

Olympic Coast National Marine Sanctuary's Advisory Council  
Science Working Group  
Final Report  
August 26, 2014

**Science Working Group Members**

Rebecca Post (co-chair) – SAC Washington Department of Ecology  
Lee Whitford (co-chair) – SAC Education alternate  
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Greg Williams – Northwest Fisheries Science Center  
Ed Bowlby – OCNMS Research Coordinator  
Liam Antrim (Staff Lead) OCNMS Resource Protection Specialist  
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**Recommendations and Actions**

1. Tom Mumford and Liam Antrim, with the assistance of Greg Williams and Katrina Lassiter, will track the progress of ecosystem indicators development for the Pacific Coast under the state's Marine Spatial Process (MSP), and to the extent feasible, provide input during this process to optimize applicability to sanctuary waters. Periodic updates should be provided to the OCNMS Advisory Council.
2. When the state's report on ecosystem indicators is finalized, OCNMS will evaluate their relevance for the sanctuary, identify other habitat types or concerns relevant to the sanctuary that are not addressed by the state's effort, and consider additional indicators, as necessary.
3. Because condition reports are the tool used by the Office of National Marine Sanctuaries to evaluate and report on ecosystem health, the Science Working Group decided to focus its efforts on defining indicators, metrics, and information or data types and data sources relevant for each of the condition report topic areas. A matrix linking indicators with specific condition report topics was generated. This matrix can be considered a working document that can be updated at any time new information and insight is available.
4. The Science Working Group recommended that they disband at this time, primarily because no tasks have been identified for the near future.
5. Individuals with relevant expertise will be contacted to assist with the updating of OCNMS' science needs documents.

## **Purpose**

The purpose of the Science Working Group (SWG) as identified in the group's Charter is to focus on two related issues:

1. Provide recommendations on OCNMS ecosystem health indicators, including indicator species to support evaluation outlined in the next generation sanctuary Condition Report
2. Provide recommendations for establishing OCNMS as a sentinel site in support of long-term monitoring for climate change and other purposes

These purposes were fused into a Mission Statement from the SWG's Charter: The Science Working Group will evaluate potential indicator species for ecosystem assessment and indicator parameters for climate change for the outer Washington coast, with a goal of developing recommendations for monitoring programs in OCNMS.

## **Background**

The SWG was identified as a priority in the Advisory Council's 2013 work plan and was established at the September 20, 2013 meeting to address strategies and activities in the OCNMS 2011 management plan.

- Strategy ECO9: Ecosystem Processes, Activity A: Evaluate indicator species identified by and currently used by OCNMS (e.g. in condition reports) and regional co-managers (e.g., monitoring).
- Strategy CLIM2: Sanctuary as Sentinel Site, Activity B: Work with the AC ...to help 1) develop a climate change research prospectus describing specific climate change research priorities for the sanctuary, and 2) identify marine chemical, physical, and biological indicators of climate change for monitoring.

These management plan strategies were developed in 2010-2011. Since then, other regional efforts were initiated to identify ecosystem indicators including 1) NOAA's Northwest Fisheries Science Center (NWFSC) through the Integrated Ecosystem Assessment (IEA) initiative, 2) the Puget Sound Partnership, and 3) Washington State in the context of coastal marine spatial planning (MSP). Of direct relevance to OCNMS, Washington State in May 2013 initiated a process to identify ecosystem indicators on Washington's Pacific Coast and contracted in 2014 with the NWFSC Ecosystems Science Division to lead this effort, which is expected to produce a suite of ecosystem indicators for Washington's Pacific Coast by June 2015.

