnerships, there are equity issues with the current program, as identified by ODFW, interviewees ([Robison 2022](#)), and our review of documents. Namely, expensive insurance requirements and accessibility issues with the online tender process have deterred interested vessel owners or overlooked potential partners who are unaware of the contracts, especially smaller vessels (p. 56 [Synthesis Report](#)). Furthermore, there is no information provided on exactly how many vessels have been used and whether equity-based considerations were used to determine who gets contracts. For example, were fishermen displaced by the reserves hired? Whether displaced or non-displaced fishermen are contracted influences whether the use of fishing vessels can 1) partially offset negative impacts of displacement and 2) begin to build relationships with individuals and groups initially resistant to or hesitant about the reserves. Indeed, individual fishermen have expressed concerns about not receiving research contracts, which they perceived as a promised economic benefit of reserve implementation ([Robison 2022](#)).

5.6. Has scientific and other information been made available to the public through outreach and websites (PPG2)?

### **Conclusion**

Information about the reserves and the Marine Reserves Program has been shared through the [program website](#) and through [outreach documents and events](#) ([Table 5.2.1](#), Question [5.2](#)). This does not mean information is accessible to the most important user groups. There is not enough information for us to comment fully on whether targeted audiences were reached or the effectiveness of the documents in communicating key messages. The Marine Reserves Programs' communication and outreach critically lacks a fulltime communications staff member.

### **Recommendation**

We recommend that ODFW prioritize filling the currently empty communications position to enhance in-person outreach. Ideally, this person needs to use both digital and in-person communication efforts with a variety of audiences, as those most likely to be impacted by reserves are less likely to use digital communication.

Conducting an evaluation (potentially collaboratively) of whether these scientific and outreach materials are reaching the diverse audiences would also be beneficial.

### **Accessibility of information**

ODFWs communication approach includes the development of communication plans, collateral materials, traditional media outreach, social media outreach, and community engagement ([Table 5.2.1](#), Question [5.2](#)). These have been primarily shared via the [program website](#), via emails to listservs and handouts by outreach partners. This is a notable increase in outreach effort compared to the early stages of the Marine Reserves Program. However, there is limited information to assess whether these materials are reaching the correct audience or having a positive affect towards ODFW's communication goals. Additionally, Oregon's marine reserves are not allowed to have their own social media presence apart from ODFW, which may hamper outreach.

ODFW developed five outreach objectives during their 2014 strategic communications planning. Three of these objectives include the concept of 'trust' building within ODFW's constituents (p. 113 [Synthesis Report](#)), which requires relationship building and willingness to be vulnerable on both parties (including ODFW; [Adkisson 2019](#)). It's not clear that these objectives can be met with the current dissemination-forward (as opposed to engagement) approaches undertaken by ODFW.

Current challenges we see facing the outreach and engagement program (including and beyond those highlighted by ODFW) include:

- The reserves program **has 1 full-time equivalent (FTE) set aside for communication and engagement**, but this position was only filled during one biennium (2013-2015) due to budget cuts (p. 58 [Synthesis Report](#)). While ODFW received some support from Non-ODFW and ODFW temps, fellows and interns, the overall lack of a communications officer has impacted 1) other staff who must carry out ongoing tasks, and 2) transparency, outreach, and engagement.

This is a critical need considering that adverse impacts qualitatively appear to have arisen largely due to misunderstandings and lack of communication. Moreover, it is imperative that in the search to fill this position, the appropriate professional qualities are taken into consideration. This person does not need to be a biologist; it is much more important, in fact, that this person has educational and professional experience in outreach and communication, and ideally communication approaches that incorporate relational organizing, conflict management, and facilitation. Because the social groups most likely to be adversely impacted are less likely to use social media, websites, and other technological approaches to communication, this person needs to employ significant boots on the ground approaches. The success Oregon Sea Grant extension personnel have had in engaging with coastal fishing communities points to the potential success of those approaches.

- **Few metrics or indices are being used by ODFW to evaluate their outreach and engagement** (p. 133 [Synthesis Report](#)). For example, the total number of newsletter subscribers, unique email open rate and eNewsletter click rate have all increased since 2015, however there are no targets set for these metrics, nor, more critically, is there any indication whether those accessing the newsletter are the target audience.

A Communications Needs Assessment ([Kearns & West 2019](#)) found traditional media outreach to be the weakest aspect of the communication plan, and that direct community and stakeholder engagement (via in person events) the strongest across the goals set out in Phase 1 (branding and awareness building) and Phase 2 (cultivating relationships). However, there were no specific metrics outlined to support these claims. [Nine research studies](#) relating to outreach and communication of Oregon's reserves have also been undertaken as part of the human dimensions research. These studies currently provide the most robust testing of ODFW's communication strategy. For example, based on the knowledge surveys there is generally 'low' factual knowledge (<50%) about the reserves across the state, including coastal communities (p. 36, 2022 Outreach Analysis Summary), although without a defined target it is not clear whether this level of knowledge is considered too low or not.

- The main outreach methods used (digital media, collateral materials, social media, reports, and peer reviewed journal publications) are **not likely to be read by those most affected** by the reserves (e.g., resource users, reserve skeptics). Public presentations and outreach events have occurred, but it is unclear 1) the extent to which these effectively recruited participants who most need engagement, and 2) the extent to which the opportunities allowed for two-way relationship building.
- Non-Government Organizations (NGOs) and marine reserve community groups have been instrumental in amplifying and extending ODFW's local engagement ([Marine Reserve Community Groups](#)). While this increases what can be accomplished and builds engagement of some community segments, there are **possible limitations to relying on community groups and NGOs**. Primarily, generally pro-marine reserve community groups and certain NGOs may miss engaging with or, in worst case, alienate stakeholders like fishermen (resource users), who feel their livelihoods are being threatened or their voices unheard. Furthermore, the local nature of community groups means that their geographical reach is limited. Indeed, most of the outreach events occurred in only three coastal communities (Newport, Port Orford, and Yachats) or in the Willamette valley (Portland, Eugene, Corvallis).

