



OREGON OCEAN SCIENCE TRUST SUMMIT REPORT

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MAY 11–12, 2016
NEWPORT, OREGON

Executive Summary

The Oregon Ocean Science Trust convened 45 ocean experts and agency decision makers in Newport, Oregon May 11–12, 2016 to identify priority research and monitoring funding needs for Oregon’s nearshore (territorial sea) area, scalable to budget resources available, that will provide baseline and trend data and inform key research questions related to changing ocean conditions as a result of climate change, shifts in marine habitat, and changes in marine fish and wildlife populations. In addition, the group identified topics that can provide peer-reviewed science that will be of utility for state and federal agencies that have management responsibilities in the nearshore.

Representatives from the Oregon Department of Fish and Wildlife, Oregon State University, and Oregon Sea Grant presented a synthesis of key Oregon nearshore research and monitoring needs, then summit participants articulated and prioritized nearshore research and monitoring needs in four categories relating to (1) the distribution and abundance of nearshore species and habitats, (2) species and habitat associations and interactions, (3) the effects people have on nearshore resources and the effects of nearshore resources on people and coastal communities, and (4) the effects of climate change and ocean acidification on species and their habitats and ecological function.

Summit participants developed research questions to address priorities, focusing primarily on baseline information associated with nearshore species and habitats as well as key threats and stressors to the nearshore ecosystem, e.g., climate change effects, harmful algal blooms, coastal pollution, and ocean acidification, and how ecosystem function is affected by these threats and stressors.

Participants proposed two different approaches to nearshore monitoring. One approach would identify priorities and suggested priorities included measuring ocean variability (La Nina and El Nino, HABs, hypoxia events, etc.) using gliders to provide the basic data and the context for any other research projects and management decisions, followed by secondary priorities to build and instrument shore-based stations that have ocean water intakes, and tertiary priorities to characterize the ocean by repeating the Newport Hydrographic line on southern coast (an area that is currently not monitored). The second approach would measure physical, chemical, biological, and human parameters including both fishery-dependent and fishery-independent sampling, other types of uses (e.g., recreation), and recruitment and ocean variability. With either approach socio-economic changes and impacts could and should be measured as part of the monitoring work.

The summit concluded with a discussion of the core elements of a comprehensive research and monitoring program focused on biodiversity, harmful algal blooms, and vulnerability/resilience, and based on three possible scenarios for biennial funding: (1) less than \$1 million; (2) \$1–3 million; and (3) \$3–5 million. Elements of nearshore research and monitoring program funded at less than \$1 million per biennium, would be modest. Elements include base-level monitoring of physical parameters to determine oceanographic variability and vulnerability to ocean acidification and hypoxia at coastal nodes, recruitment monitoring for species such as mussel, crab and fishes seasonal vessel-based abundance and distribution monitoring of rocky reef species at selected sites, coast-wide socioeconomic monitoring, and data management, integration and synthesis. If \$1–3 million were available per biennium, investigators would build on the previously described effort, adding more sites to the vessel-based surveys of rocky reef species for distribution and abundance information, conducting a benthic habitat inventory, expanding coastal monitoring nodes, conducting ship-based territorial sea sampling of biological, physical and chemical parameters, and conducting small-boat monitoring activities as well as species-level ocean acidification vulnerability

research, predictive modeling of climate change vulnerability/ocean acidification impacts, coupled with activities focused on data integration and synthesis following a model similar to that of the National Center for Ecological Analysis and Synthesis. For \$3–5 million per biennium, investigators would build on the previously described work and expand monitoring of rocky reef species to obtain population assessments, launch a glider below Coos Bay, conduct expanded benthic habitat inventories, sample for pollutants, and enhance data integration and synthesis.

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OREGON OCEAN SCIENCE TRUST SUMMIT

May 11-12, 2016 Newport, Oregon

I. WELCOME AND INTRODUCTIONS

Louise Solliday, Chair of the Ocean Science Trust, welcomed everyone (a total of 46 people attended the summit – See Appendix A), emphasizing the importance of the summit to identify priority research and monitoring funding needs for Oregon’s nearshore (territorial sea) area, scalable to budget resources available, that will provide baseline and trend data and inform key research questions related to changing ocean conditions as a result of climate change, shifts in marine habitat, and changes in marine fish and wildlife populations as well as provide peer-reviewed science for state and federal agencies that have management responsibilities in the nearshore.

