Scientific Review by the

Marine Science Advisory Panel of Oregon University System Scientists of the

U.S. Commission on Ocean Policy Preliminary Report for

Governor Kulongoski's Oregon Response

EXECUTIVE SUMMARY

The Marine Science Advisory Panel (Panel) of Oregon University System scientists commends the U.S. Commission on Ocean Policy (USCOP) for its comprehensive review of the Nation's current approach to ocean policy and management and its recommendations for future improvements. The USCOP report highlights three key messages:

1. The oceans are important to all Americans.
2. A multitude of land-based and ocean-based activities are negatively affecting oceans.
3. Changes are urgently needed.

There is ample and unequivocal scientific evidence to support these conclusions. Moreover, these key messages are as important and relevant to Oregonians as they are to the entire Nation.

The USCOP anchors its recommendations for a new national ocean policy in 13 Guiding Principles. These principles range from Sustainability and Stewardship, to Ocean-Land-Atmosphere Connections, Best Available Science and Information, and Ecosystem-Based Management. The Guiding Principles, which are grounded firmly in science, capture the essence of how ocean policy should be developed and implemented. Despite the compelling logic of the principles, they currently are not used to provide positive guidance for decision-making at federal, state, or local levels around the Nation. Only recently has their importance been recognized. The Panel concludes that these Guiding Principles are solidly grounded in science, and it strongly endorses using them to anchor recommendations and decisions. (Refer to Section I of the review for scientific comment about the USCOP Guiding Principles.)

The Panel notes that most of the USCOP recommendations do not go far enough to achieve the goals articulated in the Guiding Principles. For this reason, the Panel encourages Governor Kulongoski to highlight in his response the need for the USCOP to strengthen its recommendations so that they, in fact, enable both Oregon and the country to make significant progress toward the goals outlined in the report.

The USCOP Guiding Principles mesh well with Oregon's goals for management of its natural resources, including the marine environment. Specifically, a 2003 Executive Order by Governor Kulongoski defines sustainability to mean "using, developing and protecting resources at a rate and in a manner that enables people to meet their current needs and also provides that future generations can meet their own need." In addition, since 1973, Oregon has maintained a strong program of Statewide Planning Goals that express the State's policies on land use and on related

topics. This policy framework includes Goal 19, Ocean Resources, which outlines the intent "to conserve marine resources and ecological functions for the purpose of providing long-term ecological, economic, and social value and benefits to future generations."

A common attribute of many of the USCOP Guiding Principles and Oregon's approach to ocean policy is a focus on the long term and an understanding of the interactions among ocean, atmosphere, and land. Considering the long-term consequences of various activities to the marine environment is central to responsible management and policy development. In recent years, scientists have increasingly come to recognize the interconnectedness among the physical, chemical, geological, and biological aspects of the ocean, and their interactions with human society. Yet, a long-term focus has been inadequately represented in the development and implementation of ocean policy. Oftentimes, the political and economic frameworks for managing oceans have focused largely on short-term benefits and impacts and have not examined issues from a system-wide perspective.

In order to address the USCOP Guiding Principles, new policy approaches are necessary that encourage, reward, and, where appropriate, require a long-term focus in management of the marine environment. Based on our scientific review of USCOP, we support the development of strong policies—ones that provide insurance and create buffers for inadvertent mismanagement or unexpected environmental change, preserve options, and allow natural and human systems to be resilient over the long term. For example, Congress should be urged to pass legislation to codify the Guiding Principles articulated by the USCOP as a national ocean policy. Sustained and expanded investments in research, education, and infrastructure will also be necessary to develop these sound policies and new approaches to management.

Given that these and other Oregon policies are coincident with the USCOP Guiding Principles, the Panel used these principles as a foundation for identifying priority recommendations from the perspective of the Oregon marine science community. (Refer to Section II of the review for a comprehensive outline of scientifically-relevant priorities from the perspective of the Panel, along with current scientific and higher-education efforts in Oregon that could serve as models for implementation of the recommendations, and new, important opportunities for marine research, monitoring, and education in the state.) The Panel recommends six overarching priorities:

1) A mechanism is needed for coordinated ocean policy development and implementation at the Federal level. (Chapters 4 and 6)
2) Regional ocean governance is needed to address challenges to oceans at an ecologically appropriate scale (the Large Marine Ecosystem) and engage in collaborative decision-making that involves Federal, regional, state, and local entities. (Chapter 5)
3) Formal and lifelong education is needed to teach Americans about connections in the marine environment and among ocean, land, and atmosphere, and the importance of oceans to sustaining life and providing important good and services to the Nation's economy. (Chapter 8)
4) Additional research in biogeophysical sciences, social sciences, and economics is needed to inform this coordinated approach to policy and management. (Chapters 25-28)

5) An Integrated Ocean Observation System (IOOS) is needed to improve the Nation's information base about oceans and to inform decision-making at Federal, state, regional, and local levels. (Chapter 26)
6) Expanded investments in scientific, technical, and human infrastructure are required to realize these priorities.

The Guiding Principles help not only to define a vision for future ocean policy in the U.S., but also a framework against which the effectiveness and progress of recommendations made by the USCOP may be judged in the future. In addition, the 2000 Oregon State of the Environment Report identified a host of indicators by which the state measures the environmental condition of its ocean and coastal areas. (Refer to Section III for a consideration of these indicators as they relate to USCOP recommendations.) This comparison may be useful as the State identifies priority recommendations from the USCOP report, in addition to areas where the recommendations may be strengthened to address issues of concern to Oregon.

The Marine Science Advisory Panel

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SECTION I – Scientific Comment about the USCOP Guiding Principles

The U.S. Commission on Ocean Policy (USCOP) has articulated a set of overarching Guiding Principles to frame the creation of a new national ocean policy. When taken collectively, these principles provide a careful, circumspect, and ambitious context from which to develop policies that will promote vibrant coastal communities, healthy and resilient ecosystems, abundant wildlife, sustainable fisheries, clean and safe shorelines, and enjoyable and inspirational recreational opportunities—in short, the visions that Oregonians articulate for their coast and ocean. The Guiding Principles align closely with Oregon's Statewide Planning Goals, policies, and values. In fact, they underscore the importance of weighing long-term interests more heavily than short-term ones in the balance of competing uses. They are holistic in geographic scope, rather than focused on a single component of a complex ecosystem. The USCOP Guiding Principles were conceived to foster an atmosphere of objective scientific inquiry to form the basis of policy and decision-making to reconcile the diverse needs of all Oregonians.

The Guiding Principles capture the core elements of "what has been missing" from management to date, at the federal, state, and local levels. For example, the long-term theme that cuts across many of the Principles is central to responsible management and yet has been inadequately represented. Instead, the political and economic framework for management has often focused only on the short term and has not examined issues from a system-wide perspective. By developing operational content for the USCOP Guiding Principles and the current policies of Oregon, the Nation and the state can make measurable progress in ocean and coastal management.

The USCOP Guiding Principles and Oregon policies also provide a set of templates against which recommended actions are to be judged. During its deliberations, the Panel has asked if the various proposed policies and actions recommended in the USCOP report will lead to such goals as *Sustainability* or *Ecosystem-Based Management*, which are outlined in the Principles. In many cases, the answer was "no, not without strengthening the proposed approach." Governance frameworks could move toward a long-term focus by encouraging, rewarding, and, where appropriate, requiring policies and actions which take a long view. This task is politically challenging, but necessary and appropriate for meaningful change. Additionally, it must be recognized that policies and actions, even once approved against the template of Guiding Principles, cannot remain static. This notion is embodied in the USCOP Guiding Principle of *Adaptive Management*. *Adaptive Management* recognizes that policies and actions that provide insurance and create buffers for management uncertainties or environmental change, preserve options, and allow recognition of resiliency in natural and human systems are needed—for research, monitoring, management, and funding alike. Similarly, changes to the ecosystem from processes acting over long time scales are important to acknowledge when developing policies and actions that address the Guiding Principle of *Ecosystem-Based Management*.