5.7. Have the allowable uses of marine reserves been effectively communicated to the public and ocean users? (IPG5)

### **Conclusion**

Outreach analyses suggest that information on the allowable uses of the marine reserves is reaching and being retained in about half the population of residents living along the I-5 corridor and in coastal Oregon communities or fewer. General factual knowledge about reserve uses has increased over time, but knowledge about whether ocean development or keeping fish is allowed in the reserves has decreased. Furthermore, there was majority belief that the communication needs are sufficient, but compliance has decreased over time.

As there is no definition of or goals for what is deemed effective, we cannot comment on whether the results from these outreach analyses demonstrate effective communication.

### **Recommendation**

If ensuring that allowable uses of the reserves is effectively reaching diverse audiences, including the public and ocean users, we recommend that ODFW set clear, measurable goals and continue to undertake outreach analysis to determine if effective communication is occurring.

### **How allowable uses were communicated**

Compliance and regulations were the focus of ODFW's initial (pre-2014) outreach and engagement/education efforts (p. 133 [Synthesis Report](#)). The rules and boundaries of the marine reserves were communicated via tabling events, community meetings, one-pagers on the [reserves website](#), brochures, infographics, signs placed at access points, and within the Commercial Fishing Regulation and Oregon Sport Fishing guides (yearly printed books). [Thumbdrives](#) were also provided for easy upload of site coordinates to vessel computers (pp. 150-153 [Synthesis Report](#)).

### **Outreach analysis**

According to a general public survey, factual knowledge about the reserves was found low (42% - 62%) by the general public, and has changed little between 2012-13 and 2021 (p. VIII [Human Dimensions Technical Appendix](#)). Specifically, no more than 60% of people (communities of place, rest of coast, coast total, and I-5 corridor) correctly identified allowed uses (commercial fishing, keeping caught fish, who can access, wind energy and fish farms, and non-extractive recreation). The increase in knowledge was highest for non-extractive recreation (up to 43% correct knowledge in 2021) and who is allowed in the reserves (up to 64%). Knowledge about whether ocean development or keeping fish is allowed in reserves decreased slightly (2022 Outreach Analysis Summary), likely due to competing information sources on these topics. Similarly, surveys of impacted fisherman found several misunderstandings about the goals of reserves, though not necessarily allowable uses ([Robison 2022](#)).

However, 25 of the 28 respondents to the Communication Needs Assessment ([Kearns & West 2019](#)) agreed or strongly agreed with the statement *"Marine Reserves Program staff successfully inform the public on the goals, objectives and purpose of the marine reserves program."* Two people disagreed, and nine of the respondents were fisherman, but their specific responses are not listed. Furthermore, visitor intercept surveys conducted by the American Cetacean Society found that *"awareness that Oregon has a marine reserve system increased over the years, beginning at 30% in 2016 and ending at 50% in 2021"* (p. 91 [Human Dimensions Technical Appendix](#)).

Finally, compliance – measured as the number of violations per OPS enforcement hours, weighted by the number of reserves in effect – has decreased since 2014 (p. 154 [Synthesis Report](#)), especially for recreational vessels. Although this may be reflective of changes in

other social and economic variables, such as the number of vessels in the water or willingness to violate.

Critically, ODFW have not defined what is deemed effective or set outreach goals, which met would signify effectiveness. As such, we cannot comment on whether the aforementioned results demonstrate effective communication.

5.8. How have educational opportunities (formal and informal) and public engagement associated with marine reserves been encouraged? (IPG4)

### **Conclusion**

Educational and public engagement opportunities have been provided by ODFW, both for higher education students and the general public.

### **Recommendation**

We recommend that ODFW continue with educational opportunities and public engagement initiatives, including liaising with state departments, local community groups and Non-Government Organizations to support broader outreach and educational opportunities.

### **Educational and public engagement opportunities**

Formal and informal education opportunities created by the Program include:

- ODFW has hosted 5 post-graduate fellows (1-2yrs each) and 19 undergraduate student interns (as ODFW staff or non-ODFW staff), and awarded \$45,000 in scholarships to 15 graduate students (p. 49 [Synthesis Report](#)). These placements have researched or contributed to research within or relevant to the marine reserves and provide educational experiences in marine science, social science, and science communications.
- The Marine Reserves Program liaises with Oregon Parks and Recreation Department, who *“provide interpretative and educational opportunities to enhance recreational experiences”* (p. 8 [Synthesis Report](#)), and Oregon State Police who *“provides information and education in support of voluntary compliance”*. No detailed information on these actions is provided.
- Local community groups and Non-Government Organizations (NGOs) coordinate outreach and educational projects and events, which ODFW support (funding or in-kind support) and/or attend, where possible. For example, interpretive signs have been developed and implemented at reserve sites, led by community groups, NGOs, and watershed councils (for other examples see p. 142 [Synthesis Report](#)).

5.9. How have economic opportunities associated with marine reserves been encouraged? (IPG4)

### **Conclusion**

Economic opportunities associated with the marine reserves have been limited to research contracts with fishing vessels. It appears, however, that these contracts are limited to specific individuals and have not been broadly available and/or obtained by vessels across the impacted sites.

### **Recommendation**

We recommend that ODFW consider multiple pathways to enable (and thus encourage) different types of fishermen and coastal residents to engage in research-based economic activities.

We also recommend that ODFW consider collaborations with tourism-focused organizations to emphasize economic opportunities. Possible examples include Oregon Coast Visitors Association as well as individual coastal visitors' associations and tourism-related groups.

### **Economic opportunities**

The primary economic opportunity directly associated with the reserves is the contracting of fishing vessels by ODFW to aid the ecological monitoring program. New contract opportunities are released to the public via email/phone/text alerts, through the eNewsletter, and via dock walks. Details of the process (usually through the state's open competitive bidding process) are available in the [Reserve Management Plans](#).