Gabriela Goldfarb from the Oregon Governor’s office emphasized the importance of informing near-term ocean management decisions. She described the recommendation of the Ocean Task Force on Nearshore Research as a key driver in the creation of the Ocean Science Trust, acknowledging the presence of two legislators at the summit as a signal of the importance of the summit. Goldfarb described the pressing issues facing Oregon’s nearshore and the need for both human dimensions and natural sciences to inform management decisions.

II. KEY OREGON NEARSHORE RESEARCH AND MONITORING NEEDS

Current nearshore research and monitoring needs were presented by representatives from the Oregon Department of Fish and Wildlife, Oregon State University, and Oregon Sea Grant.

Caren Braby, Oregon Department of Fish and Wildlife Marine Resources Program Manager, characterized the difficulty of sampling in Oregon’s nearshore, but noted the importance of the nearshore to Oregon’s sport and commercial fisheries (e.g., Dungeness crab fishery is largely centered in the nearshore). Insufficient staffing, resources, and solutions drive the need to work with many partners and in numerous management venues. Federal partners rely on Oregon entities to be experts on species that exist in the nearshore, thus it is important to have an actionable strategy to make strategic investments in nearshore research and monitoring. ODFW has developed the Oregon Nearshore Strategy (as part of the Oregon Conservation Strategy) as a State Wildlife Action Plan (SWAP) completed in cooperation with the US Fish and Wildlife Service. The Oregon Nearshore Strategy is not a strategic plan – it’s a statement of what is important and what collaboration opportunities exist to help frame nearshore issues, and it includes education and outreach, research and monitoring, and management and policy strategies – the purpose of the summit is to focus on research and monitoring. The nearshore strategy has been used in policy discussions (e.g., renewable energy siting), and the completed plan ensures that ODFW is eligible to receive federal support to implement the plan.

Francis, Chan, Associate Professor, Senior Research, Department of Integrative Biology at Oregon State University, discussed his role as co-chair of the West Coast Ocean Acidification and Hypoxia Science Panel, which was convened by the California Ocean Science Trust. The panel, which consisted of 20

scientists, was charged with advancing understanding of and developing options for addressing ocean acidification. They formulated 14 actions that could be accomplished within the next two years. The goals of the panel were to make science accessible to everyone and create an achievable road map that has impact. It was noted that the scale of what is available to use is mismatched to the information available. Monitoring should:

- Be relevant to management, and scientists should work collaboratively to identify gaps.
- Be question driven – what will it inform?
- Include ecosystem monitoring – simply monitoring the chemistry or fish populations alone is insufficient.
- Build from what currently exists.
- Recognize that it's about the people that interpret the data.

Relative to research priorities:

- The numbers and effectiveness of solutions are proportional to existing knowledge.
- Current funding is unlikely to provide the resources necessary to implement priorities. There is a disconnect between data/information we are generating and what data/information we need to manage.
- The focus is on developing models – we want to be able to evaluate effectiveness. Models have to be validated.
- Research priorities should address exposure, vulnerability, and adaptive capacity.
- The effectiveness of mitigation approaches should be evaluated.

The panel report was released in April of 2016, and outreach has occurred with decision makers, Ocean Policy Advisory Council (OPAC), National Oceanic and Atmospheric (NOAA) administrators (regionally and in DC), and the Environmental Protection Agency (EPA).

Of the 14 action items proposed by the panel in April of 2016, seven are currently being acted upon (e.g., revision of water quality criteria – a bill in California has been introduced to revise water quality criteria). Chan emphasized the importance of prioritizing opportunities and where disproportionate positive impact are projected.