Also, in the 2010-2011 timeframe, NOAA was developing a Sentinel Site Program (<http://oceanservice.noaa.gov/sentinelsites/>). Whereas our nation's system of national marine sanctuaries provide designated locations where research on climate change impacts to coastal and marine ecosystems could be centered, the Sentinel Site Program limited the scope and focus of initial efforts to the issue of sea level rise, and proceeded to designate five sites around the nation for this program. These sites are Chesapeake Bay, North Carolina, Northern Gulf of Mexico, Hawaiian Islands, and San Francisco Bay. While a direct linkage between NOAA's Sentinel Site Program and Office of National Marine Sanctuaries (ONMS) did not initially occur, ONMS continues to promote national marine sanctuaries as intensely studied and monitored areas and ocean observing sites where research should be supported and leveraged through collaborative efforts.

These developments steered the SWG from the specific activities identified in the OCNMS management plan toward the following efforts to support the purposes identified for the group.

1. Indicators and metrics for the next OCNMS Condition Report
2. Update of the OCNMS Science Needs documents, with particular focus on the Climate Change and Ocean Acidification document

### **Meetings**

All SWG meetings were held as conference calls, which were held on October 31, 2013, January 22, and March 13, 2014. OCNMS staff provided context for discussions and distributed preliminary draft documents to facilitate discussion. In addition to information sharing and comments provided via conference calls, review comments were also provided digitally by SWG participants and used by OCNMS staff to refine draft documents.

### **Indicator species and metrics for the next OCNMS Condition Report**

Ecosystem indicators are empirically tractable metrics that serve as proxies for key attributes of natural and socioeconomic systems. “Empirically tractable metrics” means the indicators need to be reasonably easy or feasible to measure or monitor.

*Decision: The SWG determined that the most effective route toward indicator species identification for OCNMS is to wait for results from the state’s ecosystem indicators work being performed for coastal marine spatial planning and expand on those recommendations, as appropriate or necessary.* The state’s effort uses an established and comprehensive process to evaluate indicators and is being conducted by regional experts in the field of marine ecosystem indicators (i.e., NWFSC). This process evaluates potential indicators using a suite of criteria. Indicators must be theoretically-sound, relevant to management concerns, respond predictably, sensitive to changes in ecosystem attributes and management actions, and understood by the public and policy makers. After indicators are identified through the state’s process, OCNMS can evaluate the recommendations and determine if any changes or additions are necessary to address the sanctuary area. For example, OCNMS may want to identify indicators for additional habitat types not addressed by the state’s process.

ONMS condition reports provide a summary of resources in each sanctuary, pressures on those resources, the current condition and trends, and management responses to the pressures that threaten the integrity of the marine environment. Four subject areas are addressed in condition reports - water quality, habitats, living resources, maritime archaeological resources. There are ecosystem indicators implied but not specifically identified as indicators in the standardized format for condition reports. These are:

- water quality – eutrophic conditions, human health, climate change-related alteration of water quality, other stressors
- habitats – integrity of major habitat types, contaminants
- living resources – biodiversity, non-indigenous species, keystone/foundation species, other key species
- maritime archaeological resources – integrity of maritime archaeological resources, hazards associated with these resources
- human dimensions – changing levels of human activities, changing influential drivers

*Decision: Because condition reports are the tool used by ONMS to evaluate and report on ecosystem health, the SWG decided to focus its efforts on defining indicators, metrics, and information or data types and data sources relevant for each of the condition report topic areas.* To accomplish this, the SWG reviewed each of the 17 questions to be addressed in the next OCNMS Condition Report and developed a matrix table summarizing:

- metrics or indicators used in the 2008 OCNMS Condition Report
- suggested indicators for the next OCNMS condition report
- data sources for suggested indicators
- questions and comments relevant to each topic

This matrix table is included as an appendix to this report but should not be considered a final set of recommendations or consensus-approved product of the working group. It is acknowledged that this table can be improved, expanded and refined in the future. Additional effort at this time seems unwarranted, however, because the next OCNMS Condition Report is not likely to be drafted for several years, perhaps not until the next update of the OCNMS Management Plan is scheduled. The compilation of information and issues in this table may be useful to inform research priorities for OCNMS and others involved in marine resource management and conservation on the outer coast of Washington state.