In summary, the Panel concludes that the USCOP Guiding Principles closely align with Oregon's statewide goals, policies, and values, and endorses their operational definition and eventual application as templates and measures against which to weigh new policies and actions. The Panel notes that most of the USCOP recommendations do not go far enough to achieve the goals articulated in the Guiding Principles. Stronger recommendations will be needed if the country is to achieve the lofty goals called for in the report.

SECTION II – Comprehensive Review of USCOP Recommendations as Relevant to Marine Science and Higher Education in Oregon

The Marine Science Advisory Panel (Panel) identified six overarching priorities during its deliberations (see Executive Summary):

1) A mechanism is needed for coordinated ocean policy development and implementation at the Federal level.
2) Regional ocean governance is needed to address challenges to oceans at an ecologically appropriate scale (the Large Marine Ecosystem) and engage in collaborative decision-making that involves Federal, regional, state, and local entities.
3) Formal and lifelong education is needed to teach Americans about the connections in the marine environment and among oceans, land, and the atmosphere, and the importance of oceans to sustaining life and providing important good and services to the Nation's economy.
4) Additional research in biogeophysical sciences, social sciences, and economics is needed to inform this coordinated approach to policy and management.
5) An Integrated Ocean Observation System (IOOS) is needed to improve the Nation's information base about oceans and to inform decision-making at Federal, state, regional, and local levels.
6) Expanded investments in scientific, technical, and human infrastructure are required to realize the aforementioned priorities.

The Panel used these priorities as guideposts for completing a comprehensive review of the USCOP recommendations. Based on these priorities, the Panel has selected a number of recommendations that are of particular relevance and high priority to marine science and higher education in Oregon. These recommendations are outlined in the following pages. In addition, the Panel identifies current scientific and higher-education efforts in Oregon that could serve as models for implementation of the recommendations, and new, important opportunities presented by the USCOP recommendations for marine research, monitoring, and education in the state.

PRIORITY 1: A mechanism is needed for coordinated ocean policy development and implementation at the Federal level.

The Panel recognizes the need to coordinate ocean policy development and implementation at the Federal level. One possible approach to address this need is through the structural change recommended by the USCOP at the highest levels of government. The Panel agrees with Recommendation 4-1, to establish an interagency National Ocean Council at the level of the President. The National Ocean Council would facilitate communication of data and information for scientifically-informed decision-making at the national and regional levels, distribute funding necessary to support basic and applied research and monitoring, and assess the state of the Nation's oceans and coasts on a periodic basis to measure the achievement of national ocean goals, as specified in the USCOP report. The National Ocean Council structure could enable USCOP science-relevant recommendations to be translated into meaningful action.

The Panel also supports establishment of the Committee on Ocean Science, Education, Technology, and Operations (COSETO) within the National Ocean Council to coordinate and

plan federal marine facilities and operations, federal oversight of the Integrated Ocean Observing System, and coordination of ocean-related efforts (see Recommendation 4-7). In addition, the Panel endorses the USCOP recommendation to create a formal structure for input from nonfederal individuals and organizations through the Presidential Council of Advisors. This direct conduit for information to the President would be a welcome opportunity for communication from the perspective of the marine science and education communities.

In addition to its National Ocean Council recommendations, the USCOP sets forth a three-phase process to: 1) strengthen the National Oceanic and Atmospheric Administration (NOAA), primarily through enactment of an organic act, 2) consolidate selected ocean and coastal programs from other agencies into NOAA, and 3) include oceans and coasts within a unified federal agency structure (such as creation of a Department of Natural Resources) to manage all natural resources. The Panel agrees that agencies and the capacity to coordinate and collaborate among the management system should be strengthened. An organic act for NOAA would be a step forward in defining roles and responsibilities. However, the Panel cautions that Phases Two and Three the proposed process will take an amount of long-term funding and leadership not previously demonstrated, and may be unrealistic.

A second possible approach to coordinated policy development and implementation at the federal level is through clarification of federal agency responsibility for each current and foreseeable use in the offshore area. Under Recommendation 6-1, a lead federal agency is designated to coordinate with other federal agencies and authorities. The Panel endorses this approach because it provides a natural mechanism for collaboration with regional ocean councils.

The National Ocean Council and regional ocean councils are also instructed to establish a coordinated ecosystem-based offshore management regime, resting partly on notions of balancing multiple uses through a set of guiding principles and collecting resource rent from new and emerging offshore activities. While the principle of "fair return" as articulated in the USCOP report has the initial appearance of being reasonable, the Panel is concerned that, in practice, it may be counterproductive to addressing the USCOP Guiding Principles of Stewardship and Sustainability.

PRIORITY 2: Regional ocean governance is needed to address challenges to oceans at an ecologically appropriate scale (the Large Marine Ecosystem) and engage in collaborative decision-making that involves Federal, regional, state, and local entities.

Chapter 5 focuses entirely on *Advancing a Regional Approach* to ocean policy development and management. A multitude of land-based and ocean-based activities are negatively affecting oceans, which makes a regional approach to governance important from both political and scientific perspectives. Politically, a regional approach is imperative because activities impacting the marine environment are diverse and cross political jurisdictions. To meet USCOP Guiding Principles such as Sustainability, Stewardship, and Multiple Use Management, effective policy and management will take an across-jurisdictional approach.

The examples of regional approaches articulated at the beginning of Chapter 5 illustrate the need for regional approaches. While these examples offer a good starting point and important progress in moving toward the USCOP Guiding Principle of Ecosystem-Based Management, they cannot yet be characterized as successful examples given that the problems facing the health of the Chesapeake Bay and the Gulf of Mexico, and salmon in the Pacific Northwest persist.

From a scientific perspective, a regional approach to ocean governance is necessary to address challenges to oceans at an ecologically appropriate scale, the Large Marine Ecosystem (LME). These areas define functional, cohesive ecological units that provide a logical basis for the scale of regional governance. LMEs capture the interconnectedness among the physical, chemical, geological, and biological aspects of the ocean. Fish, larvae, pollutants, nutrients, and the organisms that generate harmful algal blooms move within an area bounded by the ecosystem, not political boundaries within that ecosystem. LMEs have long been recognized in oceans; for example, the current regional fishery management councils (RFMCs) are largely based on these units. LMEs make good sense from a management standpoint as well as an ecological standpoint, and are the appropriate units for the establishment regional ocean councils (ROCs), which are called for in Recommendation 5-1.

Off Oregon, the necessary and appropriate scale for establishment of a ROC is the California Current LME, which lies off the coasts of Washington, Oregon, and California. The Panel identifies this scale of regional governance as a priority. Yet, this defined area goes beyond the USCOP statement that, "Regional ocean councils should encompass relatively large areas with similar ecosystem features… At a minimum, the boundaries of each regional ocean council should encompass the area from the inland extent of coastal watersheds to the offshore boundary of the nation's exclusive economic zone. The boundaries of the RFMCs may be used as a starting point in the process of developing each council, although these regions may not always be suitable. For example, more than one regional ocean council may be necessary along the Pacific Coast where there is only one RFMC" (p. 59). The USCOP report is inconsistent in that it highlights Ecosystem-Based Management as a Guiding Principle, yet suggests that regional management units potentially be based on political boundaries. The Panel strongly suggests that the boundaries of ROCs should be determined by ecosystem boundaries.