Since 2010, ODFW has had 47 contracts with local fishing vessels, totaling over \$750,000 (p. 139 [Synthesis Report](#)). However, issues with the tender process have raised accessibility concerns that undermine this economic opportunity. See Question [5.5](#) for more discussion.

5.10. Are the educational and economic development opportunities compatible with the goal of conserving marine habitats and biodiversity? (IPG4)\*

*\*This question was originally Question 2 from the Socioeconomic Characteristics Section ([Appendix 1](#)).*

### **Conclusion**

The educational and economic development opportunities are compatible with the goal of conserving marine habitats and biodiversity. Educational opportunities include research within the ecosystem and the surrounding human systems as well as community-based information sharing (see Question [5.8](#)). The only described economic opportunities (not described as 'development') include being a research vessel or receiving small grants for research (see Question [5.9](#)), both of which are also related to habitat and biodiversity conservation.

### **Recommendation**

None.

## 6. Governance

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### *Planning/Site Evaluation*

6.1. Are the regulations guiding marine reserve use consistent with allowing marine transit, safe harbor, and beach access? (IPG5)

#### **Conclusion**

The regulations guiding marine reserve use ([Oregon Administrative Rules](#)) do not include any provisions that prevent transit, safe harbor, or beach access. That is, anyone is allowed to transit through a marine reserve, including transit with (fishing) take, and the reserves also do not hinder access to beaches or safe harbors.

#### **Recommendation**

None.

### *Program Evaluation*

6.2. Have short- and long-term nearshore resource management decisions considered research and monitoring data from the Marine Reserves? (O4)

#### **Conclusion**

While still in the early days post-implementation, research and monitoring data from the Marine Reserves Program have already been included in management decisions. Furthermore, the Ecological and Human Dimensions programs have collected valuable information, created new knowledge, and developed new methods that are highly relevant to future management decisions.

#### **Recommendation**

We recommend that ODFW continue to engage with relevant management bodies to disseminate both ecological and human dimensions research and monitoring data. The adaptive management plan we recommend developing (see Question [3.8](#)) should include guidance on how monitoring data will inform policy decisions about the reserves themselves.

#### **Management use of data and research**

The ecological and human dimensions research and monitoring data collection from the marine reserves is highly relevant to nearshore resource management. In addition to the management of the marine reserves, data and research collected from the ecological monitoring program are potentially useful for fishery stock assessments and fisheries management, biodiversity and species conservation, local management of natural and anthropogenic impacts, and spatial management decisions such as nearshore developments.

Indeed, data and information from the Ecological Monitoring Program have contributed to management actions, including some beyond the state of Oregon (p. 159-160 [Synthesis Report](#)):

- **Nearshore groundfish stock assessments** by the Pacific Fishery Management Council, including Cabezon, Blue/Deacon Rockfish, and Kelp Greenling.
- The [IUCN red listing of the Sunflower Sea Star](#) (*Pycnopodia helianthoides*) as critically endangered after the 2013-2014 outbreak of sea star wasting disease.
- The state-mandated [Ocean Acidification and Hypoxia \(OAH\) Action Plan](#) for Oregon, which aims to understand OAH impacts and develop mitigation actions in nearshore systems.

Data and information from the Human Dimensions Program have yet to be explicitly included in nearshore management decisions outside of the Marine Reserves Program. This, however, may only be a matter of time as data and information from this program is highly relevant. For example, new knowledge from the Human Dimensions Program is relevant to 1) spatial fishery management decisions (the fisheries spatial economic model; [TRG 2021b](#)), 2) port management authorities and municipalities (the coastal community indices; [TRG 2018a](#)), 3) state agencies and local governments (the coastal community profiles; [Epperly et al. 2018](#)), and 4) marine issue actions plans (e.g., Oregon's Ocean Acidification Action Plan) (p. 126, [Synthesis Report](#)).

6.3. Does each Marine Reserve have a monitoring and evaluation plan or plan component that addresses the Marine Reserves objectives? (O4)

### **Conclusion**

Each marine reserve site does not have its own monitoring and evaluation plan, rather monitoring plans for the two major research streams (human dimensions and ecology) exist. Only the ecological monitoring plans further break down monitoring by reserve site.

Neither the [Human Dimensions](#) nor [Ecological](#) Monitoring Plans explicitly state how the plan components address the defined objectives of Oregon's marine reserves ([2008 OPAC Marine Reserves Policy Recommendations](#)). Both plans include components that address part of the objectives, but no objective in its entirety ([Table 6.3.1](#)).

### **Recommendation**

We recommend that clear, explicit links between monitoring actions and the reserve objectives be included in the monitoring plans to support assessments of whether reserve objectives are being addressed.

### **Ecological Monitoring Plans**

Ecological Monitoring Plans were released in [2012](#), [2015](#), and [2017](#). The initial 2012 plan - developed prior to any reserve implementation - was developed by ODFW program staff,

with assistance and collaboration from external scientists and marine reserve community team members.

All plans include a high-level summary of the monitoring tools (e.g., hook and line sampling or SCUBA surveys) and sampling design (i.e., where and when sampling occurs, and site vs. comparison areas), but do not include any plans for data analysis or evaluation. Initially, all sampling methods were expected to be used in all reserve-comparison sites, however, site-specific challenges limited the monitoring tools that could be used at any given site. Consequently, the 2015 and 2017 monitoring plans have sections outlining the monitoring at each reserve site.

The initial 2012 plan is the only plan with specific research questions, although no explicit link is made between these questions and the defined marine reserve objectives ([2008 OPAC Marine Reserves Policy Recommendations](#)). Links between findings from the ecological monitoring and the reserve mandates are made in Chapter 5.2 of the [Synthesis Report](#) (pp. 79-80).