### **OCNMS Science Needs Documents**

The Office of National Marine Sanctuaries (ONMS) Science Needs Assessment is an evaluation of the science and information requirements (capability, information, and products) of the ONMS as defined by the management issues facing each sanctuary in the National Marine Sanctuary System. ONMS provides a web interface where current science needs are defined for each national marine sanctuary (<http://sanctuaries.noaa.gov/science/assessment/>). These assessments are based on priorities and issues identified in a site's management plan, condition report, and strategic science plan. The purpose of the ONMS Science Needs Assessment is to provide targeted information on the science requirements, to support science and management staff working to address these requirements, and to communicate these requirements to potential partners and interested organizations and individuals, particularly those in the research community. The ONMS Science Needs Assessment also provides information to federal, state, and local legislative officials interested in the management issues and science requirements at a given national marine sanctuary or monument.

For each national marine sanctuary, science needs assessment documents are built around priority management issues for which support and collaborations are necessary. For OCNMS, there are 2-page science needs assessment documents last updated in May 2010 for these topic areas: climate change and ocean acidification, deep sea coral and sponge communities, kelp forests, seafloor habitats, marine mammals and seabirds, and nearshore and intertidal areas.

The SWG has not discussed the OCNMS Science Needs documents in any detail. In March 2014, when the SWG held their last conference call, OCNMS was anticipating guidance from ONMS on updates to the science needs documents. In subsequent discussions, OCNMS committed to begin updating its science needs documents this summer, with a goal of having updated versions completed by the end of this calendar year. In general, updating of science

needs documents is an internal process led by the research staff at each sanctuary site. *Decision: OCNMS intends to re-draft its science needs documents and reach out to subject area experts for review and guidance.*

OCNMS Advisory Council - Science Work Group					
Recommended OCNMS Condition Report Indicators and metrics					
3-Sep-14					
2008 OCNMS Condition Report			Next OCNMS Condition Report		
#	topic	indicators/metrics	#	question	questions/comments/information sources
<b>Water Quality</b>			<b>Water Quality</b>		
2	eutrophic conditions	Not an issue for OCNMS	1	What is the eutrophic condition of sanctuary waters and how is it changing?	*eutrophication is not an issue for OCNMS *anticipated rating "Good - eutrophication has not been documented, or does not appear to have the potential to negatively affect ecological integrity" *harmful algal blooms and hypoxia on the outer coast are not thought to result from eutrophication (human-introduced nutrients) *www.nanoos.org
3	human health	harmful algal blooms (frequency, areal extent and duration)	2	Do sanctuary waters pose risks to human health and how are they changing?	*beach advisories/closures (bacterial or chemical contamination) *seafood harvest closures *seafood contamination / fish consumption advisories *water quality ratings *HABs (frequency, extent, duration) *animal diseases transmissible to humans *contaminant loading in marine mammals (human prey) *seafood contamination from Fukushima radiation *pollutants in trans-Pacific air
	climate change-related alteration of water quality	hypoxic conditions (frequency, areal extent and duration); pH	3	Have recent, accelerated changes in climate altered water conditions and how are they changing?	*water temperature, salinity *hypoxia (frequency, extent, duration) *acidity/pH *sea level *upwelling intensity and timing *storm intensity and frequency *erosion and sedimentation patterns *freshwater delivery *address key issues identified in the Climate Change Site Scenario
1	specific or multiple stressors affecting water quality	hypoxia, harmful algal blooms, acidity/pH, contaminants	4	Are other stressors, individually or in combination, affecting water quality, and how are they changing?	*addresses anthropogenic stressors not covered in other questions. *a compilation of anthropogenic stressors can be found in Teck et al. (2010) *NWFSC has a variety of spatially explicit time series associated with anthropogenic stressors. See Drivers and Pressures (Andrews et al. 2013) in IEA ( <a href="http://www.noaa.gov/iea/CCIEA-Report/drivers/index.html">http://www.noaa.gov/iea/CCIEA-Report/drivers/index.html</a> ).
<b>Habitat Resources</b>			<b>Habitat Resources</b>		
5	major habitat integrity	intensity and distribution of bottom trawl effort; kelp bed distribution	5	What is the integrity of major habitat types and how are they changing?	1 shoreline armoring/alteration 2 oil spills 3 marine debris 4 biogenic habitats (measured by area surveyed/available data; bottom trawl area access) 5 acoustic environment *need to define major habitat types *addresses extent and quality of existing habitat in comparison to "pristine" conditions *Harris and Baker (2012)
7	contaminants	sediment contaminants	6	What are contaminant concentrations in sanctuary habitats and how are they changing?	*chemical contaminants in benthic habitats, sediments *Fukushima radioactivity *regional contaminant issues (e.g., Hg) and relevance to marine area *address emerging contaminant sources