The Panel also recognizes that while the California Current LME should be the basic unit for management, certain problems may require a refinement of this geographic scale to adequately address the issue. Some smaller-scale issues (e.g., Columbia River sediment management) may require a consideration of a subregion of the California Current LME, while other issues require a focus larger than the LME. For example, the atmospheric deposition of nitrogen and other pollutants in the Pacific Northwest is oftentimes from global sources, such as those around the Pacific Rim. Increasing economic development in Asia will impact Oregon's air quality, with subsequent impacts through atmospheric deposition. Recent estimates note that the Los Angeles Basin expects to receive most of its pollution from outside of the U.S. beginning in this decade. Yet, the issue of the potential for global changes to impact coastal marine ecosystems is not well recognized. A comprehensive understanding of marine ecosystems requires continued and expanded examination of the global-scale changes that affect them. Different problems and issues should be solved using knowledge about geographic scales appropriate to the patterns and

processes that cause the problem. Nevertheless, LMEs provide the appropriate, basic unit for regional ocean governance.

The Panel endorses Recommendation 5-2 regarding establishment of regional ocean information programs (ROIPs). The regional coordination, prioritization, and funding functions of the proposed ROIPs are urgently needed. While it is critically important that these programs deliver information that is relevant to policy, management, and outreach, the ROIPs must be solidly science-based—not agency-based—to be truly successful. The USCOP recommends that the ROIPs "may be subsumed within the regional ocean council structure" (p. 59). Yet, multiple reports from the National Research Council (NRC) of the National Academy of Sciences highlights the lessons learned about design and execution of scientific information, with the consistent conclusion that science agencies are most appropriate to deliver the best scientific information. For this reason, oversight of the proposed ROIPs likely should come from a science agency.

The Panel reiterates that, like the ROCs, the logical scale for ROIPs is an integrated area defined by LME boundaries. This scale contrasts with the ROIP regions outlined on pp. 61-62 of the USCOP report, which recommends three west-coast regions (Northwest, Central West Coast, and Southern California).

A regional approach based on LMEs also applies for regional ecosystem assessments. The Panel agrees with Recommendation 4-3, which states that regional ecosystem assessments should be developed and periodically updated. However, the appropriate scale at which assessments, research, and monitoring should be conducted along the West Coast is the California Current LME, not three separate areas as outlined by the USCOP.

A number of past and existing efforts in Oregon have the potential to serve as models for portions of a ROIP and as foundation for the regional ecosystem assessments, including:

- The U.S. GLOBEC Northeast Pacific Program, which conducts multi-disciplinary research designed by oceanographers, fishery scientists, and marine ecologists to examine the potential impact of global climate change on ocean ecosystems.
- PISCO, the Partnership for Interdisciplinary Studies of Coastal Oceans, with its focus on coupling interdisciplinary marine research, monitoring, and policy-relevant outreach for the nearshore area of the California Current LME.
- PNCERS, the Pacific Northwest Coastal Ecosystems Regional Study, with its natural-science, social-science, and economic studies of nearshore and estuarine ecosystems in the Pacific Northwest to inform coastal management and decision-making.

For the ROCs, ROIPs, and regional ecosystem assessments, adequate support in the form of funding and human capital is critical to success.

Following are the Panel's review of specific issues detailed in the USCOP report that relate to regional ocean governance.

Achieving Sustainable Fisheries

Chapter 19 of the USCOP report recognizes the importance of a solid scientific basis, the creation of properly aligned incentives, and the shift toward Ecosystem-Based Management for decision-making about fisheries.

The report addresses the scientific basis of decision-making in (Recommendations 19-1 through 19-4). These focus on the requirements, roles, and responsibilities for the Scientific and Statistical Committees (SSC) of the RFMCs. When considering the Pacific Fishery Management Council (PFMC), which makes decisions about fisheries off the coasts of Washington, Oregon, and California, the reliance on volunteer labor for SSCs has resulted in a very small pool of qualified and willing members. By recommending compensation, the USCOP report provides an opportunity to enlarge the pool of potential members. In addition, these recommendations will strengthen the source of science advice to the PFMC by providing stronger screening and independent assessment of expertise. In addition, the recommendations suggest that the SSC will help not only to review the existing scientific information on which decision-making about fisheries is based, but also to identify important scientific information. This suggestion changes the current role of SSCs from reviewers to providers of information. The Panel agrees that rigorous independent review of the science basis for decision-making is important. The PFMC already conducts a modified within-region independent review of the biological science through the Stock Assessment Review Panel (STAR) process. This process provides a good starting point from which to work. However, funding will be required for these recommendations to be realistic.

The importance of properly aligned incentives for decision-making about fisheries is noted by the USCOP. Recommendation 19-6, which suggests that no fishing be allowed to take place without an approved fishery management plan, shifts the burden of proof from "fish unless prevented" to "fish only when allowed." It will provide an incentive to have a full regulatory approach developed. Recommendation 19-15 also addresses incentives by highlighting the importance of allowing dedicated access privilege tools to be developed for fisheries management. Regarding the PFMC, the moratorium on Individual Transferable Quotes (ITQs), in place from 1996-2002, was a problem. At the time the moratorium was implemented, PFMC had one ITQ program in development and others planned. ITQs are a mechanism that addresses the problem of overcapacity, which is a major concern for PFMC fisheries. By ending the race for fish, dedicated access privileges such as ITQs change the incentive structure of fishing and also provide a mechanism to reduce fishing capacity. This recommendation will be welcomed by PFMC fishing industry members, fishery scientists and managers. Recommendation 19-16 would help to address the overcapacity of the fishing fleet off the West Coast, including the removal of tax incentives to unnecessarily increase capacity.

The USCOP report highlights the importance of moving toward an Ecosystem-Based Management approach to fisheries management. Recommendations 19-21 and 19-22 state that NOAA Fisheries should transition away from a single-species approach, first to multi-species, then to an ecosystem approach. The recommendation is attempting to ensure that practical steps are taken to define and protect what are now called Habitat Areas of Particular Concern, but from an ecosystem perspective. The Panel supports these recommendations, but acknowledges that they will require specific operational guidance to be developed. The Panel also notes that

the influence of global-scale shifts in ocean circulation, as well as global economic forces on U.S. fisheries is important and potentially immense. Oregon, by virtue of its location on the Pacific Rim, could pursue both research and decision-support issues that connect global and regional-scale ecosystems and economies.

In addition, Oregon, along with other states along the West Coast, is well positioned to serve as a model for implementation of some USCOP recommendations related to fisheries. For example, several programs already exist in and beyond Oregon to enable cooperative research, which is suggested for expansion in Recommendation 19-9. Ongoing cooperative research in this region is encouraged by and conducted through such programs as:

- Port Liaison Project funded through the NOAA Northwest Fisheries Science Center
- Cooperative Institute for Marine Resources Studies at Oregon State University (OSU)
- Scientists and Fishermen Exchange, created by Extension Sea Grant in Oregon

The USCOP report highlights new opportunities for growing the information base about fisheries off the Oregon coast by suggesting:

- Saltwater anglers be required to purchase licenses to improve in-season data collection on recreational fishing, which would address the paucity of data about recreational fishing in the PFMC region that results in poorly informed management decisions.
- Vessel monitoring systems (VMS) be phased in as a requirement for licensing, which would help contribute to monitoring and data collection about fisheries.
- VMS be integrated into a larger data system, which would create new possibilities for timely, accurate, and comprehensive monitoring and reporting of fisheries data.

Connecting the Oceans and Human Health

Chapter 23 addresses a number of human health issues related to the ocean, including marine bioproduct discovery and development. Under the Guiding Principles of Ecosystem-Based Management (including the precautionary approach) and Preservation of Marine Biodiversity, scientific research is intended to be conducted and information relayed to support the development of bioprospecting criteria. These criteria would address the USCOP Guiding Principle of Best Available Science and Information and Oregon's Statewide Planning Goal 19, Ocean Resources. Areas of special sensitivity, including deep-water coral ecosystems and hydrothermal vent communities, may lay off the coast of Oregon, thus this issue is important to the state.