Shelby Walker, Oregon Sea Grant Director, discussed the four new thematic areas established by Oregon Sea Grant's Strategic Plan:

- Ecological, social, and economic aspects of coastal development
- Adaptation to acute or chronic coastal hazards
- Human and natural dimensions of coastal and marine fisheries
- Cultural beliefs, learning, and valuation of coastal and marine issues

She noted the importance of considering cumulative, synergistic effects versus a single discipline focus, integrating the natural and social sciences, and bringing together tools and models as part of a comprehensive synthesis of information. Walker described the balance of long-term investments with short-term flexibility to address emerging ocean issues, and noted the National Science Foundation is investing in a 25-year ocean observing initiative. There is a scale mismatch that exists – we know something about so few places in the nearshore to assess vulnerability. She also emphasized the importance of partnerships.

III. TOP PRIORITIES FOR OREGON'S NEARSHORE RESEARCH AND MONITORING

Summit attendees were asked to convene in three breakout groups to describe Oregon's top nearshore research and monitoring priorities in four categories, characterizing the research priorities as questions:

- I. Distribution and abundance of nearshore species and habitats.
- II. Species and habitat associations and interactions that exist in the nearshore to inform ocean health (ecosystem function).
- III. The effects people have on nearshore resources and the effects of nearshore resources on people and coastal communities.
- IV. The effects of climate change and ocean acidification on species and their habitats and how these key stressors will influence ecological function and species in nearshore habitats in the future.

A. RESEARCH

The compilation of the breakout groups' questions are grouped within each of the four categories:

I. DISTRIBUTION AND ABUNDANCE OF NEARSHORE SPECIES AND HABITATS

How do the geomorphology, oceanography, species present (including key priority focal species), and physical and biological habitats vary within the Oregon's nearshore zone?

- **Methodologies/technologies**
 - What are non-traditional user-informed methods as well as best survey methodologies/new technologies of collecting information on distribution and abundance of nearshore species and habitats (e.g., age structure and life history)?
 - How do we map all habitats, and what are the best methods? How do we understand the variability? What are the key gaps? How do we map the inner shelf?
 - How can we combine research and monitoring efforts to analyze multiple phenomena simultaneously?
 - How can we use species to help describe habitats?
 - Are there key surrogates or proxies?
- **Habitat shifts**
 - Are benthic/pelagic habitats and species shifting (e.g., geospatially) (compared to historical patterns), will they shift over time and how (e.g., variability), and how does this knowledge relate to economics, business, culture and policy decisions?
- **Data**
 - How can we use fishery-dependent data to improve our research and monitoring efforts?
 - What is the distribution and abundance of ecologically and economically important species in Oregon's nearshore ocean and how are these changing over time?
 - Which species and habitats can act as indicators of the status of ecological services, changing conditions or other factors?
 - What are important characteristics (or parameters) that describes benthic and pelagic habitat and how do they vary in time and space?

II. SPECIES AND HABITAT ASSOCIATIONS AND INTERACTIONS THAT EXIST IN THE NEARSHORE TO INFORM OCEAN HEALTH (ECOSYSTEM FUNCTION)

- **Harmful Algal Blooms (HABs)**
 - What ocean conditions and their drivers lead to formation of HABs, and where and when are areas most susceptible to HABs (e.g., off shore vs. shoreside impacts)?
 - What environmental conditions lead to the production of marine biotoxins by HABs in Oregon waters?
 - How do we communicate with people about HABs?

- **Food web relationships**
 - What is the relationship among ocean conditions and fishing behavior on forage fish abundance?
 - What are the impacts and changes in forage fish/prey species abundance?
 - How does the species-specific food chain influence production?
 - What are the roles of copepods, kelp, larval plankton, top level predators (marine birds), juvenile fish, forage fish, and other species in specific habitats, and how do management actions affect these interactions?

- **Recruitment**
 - What causes variability in recruitment and does it correlate to marine organism abundance?

- **Habitats**
 - What are the habitat characteristics/features that correlate to/index with fish stocks?
 - What are the habitat types (oceanic, atmospheric, physical) that exist in the nearshore, and where are they physically located?
 - What are the connections among habitats, and what are the indicator species (and their competition/interactions) that will help identify the connections and inform management?
 - What are the important, sensitive or unique species and habitats within the nearshore, from an ecological and economic perspective, and do we understand ecological succession to assess the effects of individual species over time?
 - What are the drivers (habitats, physical processes < abundance of food) for species distribution and abundance?
 - What specific habitats are limiting?