Based on the information provided, not all the reserve objectives are fully addressed in the ecological monitoring plans ([Table 6.3.1](#), see also Question [3.8](#)). All issues we raise here are addressed in more detail elsewhere in the report:

- *Objective 1:* Multiple methods for monitoring biodiversity and habitat are occurring at all reserve and comparison sites and are planned through to 2023. Seafloor mapping occurred between 2009 and 2011, and extensions of this were planned in the [2012 Ecological Monitoring Plan](#) (p. 12). However, no mention of seafloor mapping is made in the later plans ([2015](#) and [2017](#)). Biodiversity, habitat, and seafloor mapping are critical to assessing whether areas of high natural biodiversity, abundance, and special natural features are included in the reserves. Furthermore, there are no plans outlined in the monitoring reports to assess biodiversity or habitat outside of the reserve or comparison areas, which is critical to evaluating how reserve areas compare to the rest of the Oregon coast (see also Questions [3.1](#) & [3.2](#)).
- *Objective 2:* Biodiversity, species abundance/density, and habitat monitoring via a range of methods is occurring across all sites and is planned up to and including 2023. The habitat characteristics of each reserve have been documented and changes in habitat overtime will be captured as planned. This is critical to understanding how the reserves are protecting marine habitats. However, while the impacts of certain disturbances have been captured through the ecological monitoring program (e.g., effects of the Sea Star Wasting Disease; pp. 86-87 [Synthesis Report](#)), there are no explicit research plans outlined in the monitoring reports to test whether reserves enhance the resilience of nearshore ecosystems to impacts (see also Questions [3.7](#) & [3.9](#)).
- *Objective 3:* Ecological research is occurring and is planned to continue to occur until 2023 in all the reserve sites and their comparison areas. However, no plans are

outlined in the monitoring reports to test whether the reserves are large enough to allow evaluation of the ecological effects of reserves (see Question [3.4](#)).

- *Objective 4*: Ecological monitoring is planned and occurring within the reserves and comparison areas, but there are no explicit research plans outlined in the reports addressing natural and human-induced stressors (see Questions [3.7](#) & [3.9](#)). Likewise, there are no plans outlined regarding how the research and monitoring information will be used in management.

### **Human Dimensions Monitoring Plans**

Human dimensions monitoring plans were released in [2012](#) and [2017](#). The initial 2012 plan - developed prior to any reserve implementation - was developed by ODFW program staff, with assistance and collaboration from external scientists and marine reserve community team members.

Both plans are overarching, program-wide plans, and do not consider monitoring by reserve site. The plans outline the monitoring activities that are being undertaken, but no specific timeline of monitoring is provided. No plans for analysis and evaluation of the monitoring data are provided in the plans.

The plans 1) outline six overarching human dimensions questions, 2) consider different methodological approaches to collect data on four different research categories, and 3) identify different unit of analysis (e.g., individuals to state constituents). These are directly relevant to assessing whether the Marine Reserves Program is avoiding adverse socio-economic impacts (*Objective 3*). However, because of the lack of defined indicators for 'social' impacts and a definition for 'significance', the full extent to which this monitoring plan can address this objective is left to subjective interpretation (see Questions [4.1](#) & [4.2](#)).

Human dimensions research related to the reserves is ongoing. Neither human dimensions plan outlines how the research and monitoring information will be used in management, although the findings are relevant (*Objective 4*).

**Table 6.3.1** Marine Reserve objectives, as outlined in the [2008 OPAC Marine Reserves Policy Recommendations](#), that are relevant to (filled squares) and our assessment on whether they are included in the human dimensions and ecological monitoring plans (ticks). Three full ticks indicates that the monitoring plan fully address all relevant aspects of the objective; two ticks indicates that the plan addresses multiple parts of the objective but not all, or all parts but not fully; one tick indicates that the plan only addresses a portion of the relevant aspects of the objective.

<b>Marine Reserve Objective</b>	<b>Ecological</b>	<b>Human dimensions</b>
1. Protect areas within 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.	✓✓✓	NA
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.	✓✓✓	NA
3. Site fewer than ten marine reserves and design the system in ways that are compatible with the needs of ocean users and coastal communities. These marine reserves, individually or collectively, are to be large enough to allow scientific evaluation of ecological effects, but small enough to avoid significant adverse social and economic impacts on ocean users and coastal communities.	✓✓✓	✓✓✓
4. Use the marine reserves as reference areas for 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 nearshore resource management and adaptive management of marine reserves.	✓✓✓	✓✓✓
5. Although marine reserves are intended to provide lasting protection, individual sites may, through adaptive management and public process, later be altered, moved, or removed from the system, based on monitoring and reevaluation at least every five years.	NA	NA

- 6.4. Do the Marine Reserves as a system and each Marine Reserve have a management plan with the following?
- a. *SMART (specific, measurable, achievable, relevant, time-oriented) objectives*
  - b. *standardized ecological and socio-economic monitoring protocols*
  - c. *compliance/enforcement plan*
  - d. *demonstrated long-term funding plan in alignment with objectives (IPG1)*

### **Conclusion**

Each marine reserve site has a Management Plan that includes site-specific aspects and, where relevant, aspects that are inherited from the Marine Reserves Program as a whole. The objectives outlined in the Management Plans and Monitoring Plans are the objectives for the marine reserves, which follow some, but not all aspects of the SMART objectives' framework. No explicit objectives are outlined for management or monitoring.

Ecological and socioeconomic monitoring protocols are outlined in the management plans, and supplemented with monitoring plans. Compliance and enforcement plans are included in each management plan, but funding for these does not extend beyond the current Marine Reserves Program (reviewed in 2023).

### **Recommendation**

In our [overarching recommendations](#) and in Questions [3.7](#) and [4.2](#), we recommend ODFW develop clear, hypothesis-driven research and monitoring plans for the Ecological and Human Dimensions Research Programs which – among other recommendations - include standardized monitoring protocols/methods. Using the SMART framework to develop clear objectives for each of the monitoring plans will support in developing these standardized methods. Additionally, we recommend that the plans be framed with an adaptive management approach (Walters 1986, White et al. 2011). That is, they should set SMART objectives and collect monitoring data, but also explicitly address how and when monitoring data will be compared to the objectives to determine if adjustments to management are called for. The question of when adaptive management decisions should be made depends on both ecological considerations and on the administrative and logistical costs of conducting such evaluations and decision-making processes.