Harmful algal blooms (HABs), marine bacteria and viruses, and contaminated seafood are also all discussed in the context of reducing the negative health impacts of marine microorganisms. According to a USCOP chart on HABs, the Oregon coast has experienced incidences of Neurotoxic Shellfish Poisoning and Amnesic Shellfish Poisoning, particularly in the area of the Columbia River plume. The USCOP directs several federal agencies and a newly proposed multi-agency entity, the Oceans and Human Health Initiative, to increase research and monitoring efforts and funding for HABs and marine microbiology and virology in general. The regional ocean information programs will need to coordinate with these efforts to receive the support necessary to adequately research and monitor these phenomena off the coast of Oregon and in the region. They also will support the USCOP's identified need to protect the safety of

the Nation's seafood supply through development of rapid, accurate, and cost-effective means for detecting pathogens and toxins in seafood and the subsequent warning of at-risk populations when unsafe conditions are present. This research and monitoring support will necessarily be integrated into the ocean observing system proposed by the USCOP. In addition, scientifically-based information about seafood safety, from both foreign and domestically-landed and cultivated fish, can be distributed through public outreach and education programs to Oregonians, both as preplanned materials and as a rapid-response warning system. Oregon Sea Grant and other educational programs could assist with these efforts.

Conserving and Restoring Coastal Habitat

The USCOP recommends that one function of the ROIP is to determine regional habitat conservation and restoration needs, goals, and priorities that mesh with coastal habitat goals developed by the NOC (Recommendation 11-2). This recommendation highlights the need for Oregon to work together with other coastal states to develop a standardized habitat classification system that is based on a series of common and regionally-applicable units for the mapping of coastal habitats. Moreover, Oregon, Washington, and California could take this opportunity to collaborate on development of a unified system of metrics to gauge the extent of habitat loss, including retrospective assessments of habitat alteration and historical changes in coastal land-use patterns. Pacific Northwest states might formulate a sub-regional approach to the establishment of priorities for coastal habitat preservation, identify critical restoration needs, and develop a regionally-based mechanism to capitalize on timely opportunities for conservation of habitats that meet regional criteria for restoration and enhancement.

Oregon has already taken steps forward in conserving and restoring coastal habitat, and developing a science-based framework to monitor and evaluate the effectiveness of coastal habitat restoration efforts.

- Oregon has turned the tide on loss of coastal tidal marshes, due to adoption of statewide planning goals (Goal 16), restoration activities, and beneficial uses of dredge spoils.
- OSU is a leader in coastal mapping.
- Oregon already has completed a hydrogeomorphic (HGM) assessment of coastal tidal wetlands.
- The Oregon Watershed Enhancement Board (OWEB) coordinates a program for land acquisition, restoration, and monitoring that is focused on improvement in coastal watersheds, including estuaries.

Oregon also can seize on new opportunities presented by the USCOP recommendations to secure resources to update Oregon's estuary maps, which now are three decades old.

Employing Marine Protected Areas as a Management Tool

The federal definition of Marine Protected Areas (MPAs) is "any area of the marine environment that has been reserved by Federal, State, territorial, tribal or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." The USCOP recognizes that MPA is a broad, umbrella term created for many different reasons, including conserving living marine resources and habitat, protecting endangered or threatened species,

maintaining biological diversity, and preserving historically or culturally important submerged archaeological resources. It also recognizes that MPAs are important tools for the Guiding Principles of Ecosystem-Based Management, particularly when designed within the broader context of regional ecosystem planning and employed in conjunction with other management tools. The USCOP does not, however, define marine reserves, a subcategory of MPAs that protect discrete areas in the ocean by prohibiting extractive or destructive activities in perpetuity.

Current scientific understanding indicates the particular usefulness of marine reserves and networks of marine reserves, as one tool in the toolbox of ecosystem-based management and sustainable fisheries management. The Oregon Ocean Policy Advisory Council (OPAC) MPA process examined scientific information and heard from stakeholders over a two-year timeframe. At the end of that time, OPAC determined that marine reserves are a useful tool in marine resource conservation of Oregon's Territorial Sea, and that a limited system of marine reserves should be established as soon as possible, after stakeholder input on design and site selection, to test and evaluate the effectiveness of reserves in meeting Oregon statewide planning goals. Marine reserves are particularly useful in this ecosystem-based management context because they protect part of or entire ecosystems, and have particular implications for the USCOP Guiding Principles of Ecosystem-Based Management, Preservation of Marine Biodiversity, and Stewardship. MPAs, including marine reserves, enhance Multiple Use Management by creating zones for a diversity of uses. In the fisheries management context, marine reserves may be useful to provide insurance against unintended mismanagement by employing the precautionary approach, baseline information against which to evaluate the effects of extractive activities, and places for education and scientific study.

Managing Offshore Energy and Other Mineral Resources

From a scientific perspective, the USCOP recommendations for managing offshore energy and other mineral resources are sound. Almost all issues in this chapter involve regulatory and oversight authority. Some issues, however, are particularly relevant in light of scientific planning, research, and monitoring activities through the proposed ROIPs.

Recommendation 24-4 directs the National Ocean Council and the Department of Energy, among other entities, to review the status of methane hydrates research and development to determine if methane hydrates can contribute significantly to meeting the nation's long-term energy needs. Off the Oregon coast, interest from and work by Oregon scientists on methane hydrates already is underway. Any investment provided to this research through Recommendation 24-4 will be of benefit, particularly for studying the dynamics of methane gas hydrates through the planned cabled observatory on the Juan de Fuca Plate and tying that research into regional ocean information programs and the regional and national ocean observing systems. Research and monitoring activities will help address the USCOP Guiding Principle of Best Available Science and Information to guide future activities.

Oregon's offshore oceanic environment also makes it a good candidate site for renewable energy development, such as offshore wind farms, current/tide conversion, and thermal energy conversion. Limitations include commercial and technological development. Research sites elsewhere (e.g., current and tide conversion models exist off the coast of Washington) should be

examined. While promoting renewable energy over nonrenewable sources, the Panel suggests that the precautionary approach should be used in developing the Best Available Science and Information for development standards. All of these activities could have important, unexpected impacts; for example, energy extraction from internal tides might reduce the amount of energy available for mixing, thus decreasing nutrient inputs to the nearshore ocean in some locations.

Lastly, while gravel extraction is not likely to become an issue due to plentiful sources in the Coast Range and the Cascades, there are extensive polymetallic sulfides off the coast of Oregon, within the Exclusive Economic Zone on the Endeavor and related ridge segments. Because the technological ability to mine those resources is so far away, research priority at this stage should be low, but kept in mind.

Preventing the Spread of Invasive Species

Although Oregon is among the pioneering states that have enacted legislation to require discharge of ballast water offshore, Oregon ports and harbors are still highly vulnerable to the continued introductions of non-native species. The number of vessels that successfully complete a total mid-ocean exchange of ballast water is still small in comparison with the number of vessels that undergo partial ballast exchange or do not attempt ballast replacement before arrival in the deep-water ports of Portland, Coos Bay, and Newport. In addition, Governor Kulongoski's efforts to revitalize the economies of coastal ports and promote increased maritime commerce likely will lead to an increase in the number of foreign ships that bring cargo into and out of Oregon's ports and harbors. Consequently, the USCOP recommendations in Chapter 17 provide an opportunity for Oregon to take steps to protect its vulnerable ports and harbors by lending support for development of a national compulsory ballast management program. This program would include mandatory mid-ocean exchange and research into methods for the shipboard treatment of ballast water during transit.