- **Species-habitat associations/interactions (including people)**
 - What is the strength and persistence of species-habitat association in time and space?
 - What are the primary drivers of shifts in species-habitat associations and interactions?

- **Ecosystem Function**
 - What aspects of ecosystem functions are most important?
 - What aspects of food web nodes, including forage fish and other key species, are most critical to monitor?
 - How do invasive species affect the ecological function of the nearshore?

III. THE EFFECTS PEOPLE HAVE ON NEARSHORE RESOURCES AND THE EFFECTS OF NEARSHORE RESOURCES ON PEOPLE AND COASTAL COMMUNITIES

- **People**
 - How do people relate to protected areas and the ocean generally, and do changes in ocean understanding and knowledge change policy and individual behavior?
 - What are the demographic and/or behavioral changes we can anticipate in Oregon, and how do these changes influence how people value and impact ocean resources, changes in coastal pollution/contaminants (e.g., shifting coastal uses)?
 - What are the effects of human development on nearshore resources and uses?
 - What other factors affect people on the coast?

- **Pollution**
 - Are there places on the Oregon Coast where estuarine inputs influence ocean chemistry greater than ocean upwelling (e.g., ocean acidification), where anthropogenic input outweighs natural offshore changes?
 - What are cumulative impacts of non-industrial, non-point source pollution in the nearshore/mouth of estuary?
 - What are the impacts of land use on water quality in the nearshore and potential synergistic effects with climate change?
 - What is the spatial distribution of pollution inputs on the Oregon coast and of contaminant accumulation in marine organisms?

- **Fisheries**
 - What are the effects of fisheries and fisheries management on coastal communities?
 - How does fishing pressure affect marine populations?
 - What are the effects of perceived or real conflicts in fisheries management strategies on the fishery resource?

- **Ecosystem Services**
 - What is the temporal and spatial value and distribution of ecosystem services and benefits that are derived from the ocean and how do benefits change with changing climate, demographics, technology and institutions?
 - What are the existing or “baseline” values of ecosystem services and how can we utilize ecological and bio-economic modelling to assess tradeoffs, planning and adaptation?

- **Climate change**
 - How will climate change impact the amount, timing, and location of contaminants entering the ocean? How do these changes relate to threshold impacts? How do perceptions of mitigation strategies influence strategy acceptance?
 - How will climate change affect demographics of people in Oregon? Will the demographic changes lead to inequities for certain human groups/communities?

IV. THE EFFECTS OF CLIMATE CHANGE AND OCEAN ACIDIFICATION ON SPECIES AND THEIR HABITATS AND HOW THESE KEY STRESSORS WILL INFLUENCE ECOLOGICAL FUNCTION AND SPECIES IN NEARSHORE HABITATS IN THE FUTURE.

What and where are the primary manifestations of climate change expected on the Oregon Coast?

- **Climate Change Impacts**
 - What are the synergistic impacts on organisms and habitats of the key manifestations of climate change?
 - What are the detectable cultural changes that are manifesting in our communities as a result of climate change?
 - What is the correct spatial and temporal scale to monitor changes?
 - What are projections for climate change variability/ocean acidification (CCV/OA) for Oregon's nearshore?
 - Are there places that are more/less vulnerable to CCV/OA?
 - How are species affected by CCV/OA, and which species are most vulnerable? What are the sentinel species to indicate CCV/OA effects?
 - What are economic, cultural, and political impacts of CCV/OA?
 - Can we mitigate for or adapt to the direct and indirect impacts of harmful CCV/OA?
 - How can we use collaborative research and citizen science to gather climate change data?

- **Ecological Function**
 - What is the most impactful research to understand ecological function in Oregon territorial waters?
 - What are the key indicators for specific habitats?

B. MONITORING

Breakout session participants discussed what, where, and how to monitor Oregon's nearshore to inform key management decisions and to provide a report on the state of Oregon's nearshore periodically. There was discussion about considering major events in which managers needed data and information, but that information may have been missing. Examples of such events include hypoxia, domoic acid and crabs, in-season closure of nearshore fisheries, oyster production and ocean acidification, ocean energy permitting, poor salmon returns, hypoxia events, marine reserve siting, groundfish collapse, RCA closures, harmful algal blooms and seabird die-offs, clam closures.