### **Management plans**

The marine reserves as a system does not have an overarching management plan, rather each reserve site has a specific [Management Plan](#).

### **SMART objectives**

All Management and Monitoring Plans include the objectives of the marine reserves, but not specific objectives for each site nor explicit objectives for management or monitoring ([Table 6.3.1](#), Question [0](#)). The Human Dimensions Monitoring Plan, however, includes targeted research questions, but none of these are SMART (they are not specific and not time-orientated, making them difficult to measure or achieve).

The reserve objectives were developed to inform the siting, development, and implementation of Oregon's marine reserves and guide the monitoring, research, outreach

and compliance strategies undertaken by ODFW ([2008 OPAC Marine Reserves Policy Recommendations](#)). However, these objectives are more 'broad-brush' and less SMART (specific, measurable, achievable, relevant, and time-oriented) objectives; they tend to outline the purposes of the program, indicating why management is to be undertaken, rather than provide a performance measure that can be used to guide decision making and measure success (Williams et al. 2009).

For example, only a portion of Objective 3 has a specific target that is clearly measurable, achievable, and relevant: "*Site fewer than ten marine reserves...*". While definitions have been provided for certain terms in the objectives ([2008 OPAC Marine Reserves Policy Recommendations](#)), key definitions are absent or non-specific. For example, what is considered "*...significant adverse social and economic impacts...*" (Objective 3) is open to subjective interpretation, and "*...enhance resilience of nearshore ecosystems...*" (Objective 2) is poorly defined, making these objectives challenging to measure and achieve (see Questions [3.7](#), [3.9](#), [4.1](#) & [4.2](#)).

None of the objectives are time-orientated, although the Oregon Legislature calls for a check-in and report on the Marine Reserves Program by March 1, 2023 ([ORS](#) 196.540 through 196.555).

### **Monitoring protocols**

Ecological monitoring was originally designed at the system-wide level, however due to the unique nature of each site, monitoring has been tailored for each reserve site and its comparison areas. The [Management Plans](#) for each site outlines the monitoring protocols undertaken there, and these are supplemented by the [Ecological Monitoring Plans](#) (Question [0](#)).

Ecological monitoring protocols have evolved over time as ODFW researchers have learned and adapted to the unique conditions at each site. Consequently, the protocols are not fully standardized at this stage, however, we believe that ODFW is now in the position to standardize ecological monitoring protocols moving forward (see Question [3.6](#)).

Socioeconomic (human dimensions) monitoring protocols are program-wide, rather than specific to each reserve site. The [Management Plans](#) for each site outlines the overall human dimensions research undertaken (general descriptions of monitoring questions and approach), and this is supplemented by the [Human Dimensions Monitoring Plans](#) (Question [0](#)).

Socioeconomic monitoring protocols are less defined in the management and monitoring plans than those for the ecological monitoring. Rather, the socioeconomic research is a mix of discrete studies either standalone or repeated over time (e.g., longitudinal studies), and studies based on continuous data streams (e.g., secondary demographic and economic data like fisheries or census data). These are framed towards answering six overarching questions that address four research categories across four different levels of analysis. Human dimensions monitoring tools (focus groups, interviews, surveys, observation, modelling, and secondary data) are outlined in the management plans. That said, baseline

and subsequent studies were planned and undertaken with long-term monitoring in mind. See also Question [2.7](#).

### **Compliance/Enforcement plans**

[Management Plans](#) for each site include a section outlining a system-wide compliance and enforcement plan, as well as a small section summarizing site-specific community issues that include local compliance and enforcement challenges and opportunities. See also Question [7.1](#).

### **Long-term funding**

There is no long-term funding plan outlined in the [Management Plans](#).

6.5. Have all Marine Reserves been using ecological and socio-economic monitoring protocols (and generating associated data) that support adaptive management? (IPG3)

### **Conclusion**

The ecological and socio-economic monitoring program could support adaptive management. They have provided baseline and ongoing data that is invaluable to adaptive decision making and have done so under tight time and budget constraints.

### **Recommendation**

In developing future Ecological and Human Dimensions Monitoring Plans (see [Overarching Recommendations](#) and Questions [3.7](#) & [4.2](#)), we recommend that ODFW plan monitoring and research objectives, methods, and protocols with Adaptive Management in mind.

### **Definition**

OPAC define **adaptive management** as *“a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs and scientific information (Williams et al. 2009).”* ([2008 OPAC Marine Reserves Policy Recommendations](#)). We work within this definition.

### **Monitoring for adaptive management**

A monitoring plan needs to meaningfully contribute to adaptive management decision making. William et al. (2009), writing for the U.S. Department of the Interior, outlined key aspects of a useful monitoring plan as one that:

- 1) Is designed to **estimate system state** and other attributes needed for decision making and evaluation.
- 2) **Promotes learning** through a comparison of estimates against model-based predictions.
- 3) Is **efficient**, in that it produces estimates that have maximum precision for a given cost, or minimum cost for a given level of precision.

Over the past 12 years the Ecological and Human Dimensions Monitoring Programs have been collecting data across a range of relevant variables and indicators (see Question [2.3](#), [2.7](#) & [4.2](#)). These data provide the valuable *baseline and ongoing information* needed to support management decision making. Indeed, ODFW's [Synthesis Report](#) and this assessment report, provide substantive information on the state of the marine reserve system and the socio-economic impacts of the Marine Reserves Program that will support the 2023 reevaluation of Oregon's reserve system.

Except for economic modelling done prior to the reserve implementation ([TRG 2021b](#)), *no model-based predictions* were made for comparisons. However, the best scientific-based knowledge at the time was considered in the planning, implementation, and on-going monitoring of the reserves (e.g., [size and spacing](#) and [economics](#) workshops).