While the USCOP report focused almost entire on the spread of invasive species through ballast water, multiple vectors exist for the introduction of new species into Oregon's coastal marine and estuarine habitats. For example, Japanese eelgrass (*Zostera japonica*) was introduced into Oregon estuaries in the early 1980s via oyster aquaculture and has since spread over much of the previously unvegetated shoreline. European green crab (*Carcinus maenus*), initially introduced into San Francisco Bay via seaweed bait, has since moved northward into Oregon estuaries by larval transport on ocean currents. Chinese mitten crab (*Eriocher sinensis*) is another threat from the south, and Atlantic cordgrass (*Spartina alterniflora*) threatens from the north. In California, invasions have resulted from salt-water aquaria as well as deliberate introductions of species. The future expansion into Oregon of aquaculture using genetically-modified organisms may be an important issue as well.

Oregon offers several good examples of management, monitoring, and stewardship programs that are already working to limit the spread of invasive species:

- The Oregon Invasive Species Council.
- Sea Grant / Marine Invasive Species Team (MIST), which is a coordinated effort by the Oregon and Washington Sea Grant programs to facilitate regional research and outreach on coastal invasive species.

- Taxonomic surveys and monitoring in the Columbia River, Yaquina Bay, and Coos Bay/South Slough.

Setting a Course for Sustainable Marine Aquaculture

Chapter 22 highlights the need for additional scientific information about aquaculture practices and effects to inform the development of policies and practices for the aquaculture industry. The Panel agrees with this assessment, but notes also that aquaculture comprises a diverse portfolio species, culturing locations, and practices. Research, training, and extension about aquaculture must be sufficiently broad to address this diversity, and include natural scientists, social scientists, and economists. This focus, along with additional funding, will assist the Nation as it moves toward sustainable aquaculture that enhances production, while reducing environmental impacts.

PRIORITY 3: Formal and lifelong education is needed to teach Americans about the connections in the marine environment and among oceans, land, and the atmosphere, and the importance of oceans to sustaining life and providing important good and services to the Nation's economy.

The USCOP recommendations intend to better coordinate national and regional ocean education through Ocean.ED, under the COSETO. The Centers for Ocean Sciences Education Excellence (COSEE) would be moved from National Science Foundation (NSF) to Ocean.ED, and are to enhance their partnerships with the National Sea Grant College Program (Sea Grant) "by developing links in all the regions in which they both operate." Sea Grant colleges exist in every coastal state, including the Great Lakes. OSU is Oregon's Sea Grant college. The 30 Sea Grant colleges have demonstrated their commitment to ocean education throughout their 35-year history. To help move towards regional cooperation with COSEE, it would be helpful if the Sea Grant network of universities were mobilized and funded as COSEE partners to create a broad base for ocean education programs.

With regards to informal education, Sea Grant is ready to provide its human capital to the effort, and already has a nationally-networked extension program in place that can further the USCOP recommendations to work with other appropriate entities to enhance community education. In the light of this, Sea Grant can help COSEE networks to establish and evaluate similar informal and adult education programs in ocean science. Establishment of an Oregon COSEE, as per the USCOP recommendation to expand these centers, would help facilitate a partnership between Oregon researchers who are already leaders in Federally-funded programs in adult literacy with Oregon's community colleges, as well as expand efforts to develop and assess "free choice" learning.

In addition to Oregon universities, the educational and outreach programs provided by such groups as the South Slough National Estuarine Research Reserve (NERR) can provide a model for diverse education that focuses on estuaries as part of the ocean ecosystem:

- Technical advisory services and professional seminars provided by staff scientists

- Financial support for graduate thesis work in the form of NERR Graduate Research Fellowships
- NERR Coastal Training Program, which provides information delivery to coastal zone decision-makers
- Operation of an estuarine interpretive center to provide visitors and the public with educational displays, guided programs, videos, maps, and printed materials
- Operation of an active K-12 education program for school children, including teacher-training workshops and on-line web-broadcast outreach activities

Undergraduate and graduate education is to be enhanced under the USCOP recommendations primarily through cross-cutting mechanisms that allow traditionally separate disciplines to integrate. The number of social scientists and economists in management agencies is generally lacking. The Oregon University System (OUS) is well positioned to address the need for agency scientists to be trained using an interdisciplinary approach. This need could be addressed through academic departments that provide in-depth disciplinary graduate education in the social sciences and the conduct of social-science research: anthropology, sociology, political science, law, and resource economics. These programs have a history of providing interdisciplinary exposure to marine issues while providing disciplinary depth. An approach such as this is important given that interdisciplinary training is needed, but should not replace strong disciplinary training that will contribute positively in an agency setting.

Potential exists to expanding several existing graduate programs within the OUS to better integrate ocean science, law and policy, and social sciences:

- Marine Resource Management Program (MRM) at OSU, which is a national leader in training Master's level students in policy and management in the context of a solid program in ocean sciences.
- The J.D. degree at the Ocean and Coastal Law Center of the University of Oregon, which already uses distance-education technology to teach UO's Ocean and Coastal Law course to MRM students at OSU.
- The existing intercampus Master's and Ph.D. programs in Environmental Science and Environmental Policy between OSU and UO.

PRIORITY 4: Additional research in biogeophysical sciences, social sciences, and economics is needed to inform this coordinated approach to policy and management.

Chapter 25 describes the need to create a national strategy for increasing scientific knowledge that can inform decision-making about oceans. The Panel endorses Recommendation 25-1, which would double the federal ocean and coastal research budget over the next 5 years. This funding would enable research priorities identified throughout the USCOP report, ensuring that these priorities would not be unfunded mandates.

The Panel also agrees with the recommendation to develop a national ocean research strategy. Such a strategy would benefit from developing a careful process by which regional as well as national needs are addressed and to avoid unnecessary duplication. It is important that the national ocean research strategy encompass both basic and applied research.

The USCOP specifically notes the potential to expand the National Sea Grant program, which seems to the Panel to be a reasonable way to address the recent history of stagnant funding levels for a demonstrably successful federal/regional research program. The Panel thinks it important to highlight that Sea Grant is not just a coastal research program, but instead extends from headwaters to bluewater (particularly in the areas of fishery management, fishery science, and international law). For example, in the past, Oregon Sea Grant has funded fisheries oceanography research.

The Panel wholeheartedly supports Recommendation 25-3, which would create a national social science and research program, and require all ocean agencies to include socioeconomic research within their purview. This recommendation addresses a chronic inadequacy in social science research and data collection among biology and oceanography-dominated ocean agencies. It supports findings and recommendations from the 2003 NOAA Social Science Review Panel Report to significantly strengthen the social and economic research for oceans and coasts. It also proposes formal mechanisms to address fragmentation and inconsistencies among existing data programs that exist outside of ocean agencies.

The Panel supports recommendations to expand funding for ocean exploration, which is an issue important to Oregon. Researchers from OSU's College of Oceanic and Atmospheric Sciences (COAS) are leaders in this arena, including the use of submersibles, autonomous underwater vehicles (AUVs), and remotely operated vehicles (ROVs). Based on past experiences with these technologies, the Panel notes that such ocean exploration may be most appropriately directed by a science agency, such as NSF. NSF has shown excellent capacity to lead these activities, given their strong connection between exploration and research. Moreover, the capabilities of ROVs and AUVs are advancing rapidly, and it is difficult to see how a mission-driven agency such as NOAA can provide adequate leadership in this arena.