New monitoring could focus on low hanging fruit and build on existing data sets. It was noted that any new monitoring should fully integrate with Integrated Observing Systems, and that a key first step may be to compile and organize a catalog of existing datasets to identify data gaps as well as existing resources (e.g., the National Marine Fisheries Service California Current report could provide examples of potential indicators; tribal sovereign nation members may collaborate on historical and future use of specific sites).

To address **what is measured**, two approaches were offered:

- A.** One approach would be to identify high priorities and some potential priorities included measurements that inform our understanding of ocean variability (e.g., La Nina and El Nino, HABs, hypoxia events, etc.) to provide the basic data and the context for any other research projects and management decisions. Such an approach would be most effective if the monitoring complements existing ocean observing systems. Physical parameters (temperature, salinity, conductivity, DO, pCO₂, velocity) would be collected at 6–7 sites using gliders. The second priority for this approach would be to build and instrument shore-based stations that have ocean water intakes and/or establish secure monitoring stations on jetties, docks or piers. The third priority for this approach would be to characterize the ocean by repeatedly conducting a nearshore oceanographic cruise (i.e. similar to Newport Hydrographic Line) on the southern coast (in an area that is currently not monitored).
- B.** The second approach (shore-based stations) would involve monitoring a suite of physical, chemical, biological, and human parameters including many of those mentioned in A, above. The number of parameters and spatial/temporal extent of the measurements would be scaled to the funding level and should be closely coordinated with existing monitoring programs. The following parameters were considered high priority:
- Physical and chemical parameters (EOV's)
 - Temperature, salinity, ocean nutrient distributions (nitrates, etc.), dissolved oxygen, pCO₂, velocity, pH, alkalinity, chlorophyll fluorescence, light, emerging contaminants (see research priorities), conductivity
 - Biological Parameters (Biological EOV's)
 - Key indicator species at multiple trophic levels (plankton, fish, seabirds, marine mammals, etc.) – need a selection process to identify these or select an existing indicator framework; include recruitment, HABs, essential biodiversity variables
 - Assessing and monitoring population abundance of nearshore fishery species, especially rocky reef species, including detailed habitat mapping. This will require fishery-independent sampling to directly measure fish abundance and fishery-dependent sampling to monitor changes in fish population parameters (such as population age structure).
 - Recruitment variability
 - HABs
 - Human Parameters
 - Spatial and temporal use patterns, land use, cultural and historical value, economic contribution to coastal communities, attitudes/perceptions WRT the ocean, Surfrider Foundation, Oregon Parks and Recreation Department, counties
 - Demographic data
- Effort shift in fisheries behavior as well as physical and chemical factors

To address **where measurements** occur, participants proposed the following considerations:

- A structured approach based on an initial list of monitoring sites to be reduced and refined based on Year 1 data
- Each biogeographic region along the Oregon coast, or a periodic (i.e. annual) border to border oceanographic cruise to characterize spatial differences in nearshore oceanographic conditions
- Map of Oregon coast (Appendix B) showing 4 representative areas along the coast within which to focus ship surveys, 6 representative sites for coastal nodes and existing and potential new glider lines
- Within each focus area, potential area for monitoring would extend from the intertidal to beyond the Territorial Sea (e.g., out to about 80 meters)
- Outer Continental Shelf
- Political boundaries, counties, population centers as they relate to the map in Appendix B
- Sampling can be coordinated with existing monitoring programs in marine reserves (4 out of 5 of Oregon's marine reserves exist within the areas shown on the map)

Participants address **how often we measure**, noting it depends on the variable being measured, and discussing the need to independently gather physical, chemical, biological and human dimensions data in the winter. Ideally, sampling for the monitoring program should occur quarterly, but at a minimum, sampling should cover summer and winter seasons.