Finally, we believe that the monitoring undertaken was substantive, given the time and budget constraints. However, there is not enough information to assess whether the monitoring has produced the most precise data for the cost. Developing structured, standardized socioeconomic indicators for the Human Dimensions monitoring, for example, would help in this respect.

6.6. Does each Marine Reserve have an adaptive management plan with clear objectives, defined decision-making points, and stakeholder engagement processes? (O5)

- a. *Do the adaptive management plans include time points to assess and consider new scientific information and monitoring data?* (O5)
- b. *Do the adaptive management plans have clearly defined timelines and criteria for evaluation?* (O5)

### **Conclusion**

Neither Oregon's marine reserve system as a whole, or each marine reserve individually, have detailed adaptive management plans. However, data from the Marine Reserves Program is critical to inform the development of a formal adaptive management plan, including set monitoring protocols with specific indicators and stated assumptions.

As of 2023, Oregon's marine reserves are at their first legislatively mandated check-in and evaluation point. The biggest limitation to adaptive management is taking the time to learn from experiences and modify strategies as a result. We are only now at a stage at which it is appropriate to engage in this critical aspect of the adaptive management process for the Marine Reserves Program.

### **Recommendation**

We recommend that future adaptive management plans for Oregon's reserves be developed. These should include defined monitoring and research goals, timelines for check-ins and reevaluations, and clearly defined criteria for evaluations.

### **Adaptive management for Oregon's marine reserves**

Neither the marine reserve system as a whole, or each marine reserve individually, have detailed adaptive management plans. The Oregon Legislation calls for a check-in and report on the reserves program by March 1, 2023, at which point the program will be evaluated ([ORS 196.540 through 196.555](#)). This is the first point at which the state may consider altering management policies and practices based on the outcomes of the evaluation. Alternative management options include changing the boundaries of the reserves and changing the limitations on take/harvest ([2008 OPAC Marine Reserves Policy Recommendations](#)). ODFW states that consensus with community teams and stakeholders will be sought prior to any alterations of site boundaries or prohibitions/allowances within the sites (p. 75 [Synthesis Report](#)) though we note that the community teams that existed in 2010 no longer exist and/or would require updated membership.

When the first two pilot sites (Redfish Rocks and Otter Rock) were established, evaluation was planned to occur every five years. This was realized as unrealistic (too frequent) and the new stated timeframe is every 10 years, the first being 2023 (p. 75 [Synthesis Report](#)). In addition to this, the monitoring plans were to be evaluated and updated every 5 years, which has been done (e.g., p. 65 [Synthesis Report](#)). Beyond these, there are no other designated time points or timelines to assess and consider new scientific information and monitoring data.

Critically, Adaptive Management requires taking the time to iteratively learn from experiences and modify strategies as a result (Williams et al. 2009). ODFW's [Synthesis Report](#) and this assessment report provide the feedback to achieve this. However, developing adaptive management plans for Oregon's reserves - that include continued and iterative monitoring, evaluations, and adjustments - is critical to the future success of the Marine Reserves Program.

## 7. Enforcement

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- 7.1. Does each Marine Reserve have an enforcement plan? (IPG2)
- a. *Does enforcement implementation include clearly defined enforcement procedures, including use monitoring? (IPG2)*
  - b. *Is enforcement data evaluated on a regular basis, and is the enforcement plan modified as warranted? (IPG2)*

### **Conclusion**

Oregon's marine reserves system has an overarching enforcement plan, which applies to each site (see Chapter 5.5 [Synthesis Report](#) and Chapter 7 [Management Plans](#)). However, there are no site-specific enforcement plans. Enforcement procedures and use monitoring are defined and enforcement data is evaluated on a regular basis.

### **Recommendation**

None.

### **Enforcement details**

Enforcement efforts are primarily carried out by Oregon State Police's Fish and Wildlife Division (OSP), with the assistance of the U.S. Coast Guard (USGC). The Oregon Department of Fish and Wildlife (ODFW) provides and oversees compliance assistance through outreach and education, along with OSP and the Oregon Parks and Recreation Department (OPRD) (p. 149 [Synthesis Report](#)).

Monitoring and patrol methods (i.e., by land, by air, on the water, and through reporting by the general public) are clearly defined in the [Synthesis Report](#) (p. 150) and [Monitoring plans](#) (Chapter 7). However, there is no clear outline of procedures regarding the frequency of patrols or enforcement/use monitoring. However, patrols appear to be made in at least one marine reserve on a semi-regular monthly basis ([Marine Reserve Enforcement Summaries](#)). The public is also encouraged to call and report fish or wildlife violations to an OSP tip line.

All agency partners (ODFW, OSP, OPRD, and USCG) are committed to meeting twice per year to review compliance and enforcement. Modifications to the enforcement plan *appear* to be made as warranted. Enforcement efforts are reviewed and modified adaptively in response to data collected by OSP on its enforcement efforts, information from staff in the field, and questions or concerns by constituents (p. 150 [Synthesis Report](#)). Adjustment strategies have included targeted education and outreach, shifting or adding resources, and piloting new patrol programs. The ODFW, however, present no documented evidence of these changes.

## About the Report Authors

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Lead Investigator Dr. Will White, a marine fisheries ecologist, has worked on the design and assessment of marine reserves for >15 years, including serving on the Science Advisory Team for the California's implementation of a statewide marine protected area network and later contributing to the California MPA Monitoring Action Plan and serving on a working group that studied the contribution of MPAs to climate resilience. He has published more than 90 peer-reviewed scientific papers, at least 20 of which relate to the design and assessment of marine reserves. He has advised marine reserve design and marine spatial planning in multiple U.S. states and Canada, and provided expert testimony on oyster fishery population dynamics and management in a federal lawsuit before the U.S. Supreme Court (*Florida v. Georgia* [2014] 135 Supreme Court 47). He is also a lead investigator in the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO), a multicampus consortium studying the dynamics and resilience of Pacific coast ecosystems.