The Panel notes several potential areas of research that are important to Oregon, but which may or may not have been noted in the USCOP recommendations:

- Regarding Chapter 9, Managing Coasts and Their Watersheds, research that links the coastal ocean and watersheds is an area where Oregon could provide national leadership. Entities such as the Bonneville Power Administration have been highly supportive of coastal ocean research. The GLOBEC Program has shown that salmon returns are largely a function of coastal ocean conditions when juvenile salmon first enter the sea. Such results show that integrated ocean-watershed studies are essential. With the presence of the Columbia River watershed in the Pacific Northwest, Oregon and its neighbors could help set the pace for interdisciplinary research that addresses land-sea connections.
- Regarding Chapter 12, Managing Sediments and Shorelines, shoreline erosion is an area where Oregon has been a leader in research. Most of Oregon's erosion problems are north of Cape Blanco where the shoreline is sinking. It will be imperative to continue and expand this research in order to develop effective policies and predictive capabilities, especially as humans continue to alter sediment transport and "harden" shorelines is effective. Moreover, climate change may significantly affect the wave climate off Oregon which, when coupled with sea level rise, will change the erosion potential of Oregon's coast.

- Also regarding Chapter 12, river bars are critical for coastal navigation in Oregon, affecting both small and large ships. Although USCOP recommendations did not elaborate on this issue, Oregon could use this as an opportunity to significantly advance the state's ability to provide up-to-date information to ship operators. For example, the dynamic scientific models that couple waves, tides, and seafloor topography could help provide real-time predictions about bar conditions in many of Oregon's harbors.
- Chapter 25 recommends coordinating the development of standardized maps and charts incorporating living and nonliving marine resources. Better understanding about marine ecosystems obtained through research and exploration has the potential to dramatically improve the scientific basis for decision-making in Oregon and around the country.

The Panel does note, however, that mention about the impacts of global-scale processes on the regional systems and dynamics are conspicuously absent. Despite this absence, the impacts of changes in ocean/atmosphere processes in distant regions can greatly affect Oregon. For example, shifts in precipitation and sea-surface temperature in the tropical Pacific can affect storm tracks in mid-latitude locations such as Oregon. The USCOP is largely silent on these issues, and does not propose any research or observing systems to examine this coupling. The Panel highlights that simply studying coastal oceans in isolation is likely not sufficient to provide knowledge that advances decision-support capabilities about connections among ocean, land, and atmosphere.

PRIORITY 5: An Integrated Ocean Observation System (IOOS) is needed to improve the Nation's information base about oceans and to inform decision-making at Federal, state, regional, and local levels.

Chapter 26 comprehensively addresses Achieving a Sustained, Integrated Ocean Observing System. The federal backbone of the IOOS will consist of regional observing systems that represent a collaboration of state and federal agencies, academia, private industry, and non-governmental organizations. For this reason, many aspects of the proposed IOOS are relevant to marine science in Oregon.

Recommendation 26-2 proposes that IOOS elements be developed along regional lines under the leadership of the NOC, with NOAA responsible for implementation. Regional IOOS activity already is underway in Oregon and the Pacific Northwest. OSU and Oregon Health and Science University's Oregon Graduate Institute (OGI) are part of the Northwest Association of Networked Ocean Observing Systems (NANOOS), which is designed to help a Pacific Northwest IOOS become self-sustaining after its initial funding.

This emerging regional system will be designed and implemented as a cooperative system of data providers and information users along the Pacific Northwest coastal zone. The coastal component of the IOOS envisioned for the Pacific Northwest is a network of data acquisition and dissemination sites that will provide comprehensive and timely information about the status, condition, and future of the nearshore ocean, shorelines, and estuaries. As an example of work already underway on this front, South Slough NERR recently was awarded funding to participate in the early development of a coastal observatory pilot project for the estuaries and shores of

Oregon and Washington. The NERR will install data transmission equipment at three long-term monitoring stations located within tidal waters of the South Slough estuary. Real-time data generated by these stations will be transmitted to a centralized database and modeling facility located at the OGI, and integrated into the Pacific Northwest regional monitoring network for the nearshore ocean, estuaries, and shoreline as part of NANOOS.

As part of the development of a Pacific Northwest IOOS, OSU has included the Oregon Coastal Ocean Observing System (OrCOOS) in its Federal agenda. OrCOOS is aligned with two of OSU's thematic areas as identified in its new strategic plan: understanding the Earth as a dynamic system, and managing Oregon's natural resources. OrCOOS will provide fundamental research and education to inform policymakers regarding complex environmental issues facing the Pacific Northwest. Through its coverage of the entire Oregon coastal region, OrCOOS will create educational opportunities and inform management systems using real-time ocean information, building on the unique capabilities available at Hatfield Marine Science Center (HMSC). In addition, OrCOOS will create marine technician jobs and help to support the local coastal economies as observing elements are put in place and maintained. Oregon fishermen, some of whom are unable to fish because of increasingly common closures to fishing grounds, could contribute to OrCOOS. For example, the contributions could come in the form of using their boats to install and service ocean sensing systems or making direct ocean observations. OrCOOS would be coordinated with CORIE, an established observing system in the Columbia River estuary operated by OGI. Expanding OrCOOS and CORIE to include observing systems in Washington is a logical next step. This entire approach is consistent with Recommendation 26-2.

The Panel notes, however, that IOOS as it is proposed focuses solely on coastal oceans. Seafloor observatories (such as the NEPTUNE Observatory that will be located on the Juan de Fuca Plate off Oregon) and global observing systems are not included. In addition, very nearshore areas are excluded. Unfortunately, this approach does not consider either the impacts of remote and global-scale processes or those very close to shore. Moreover, the IOOS focuses primarily on physical observations and data products, and it does not recognize the importance of coupling biological and physical data or the integration of observations with numerical models. Although the concept of ROIPs is extremely powerful, the limitations may be that resulting systems are provincial and focus only on local needs. Oregon scientists have the potential to enhance the IOOS as it is proposed, thus addressing some of the aforementioned issues. COAS is a recognized leader in the coupling of numerical models with data, especially in the coastal ocean. This research includes both atmosphere and ocean processes. COAS also is a national leader in global-scale models and satellite observations. A successful IOOS will forge strong links between global and regional observing systems, and models and data. In addition, PISCO has demonstrated the power of interdisciplinary approaches to couple biological and physical information, along with novel ways of combining monitoring with experimental research. All of these approaches are complementary and necessary for real understanding and progress.

Recommendation 26-4 emphasizes the necessity of incorporating user needs for an IOOS to be successful. One of the key attributes of the IOOS will be the provision of near real-time predictions and decision-support tools. Moreover, these observing systems will provide significant educational opportunities in both formal and informal settings. The report focuses

primarily on the processes to develop requirements and a management structure for the IOOS, but little is said about overall system architecture, which will have a significant impact on the ability to meet user needs. Oregon has the potential to contribute knowledge about the needs of users. For example, HMSC exemplifies the types of users and contributors that exist for an IOOS: scientists from several departments of OSU along with units of the Oregon Department of Fish and Wildlife, NOAA Fisheries, NOAA's Oceanic and Atmospheric Research Program, the Western Ecology Division of the Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the USDA's Agricultural Research Service. In addition, COAS has deployed several real-time observing system components, and could bring their expertise to bear on the development processes for the IOOS.

The USCOP report proposes focusing development of the IOOS by determining a core set of data products that are necessary. The Panel recognizes, though, that this exercise could result in a massive shopping list of variables with a high level of ambiguity. For example, sea-surface temperature (SST) would appear to be straightforward, but there are many ways to measure SST, and the appropriate method depends on the questions being asked. The Panel suggests that a more fruitful approach to the development of IOOS is to define a core set of services being delivered or questions being asked. From this standpoint, Oregon Sea Grant, HMSC, PISCO, and COAS collectively have a unique capability to develop a service-driven IOOS for the Pacific Northwest. Partnerships with systems in the Columbia River estuary (i.e., CORIE) and Washington could also be developed. Several components of the observing system are presently deployed by COAS, and these data are being assimilated into predictive numerical models.