Participants discussed ways to **report results**. Participants proposed the Ocean Science Trust convene a two-day workshop with scientific investigators to build information products (conceptual). Workshop agenda could include the following topics:

- Assess data gaps and data sharing challenges to inform information sharing of long-term datasets and data collection and tool development (data portal);
- Identify priority needs to maintain operations for data set collection that inform the status of the state of the Oregon coast and thus are capable of informing management decisions. (e.g., NH Line)
- Review and consider using the NMFS California Current Integrated Ecosystem Assessment (IEA) report (<http://www.noaa.gov/ica/CCIEA-Report/pdf/index.html>), Puget Sound Partnership Vital Sign Indicators, CaCOFI (<http://calcofi.org/ccpublications/ccreports/calcofi-reports-toc/276-crtoc-vol-55-2014.html>), and Baja to Bering as potential frameworks
- Identify a manager for State of the Coast datasets
- Possible data catalog system, environmental report card
- Social vulnerability and resilience analyses
- Identify key data gaps

Participants noted that for less than \$1 million per biennium, the state would receive a snapshot of information, with some spatial distribution and seasonal variability. For \$1-3 million, the state would receive an enhanced snapshot with more sampling that could include demographic and economic changes. And for \$3–5 million, more data layers could be added, e.g., habitat, genetic, species, age-structure variability, and that longer-term sampling could be achieved.

C. A COMPREHENSIVE RESEARCH AND MONITORING PROGRAM FOR OREGON'S NEARSHORE

A comprehensive research and monitoring project design that included three themes (Biodiversity, HABs, Vulnerability/Resilience) was proposed:

Elements of **Emerging Technologies, Methods, and Innovation:** Imaging tech, DNA analysis, fisheries-independent methods, recruitment, and pollutants.

Pollution & CCV/OA—What are human impacts on nearshore environment, especially pollution-related impacts?

- Distribution of existing and emerging pollutants (pilot studies)
 - Synergistic and cumulative impacts of pollutants on key species (e.g., keystone species, commercially important species, humans)

The following integrated research and monitoring program reflecting three levels of funding for the comprehensive program was proposed. The funding levels are additive in that each successive funding level includes its list of activities plus funding activities of the previous level.

§<1 MILLION PER BIENNIUM

Monitoring: (See Appendix A as a reference)

- \$50-100K per coastal monitoring node (one site) (pH/alkalinity, salinity, temp., etc.)
- \$20K per site for recruitment monitoring (Crab, mussels, fishes, etc.)
- \$100K per site per season for vessel-based fishery-dependent abundance and distribution monitoring of rocky reef species (reference site(s)/expandable)
- \$100K for coast-wide socioeconomic monitoring

Research:

- \$50K socioeconomic study
- \$100K Data management
- Data integration and synthesis

§1–3 MILLION PER BIENNIUM

Monitoring:

- \$200K per year for vessel-based abundance and distribution monitoring of rocky reef species (expand to 3 sites)
- \$300K per year for benthic habitat inventory (locations TBD)
- \$300K per coastal monitoring node (Expand to six sites)
- \$100K per year (two sites, two surveys/year) for ship-based territorial sea sampling of biological parameters
- \$100K per year (two sites, two surveys/year) for ship-based territorial sea sampling of physical and chemical parameters
- \$100K for small boat for monitoring activities (\$2-4K per day and 20 days min. a year)
- Limited availability of state-funded research vessel research (then \$25K/day)

Research:

- \$100K per year for species-level OA vulnerability research
- \$50-100K per year predictive modeling of CCV/OA impacts
- \$250K for “lite” National Center for Ecological Analysis and Synthesis (NCEAS)-style data integration and synthesis (GIS)

\$3-5 MILLION PER BIENNIUM

Monitoring:

- \$200–500K per year for vessel-based abundance and distribution monitoring of rocky reef species (expand to 5 sites or coast-wide at upper budget level) – population assessment of rocky reef species
- \$150K for glider line off Cape Blanco (no current gliding below Coos Bay)
- \$300K per year for benthic habitat inventory (locations TBD)
- \$300–\$500/sample for pollutant monitoring

Research:

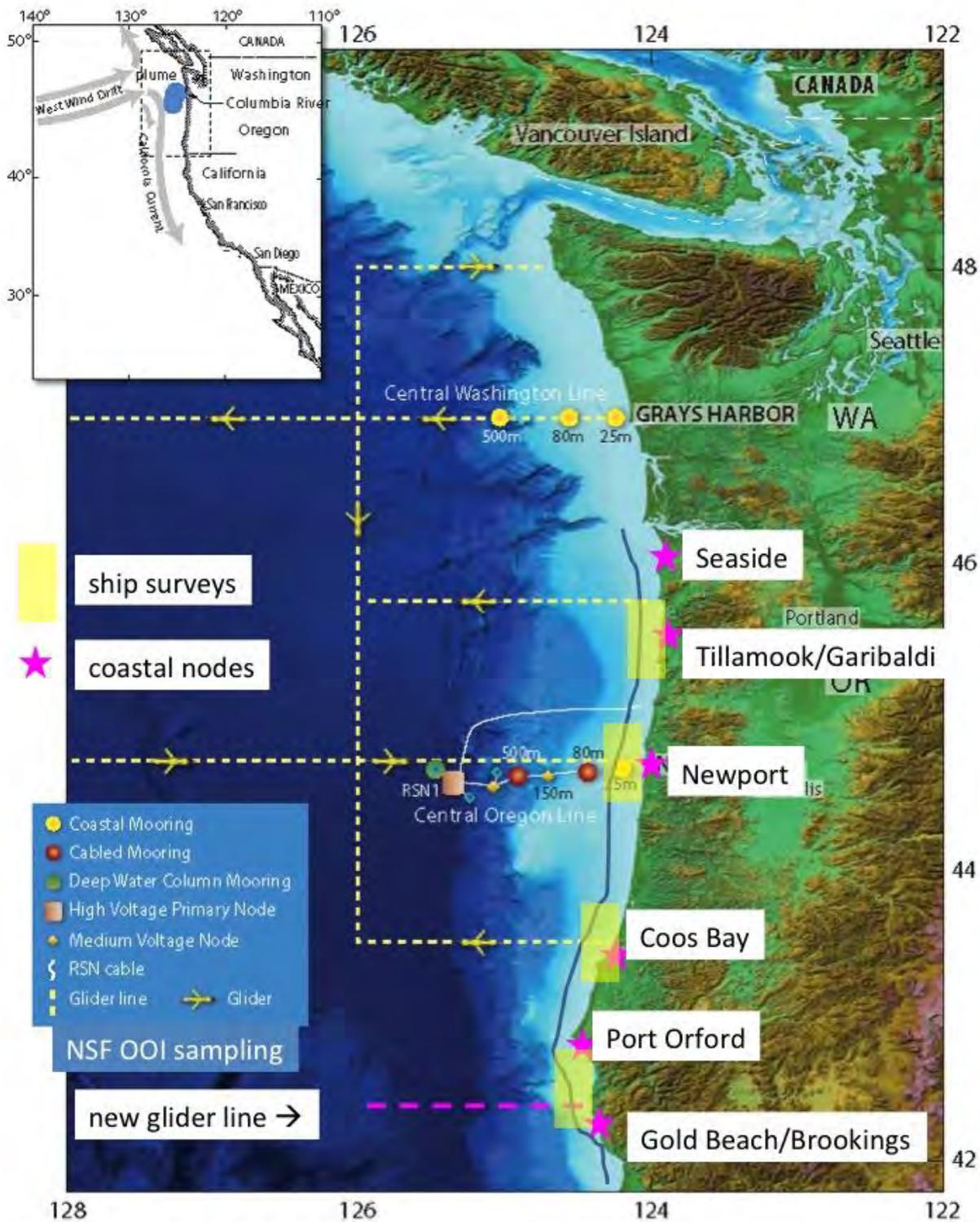
- \$250K per year NCEAS-style data integration and synthesis
- Develop bio-economic and ecosystem-values models to support development of nearshore resource management solutions.

APPENDIX A. SUMMIT ATTENDEES.

Laura	Anderson	Member	OST	laura@localocean.net
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APPENDIX B. POTENTIAL REPRESENTATIVE SITES FOR MONITORING OREGON'S NEARSHORE.



Existing Trinidad Head (41° 3.5'N) glider (NANOOS/CeNCOOS/NOAA)