Lead Investigator Dr. Kelly Biedenweg, an environmental social scientist and program evaluator, is the lead evaluator for the Puget Sound Partnership's Human Wellbeing monitoring program and an elected member to the Partnership Science Panel in Washington State. She also works in Chile identifying and training practitioners on the creation of human wellbeing indicators for marine protected areas monitoring. She was part of the California San Joaquin-San Francisco Bay Delta Social Science Task Force over 18 months, tasked with assessing and delivering recommendations on how to better incorporate social science in ecosystem restoration. Biedenweg has published over 40 peer-reviewed manuscripts and several reports evaluating the processes and impacts of environmental policies on human communities.

Research Associate Dr. Jess Hopf completed a PhD in Marine Biology and Fisheries studying the population dynamics of a key fishery species in response to rezoning in the Great Barrier Reef and published four manuscripts on that topic. She is currently studying how environmental variability affects the adaptive management of marine reserves, and how restoration actions interact with marine reserves in kelp forest ecosystems as a research associate in White's Fisheries Oceanography and Population Dynamics lab.

Research Associate Brian Erickson is a Ph.D. candidate in fisheries social science in Biedenweg's Human Dimensions lab. His dissertation is examining how psycho-social variables (e.g., emotions, perceived impacts, and trust-distrust) relate to support for or opposition to Oregon's marine reserves. He also has a Master's in Marine Resource Management and has expertise in curriculum development and classroom instruction.

Associate Investigator Dr. Jennifer Caselle, a subtidal marine ecologist, has studied kelp forest and rocky reef ecosystems in California for > 20 years as part of PISCO. Her data and analyses have contributed substantially to California's evaluations of their MPA program, and the field survey methods (including divers and remote video) she helped develop have

influenced most other field survey programs on the US west coast, including those by ODFW.

Associate Investigator Dr. Stefan Gelcich is an interdisciplinary marine scientist who, as a Pew Fellow, evaluated the social and ecological conditions that influenced the success of Chile's marine protected areas. He is the author of about a dozen peer-reviewed manuscripts related to the assessment of social impacts of marine protected areas and has collaborated globally on these assessments. He currently leads a ten-year initiative linking eight academic institutions in Chile to study social coasts.

Associate Investigator Dr. Sarah Lester is a marine ecologist who has been studying the science of marine reserves for more than 15 years, and has published several of the seminal papers in the field, including a global meta-analysis of reserve effects on biological populations. She also has expertise in communicating the science of marine reserves to non-scientist audiences, and works with several nongovernmental agencies to improve the science-based design of marine reserves and marine spatial planning in general, at sites across the globe.

Associate Investigator Dr. Kerry Nickols is a nearshore oceanographer and ecologist who has more than 15 years of experience studying the oceanography of inner-shelf and kelp forest habitats on the US west coast. She has also developed fish population dynamics models to guide adaptive management of marine reserves, and was a member of the working group that developed a framework for the upcoming evaluation of California's marine protected area network.

Associate Investigator Dr. James Sanchirico, a fisheries economist, has broad experience in studying the economics of spatial fishery management, sustainable seafood, ecosystem-based management, and the economic and behavioral responses of fishing fleets to marine reserves. He has received multiple awards for his public service contributions to sustainable fisheries management.

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# Appendix 1: Mandates & Assessment Criteria

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## Mandates

Relevant objectives, and principles and guidelines from [OPAC's Oregon Marine Reserve Policy Recommendations \(2008\)](#) .

### ***Marine Reserve Objectives***

**Objective 1 (O1).** Protect areas within 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.

**Objective 2 (O2).** Protect key types of marine habitat in multiple locations along the coast to enhance resilience of nearshore ecosystems to natural and human-caused effects.

**Objective 3 (O3).** Site fewer than ten marine reserves and design the system in ways that are compatible with the needs of ocean users and coastal communities. These marine reserves, individually or collectively, are to be large enough to allow scientific evaluation of ecological effects, but small enough to avoid significant adverse social and economic impacts on ocean users and coastal communities.

**Objective 4 (O4).** Use the marine reserves as reference areas for 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 nearshore resource management and adaptive management of marine reserves.

**Objective 5 (O5).** Although marine reserves are intended to provide lasting protection, individual sites may, through adaptive management and public process, later be altered, moved, or removed from the system, based on monitoring and re-evaluation at least every five years. NOTE: This objective was written before SB 1510 was passed (making 2023 the first time regulatory changes can be addressed)

### ***Marine Reserve Planning and Implementation Principles and Guidelines***

**Planning P&G 1 (PPG1).** The public, including ocean users, coastal communities and other stakeholders, will be involved in the proposal, selection, regulation, monitoring, compliance and enforcement of marine reserves.

**Planning P&G 2 (PPG2).** Outreach and public engagement will be an ongoing part of the marine reserves planning and implementation process. Available scientific and other information will be made available to the public through outreach and websites.

Marine Reserve Implementation Principles and Guidelines

**Implementation P&G 1 (IPG1).** Marine reserves as a system and each individual marine reserve will have a plan that includes clearly defined objectives, monitoring protocols,

compliance and enforcement provisions, effective management measures, and a commitment of long-term funding necessary to achieve its goals.

**Implementation P&G 2 (IPG2).** Marine reserves will be adequately enforced.

**Implementation P&G 3 (IPG3).** Marine reserves will be adequately monitored and evaluated in support of adaptive management. Cooperative and collaborative research will be encouraged as well as utilization of fishing vessels as research platforms. These activities will be compatible with the goal of conserving marine habitats and biodiversity.

**Implementation P&G 4 (IPG4).** Education and economic development opportunities that are compatible with the goal of conserving marine habitats and biodiversity will be encouraged.

**Implementation P&G 5 (IPG5).** Marine reserves are not intended to prevent marine transit, safe harbor, and beach access.

**Implementation P&G 6 (IPG6).** Significant adverse social and economic impacts of marine reserves on ocean users and coastal communities will be avoided and positive social and economic effects will be sought.