The USCOP notes that satellite remote sensing provides critical observations for IOOS, but the Panel suggests that the present plans for IOOS need to be expanded to include satellite sensors as part of the observing suite. If this were the case, the NOAA Cooperative Institute for Oceanographic Satellite Studies (CIOSS) at OSU, which focuses specifically on the application of satellite remote sensing to a variety of research issues related to the California Current LME, could be an important contributor to the IOOS. This work includes the development of coastal ocean products as well as satellite data assimilation.

The development and transfer of sensor technology to the IOOS is the focus of Recommendation 26-7. The Panel supports the fundamentals of this recommendation, but highlights that transfer is not a serious challenge facing IOOS technology. Rather, the problem is that development of new technology is costly and risky. Sensors need many years of development and testing under harsh conditions. In the past, the Office of Naval Research (ONR) was the primary source of funds for technology development, but ONR's capacity in this regard has dropped precipitously. Advances in information technology have outstripped the ability of most ocean instrumentation companies to incorporate the latest data-handling capabilities. For this reason, ocean instrument development remains a capital-intensive activity with little mass-market potential. The potential exists to create new approaches to technology development and intellectual property in the context of Federal/university/private-sector partnerships. In Oregon, COAS has a long record of instrument and algorithm development for coastal ocean research. Recently, a local company, WET Labs in Philomath, announced a partnership with a Canadian firm to develop new sensor systems for IOOS. Oregon entities such as these could be productive partners in the future.

Recommendation 26-8 mandates that NASA pass responsibility for its research satellites to NOAA. With its operational mandate, NOAA is the logical home for the sustained, systematic observations of the Earth system, whereas NASA is the leader in the development of new remote sensing technology and the scientific exploitation of remote sensing. Nonetheless, the 2003 report by the NRC noted the difficulty in transitioning from research capacity to operational status. The report also highlighted the need for long-term planning and coordination to ensure that essential research capacity is maintained after transition, and that the operational agency (in this case, NOAA) is prepared technically and financially to assume these responsibilities. The Panel is concerned that NOAA does not have the capacity to take over the present and planned suite of NASA research satellites. Implementation of this recommendation will take many years of planning as well as leadership. Regarding the Oregon scientific community, OSU has been a leader in ocean remote sensing for two decades, and its faculty have served on several NASA science teams, in addition to acting as project scientists for NASA missions. The Oregon CIOSS could help enable the transition of short-term NASA research missions to a long-term observing capacity within NOAA.

Recommendations 26-9, 26-10, and 26-11 concern the implementation and management of IOOS and its relationship to global observations. As noted earlier, development and operation of the IOOS needs to be pursued on a regional basis with full consideration of the ranges of needs, from observations to science analysis to decision support. Development of the IOOS must begin with a clear, achievable set of goals, and slowly expand as new capabilities and new requirements emerge. Moreover, the regional IOOS systems must be cognizant of global-scale feedbacks and impacts. NOAA may assume the leadership of this process, but it must pursue these programs in the context of coalitions between Federal, state, and local agencies as well as universities.

Opportunities to use the IOOS address Oregon information needs and/or expand existing programs that have begun to address decision-making include:

- Oregon's tsunami warning and hazard evaluation system addresses information needs related to a type of natural hazard pertinent on this coast. This extensive system, comprising both monitoring and research capabilities to alert and expand understanding of tsunamis, is an important area for further study.
- In order to adequately address the USCOP recommendations to conserve and restore coastal habitat, open access to remote-sensing platforms is needed to provide high-resolution, hyperspectral spatial information about the extent, location, boundaries, and condition of coastal habitats for rapid incorporation into geographic information systems.
- As part of the creation of a national water quality monitoring network, Oregon is presented with an opportunity to build its information base about water quality in the marine environment. The National Eutrophication Survey (published by NOAA in 1999) revealed that relatively little is known about the dynamics of nutrient loading and nitrogen availability in Oregon estuaries in comparison with other coastal states. Baseline information is needed to gauge the current status of nutrient loading and eutrophication, and to evaluate future changes in nutrients, as these can serve as fundamental ecological indicators of habitat degradation or improvement. In addition, monitoring information about levels of bacterial contamination and other water-quality parameters is generally lacking for Oregon's estuaries and coastal waters, and

development of a comprehensive, coast-wide program to monitor water quality is still in its infancy.

PRIORITY 6: Expanded investments in scientific, technical, and human infrastructure are required to realize the aforementioned priorities.

The Panel recognizes that recommendations outlined in the USCOP report require a huge investment in human capital and infrastructure. If the Nation is to achieve the vision set forth by the USCOP, the number of technically trained people needed during the coming years to accomplish this vision is huge. Growth in human capital will be required in the areas of social science, economics, public policy, natural science, and engineering.

Regarding the scientific and technical infrastructure needs to implement the USCOP recommendations, Chapter 27 focuses on Enhancing Ocean Infrastructure and Technology Development. While much of this chapter highlights capacity building in the Federal agency infrastructure, the Panel suggests that more consideration be given to university infrastructure given its role as a full partner in the ocean enterprise. In addition, it is important to recognize that the demands will far exceed the ability to fund these needed investments, so some prioritization of needs will be essential. For example, some assets must be developed as complete units (e.g., ships and satellites), whereas others can be developed in a phased manner (e.g., observing systems or laboratory equipment). Careful attention must be paid to these different needs as the associated funding required is equally as diverse. The panel suggests avoiding the tendency to favor those pieces of infrastructure that can be funded as small increments rather than large components.

Recommendation 27-4 catalogs many of the infrastructure requirements, but misses two key elements. First, the vast amount of technical capacity depends on highly-trained technical staff. These people include information technology specialists, laboratory technicians, and seagoing technicians. In many cases, these skills are needed in the private sector, and universities and government agencies cannot match private-sector salaries. In other cases, there simply is a lack of replacement of technical staff, especially in the area of ocean instrumentation design, deployment, and recovery. These skills are acquired only after years of experience. The development of an IOOS will require a larger cadre of seagoing instrument technicians, as well as project managers to design and implement the regional observing systems. The second overlooked area is the increasing demand for medical-grade laboratory facilities such as ultra-clean rooms for geochemical analyses and genomics. The costs of such labs are nearly an order of magnitude higher than the traditional labs, and funding such facilities is beyond the capacity of most academic institutions.

Surface ships are briefly discussed, but there are no specific recommendations regarding how their replacements will funded. The demands of an IOOS on ship, ROV, and AUV capacity are not evaluated, and it is likely that the Nation does not have enough available seagoing capacity to deploy and maintain an IOOS. Specific to Oregon, the research vessel *R/V Wecoma* is fast approaching the end of its life. The ocean-science community has established science-mission requirements for the "Oceans" class of ships (of which the *Wecoma* is one), and the costs to

bring ships to the level of meeting these requirements are in the range of $65-75M. No funding mechanism, however, has been identified for these improvements. COAS also has been exploring the capabilities of AUVs and their role in seafloor observatories. AUVs could play a critical role in an IOOS, but there is no established program to fund such infrastructure, which is in the range of $10M.