**Implementation P&G 7 (IPG7).** Adequate baseline data will be collected at each site prior to excluding extractive activities. The types and adequacy of baseline data, and the timing and methods of data collection will be driven by the research and monitoring objectives and sampling designs employed at each site.

## Assessment Criteria

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### Marine reserve design

1. Were areas of high natural biodiversity identified as part of the planning process? (O1)
2. Do the Marine Reserves protect areas of special natural features? (O1)
  - a. Were special natural features identified as part of the planning process? (O1)
  - b. What special natural features were identified? (O1)
3. Did the design of the Marine Reserves system incorporate community interest? (O3)
4. Were less than 10 sites established as part of the Oregon Marine Reserves? (O3)

### Marine reserve baseline assessment

1. Were baseline data obtained at each site prior to closure (IPG7)?
2. What baseline data were obtained at each site? Were methods designed and carried out so that change could be detected (IPG7)?
3. Did the nature of the baseline data differ among sites, and were these differences reflected in the subsequent monitoring decisions (IPG7)?
4. Was the timing of sampling driven by the objectives and sampling designs planned for each site, given information available at the start of the Marine Reserves process (IPG7)?

5. Were the methods of data collection appropriate for each site, given information available at the start of the Marine Reserves process, and driven by the planned objectives and sampling designs (IPG7)?

### **Ecological factors**

#### *Planning/Site Evaluation*

1. Are the reserves in areas with a strong likelihood of high species, habitat, community, functional, and/or genetic diversity? (O1)
2. Do the Marine Reserves protect representative key habitats? (O2)
  - a. Were key types of marine habitat in multiple locations identified? (O2)
  - b. Are there important key habitats that were not included in the locations chosen? (O2)
3. Do the sites provide a potential for enhanced resilience to human-caused or natural perturbations? (O2)
4. Were ecological size and spacing considerations included in the development of the Marine Reserves system? (O3)
  - a. Are the Marine Reserves of sufficient size and spacing to detect statistically significant differences between Marine Reserves and control areas? (O3)

#### *Program Evaluation*

1. Has species diversity been documented by appropriate quantitative sampling and statistics? (O1)
2. Have appropriate methods been used to sample the abundance of key species? (O1)
3. Have appropriate methods been developed for eventually determining the role of reserves in resilience of nearshore ecosystems? (O2)
  - a. Was the monitoring system designed to pick up specific kinds of perturbations that might be expected? (O2)
4. Has research been conducted by ODFW at the Marine Reserves in alignment with stated goals and objectives in Marine Reserves management plans? (O4)
5. Have existing research efforts addressed the effects of natural (e.g., climate change) and human-induced (e.g., resource use, anthropogenic input) stressors? (O4)
6. Does a database of research exist? If so, can the data be accessed? (O4)
7. Has the Oregon Marine Reserves program adapted their sampling based on lessons learned? (O4)

### **Socioeconomic characteristics**

1. Were criteria established to measure significant adverse social and economic impact? (O3)
  - a. Is there evidence (qualitative and/or quantitative) for significant adverse social and economic impacts on ocean users and coastal communities due to the establishment and management of marine reserves? (IPG6)

- b. Is there evidence (qualitative and/or quantitative) for significant positive social and economic effects on ocean users and coastal communities due to the establishment and management of marine reserves? (IPG6)
2. Are the educational and economic development opportunities compatible with the goal of conserving marine habitats and biodiversity? (IPG4)

### **Level of Community Engagement**

1. Has the public (including ocean users, coastal communities and other stakeholders) been involved in the proposal, selection, regulation, monitoring, compliance and enforcement of marine reserves (PPG1)?
2. Was outreach and public engagement an ongoing part of the Marine Reserves planning process (PPG2)?
3. Have researchers been accessing the Marine Reserves? (O4)
4. Have research efforts been coordinated among ODFW and external researchers? (O4)
  - a. Has cooperative and collaborative research been conducted in the marine reserves? (IPG3)
5. Have fishing vessels been used as research platforms? (IPG3)
6. Has scientific and other information been made available to the public through outreach and websites (PPG2)?
7. Have the allowable uses of marine reserves been effectively communicated to the public and ocean users? (IPG5)
8. How have educational opportunities (formal and informal) and public engagement associated with marine reserves been encouraged? (IPG4)
9. How have economic opportunities associated with marine reserves been encouraged? (IPG4)

### **Governance**

#### *Planning/Site Evaluation*

1. Are the regulations guiding marine reserve use consistent with allowing marine transit, safe harbor, and beach access? (IPG5)

#### *Program Evaluation*

2. Have short- and long-term nearshore resource management decisions considered research and monitoring data from the Marine Reserves? (O4)
3. Does each Marine Reserve have a monitoring and evaluation plan or plan component that addresses the Marine Reserves objectives? (O4)
4. Do the Marine Reserves as a system and each Marine Reserve have a management plan with the following:
  - a. SMART (specific, measurable, achievable, relevant, time-oriented) objectives
  - b. standardized ecological and socio-economic monitoring protocols

- c. compliance/enforcement plan
  - d. Demonstrated long-term funding plan in alignment with objectives (IPG1)
5. Have all Marine Reserves been using ecological and socio-economic monitoring protocols (and generating associated data) that support adaptive management? (IPG3)
  6. Does each Marine Reserve have an adaptive management plan with clear objectives, defined decision-making points, and stakeholder engagement processes? (O5)
    - a. Do the adaptive management plans include time points to assess and consider new scientific information and monitoring data? (O5)
    - b. Do the adaptive management plans have clearly defined timelines and criteria for evaluation? (O5)

### **Enforcement**

1. Does each Marine Reserve have an enforcement plan? (IPG2)
  - a. Does enforcement implementation include clearly defined enforcement procedures, including use monitoring? (IPG2)
  - b. Is enforcement data evaluated on a regular basis, and is the enforcement plan modified as warranted? (IPG2)