Additionally, in order to implement the ocean observing systems, the USCOP has identified many important issues in regards to ocean data and information systems: increasingly complex and more varied data sets, enormous data volumes, increasingly distributed data sources and archives, and rapidly evolving hardware and software capabilities (see Chapter 28). The Panel notes that the information technology (IT) challenge will be to support the search for new relationships between data sets and to deliver information services to a wide range of users. This delivery need is especially true in the light of the shift from centralized, mainframe computers driven by the needs of the science and technology community to a distributed computer system driven by commercial needs and mass-market forces. Ocean.IT proposed by Recommendation 28-1 should address the needs of the larger community, in addition to acknowledging the information management already underway through exiting data centers. It also will need to be responsive to the evolution of both user needs and IT capabilities. This charge will be particularly challenging because most government-acquired systems have not been successful in addressing these varied needs, primarily due to procurement policies and requirement processes. Recommendation 28-2 for NOAA and the Navy to collaborate on the delivery of standard data products will be useful, but will also run into similar difficulties because both the products and user requirements will evolve over time.

OSU may be able to assist with the Ocean.IT process, serving as both a model and participant. COAS is one of the Nation's leaders in the development and application of innovative IT to a range of oceanographic and atmospheric science problems. This work includes smart sensors to for nearshore and coastal observations, Geographic Information Systems (GIS), data assimilation models for ocean/atmosphere prediction (including ocean ecosystems), networked software applications, and high-definition data visualization. COAS researchers have been at the forefront of advising NASA, NSF, and other Federal agencies on these issues. This interdisciplinary approach stresses the connections between the components of the Earth system, as well as an understanding of linkages between ecosystems and the physical environment. In addition, COAS is responsible for a broad range of ocean data products, including those based on satellite sensors, coastal radars, and coastal video cameras. OSU also has an active program of IT development, especially in the area of low-cost, off-the-shelf technology. Its fundamental IT architecture is based on a highly-distributed approach, using state-of-the-art networking technology to link together a wide variety of IT assets. The basic principle is to retain a close connection between the science requirements and expertise with the IT implementation. The involvement of COAS faculty would place data production in close proximity to data developers, thus helping ensure that the products are based on the Best Available Science and Information, a USCOP Guiding Principle.

The notion of central data repositories with standard data products has shifted in response to changes in network capacity and local storage technologies. Central archives such as the National Oceanographic Data Center (NODC) have struggled with the increasing volume and

variety of oceanographic data. Moreover, NRC's Committee on Data Management and Computation reports from the early 1980s emphasized the importance of maintaining close links between active scientific investigations and data archives in order to ensure that data remained relevant to contemporary science. These forces have resulted in a more distributed approach to data management. Investigators are making data sets available over the Internet through Web-based interfaces to local data holdings. However, it is difficult to locate such data holdings without personal contacts to the investigator. Technologies, such as OpenDAP (Open Data Access Protocol) which is noted in Recommendation 28-3, have provided standardized methods to publish and to access such local data holdings as well as centralized data archives. New methods, such as XML (Extensible Markup Language) and data ontologies will provide more capabilities for researchers to organize and publish their data holdings and for locating and accessing data. Moreover, these approaches will enable data providers to be far more responsive to changing user needs. Although the USCOP recognizes the need to start this process, Recommendations 28-3 and 28-6 fundamentally envision a centralized process where the needs and requirements can be specified with complete certainty. The Panel suggests, however, that the reality is that modern IT systems must be designed for an uncertain world, and must be dynamic and iterative.

Regarding programs already underway in Oregon relevant to these recommendations, COAS has been one of the lead developers in collaboration with researchers at the University of Rhode Island on the OpenDAP protocol. Moreover, COAS has developed more widespread technologies based on Microsoft's .NET framework to provide a variety of Web services for satellite data archives. The most complex knowledge systems, ranging from climate-change research to homeland security, cross traditional disciplinary boundaries. They require synthesis of information from many sources, and they must adapt in response to a changing environment (including changes in the knowledge environment). In keeping with the Guiding Principles of Best Available Science and Adaptive Management, COAS has based its IT infrastructure on a distributed implementation. Moreover, new methods of extracting information from new and evolving data sets are being explored with Oregon-based software developers. This is an area where Oregon could establish national leadership in developing linkages between observing systems, knowledge extraction, and decision support.

Recommendation 28-4 proposes that Federally-funded researchers be required to submit their data sets to centralized archives. The intent of the USCOP is correct, but the Panel notes that the approach is likely not sufficient. Frequently, the Federal archives are not prepared to host and distribute new data sets being developed by the research community. Many data sets are distributed locally by the individual researcher without going to a national archive. Again, the recommendation from the USCOP is based on a centralized approach to data/information systems. The Panel highlights that Oregon researchers have a long history of interdisciplinary research across a broad range of fields, and realize that sharing data, information, and knowledge is essential for science to be successful.

SECTION III – Comparison of the 2000 *Oregon State of the Environment Report* and USCOP Recommendations

Oregon State of the Environment Report	US Commission on Ocean Policy Preliminary Report
MARINE ECOSYSTEM INDICATORS:	
Exploited Fish and Shellfish Stocks	• *Recommendation 19-21. Change designation of essential fish habitat to multi-species ecosystem-based approach*
Bottom Habitat Degradation	• Recommendation 11-2. Develop national goals for ocean and coastal habitat conservation and restoration efforts
Marine Mammals	• *Recommendation 20-2. Amend the Marine Mammal Protection Act to place jurisdiction for marine mammals within NOAA* • *Recommendation 20-4. Clearly specify categories of permitted activities that affect marine mammals* • *Recommendation 20-7. Promote expanded research, technology, and engineering program to examine and mitigate human activities on marine mammals and endangered species*
Kelp Forests	• *Recommendation 11-2. Develop national goals for ocean and coastal habitat conservation and restoration efforts*
Marine Protected Areas	• *Recommendation 6-3. Develop national goals and guidelines for the effective design and implementation of marine protected areas*
Harmful Algal Blooms and Toxic Shellfish	• *Recommendation 23-1. Expand marine research programs for virology and microbiology* • *Recommendation 23-4. Establish a national multi-agency Oceans and Human Health Initiative*
Shoreline Armoring and Beach Loss	• *Recommendation 10-1. Ensure valid, peer-reviewed cost-benefit analyses of coastal projects to mitigate impacts and coordinate with broader coastal planning efforts* • *Recommendation 10-3. Reduce incentives for development in high-hazard areas* • *Recommendation 12-1. Develop national strategy to address activities that affect sediment flows* • *Recommendation 12-4. Improve assessment, monitoring, research, and technology to enhance sediment management, and study the cumulative regional impacts of sediment management practices on coastal watersheds and ecosystems*

ESTUARINE ECOSYSTEM INDICATORS:	
Change in Area of Estuarine Habitats a. overall estuary size b. tidal marshes and swamps c. eelgrass beds	• Recommendation 11-2. Develop national goals for ocean and coastal habitat conservation and restoration efforts
Area of Estuarine Habitats Protected	• *Recommendation 11-1. Dedicated coastal and estuarine land conservation program*
Aquatic Nuisance Species	• *Recommendation 17-1. Apply uniform national standards for ballast water management* • *Recommendation 17-3. Coordinate public education and outreach efforts on aquatic invasive species* • *Recommendation 17-4. Establish a national plan for early detection of invasive species*
Freshwater Inflow	• *Recommendation 15-2. Ensure that the national water quality monitoring network includes adequate coverage in coastal areas and uplands*
Estuarine Water Quality Trends	• *Recommendation 14-1. Advanced nutrient removal for wastewater treatment plant discharges* • *Recommendation 14-2. Increase technical and financial assistance to improve septic systems and on-site treatment facilities* • *Recommendation 14-3. Fund research on removal of nutrients from animal wastes* • *Recommendation 14-6. Modernize the NPDES information system and strengthen enforcement* • *Recommendation 15-1. Develop a national water quality monitoring network of critical stations and measurements needed to assess long-term water quality trends and conditions* • *Recommendation 15-2. Ensure that the national water quality monitoring network includes adequate coverage in coastal areas and uplands*