2008 OCNMS Condition Report			Next OCNMS Condition Report		
#	topic	indicators/metrics	#	question	questions/comments/information sources
<b>Living Resources</b>			<b>Living Resources</b>		
12, 13	keystone/foundation species	seabird colonies, sea otters, groundfish stocks (population size and age structure); biogenic habitats	7	What is the status of keystone and foundation species and how is it changing?	<ul style="list-style-type: none"> <li>*sea otters</li> <li>*habitat forming species</li> <li>*forage fish</li> <li>*zooplankton</li> <li>*seagrass (foundation)</li> <li>*kelp (foundation)</li> <li>*Pisaster (keystone)</li> <li>*phytoplankton (foundation)</li> </ul> <p>Definitions: Keystone species have a disproportionately large impact on their environment relative to their abundance. Foundation species have a strong role in structuring the biological community. The distinction is not simple to understand.</p> <p>*NPS, Wooten/Pfister lab research and monitoring</p>
10	sustainable fishing		-	question dropped	*can be addressed in questions 7, 10, possibly 9
12, 13	other key species		8	What is the status of other focal species and how is it changing?	<ul style="list-style-type: none"> <li>*charismatic species</li> <li>*seabird colonies</li> <li>*cetaceans</li> <li>*Lake Ozette sockeye (nearshore marine)</li> <li>*others</li> </ul> <p>*how to define?</p> <p>*focus on population size (abundance/biomass) and population condition (age structure, contaminant loads, spatial distribution)</p>
11	non-indigenous species	number of non-indigenous species identified;	9	What is the status of non-indigenous species and how is it changing?	<ul style="list-style-type: none"> <li>*introduced species (number, threat, distribution)</li> <li>*climate-change induced range shifts</li> </ul> <p>*focus on species impacts to ecological integrity</p> <p>*what monitoring is ongoing or needed?</p>
		contaminant loading in biota			
		acoustic disturbance			
9	biodiversity	poor baseline data; ESA and other listings	10	What is the status of biodiversity and how is it changing?	<ul style="list-style-type: none"> <li>*harvest/extraction impacts</li> <li>*biodiversity measures (richness/evenness)</li> <li>*interspecies interactions</li> <li>*ESA or conservation listings</li> </ul> <p>*biodiversity addressed in other condition reports: CINMS - species diversity as proxy; extraction reduced or removed some species abundance; mostly pers comm cited; deep sea areas unknown. CBNMS - species richness not reduced but abundance has been; assessed benthic and pelagic invertebrates, fishes, seabirds and marine mammals - most from larger northern CA area. GFNMS - abundance trends for various species reviewed; habitat loss in estuaries assumed to have reduced biodiversity</p> <p>*use regionally specific portions of some larger datasets that we've incorporated into the IEA, including: NMFS bottom trawl surveys (groundfish); NMFS surface trawls (pelagic species); and zooplankton surveys (copepod diversity)</p>
<b>Maritime Archaeological Resources</b>			<b>Maritime Archaeological Resources</b>		
15	integrity of known MA resources		11	What is the archaeological integrity of known maritime archaeological resources and how is it changing?	<ul style="list-style-type: none"> <li>*lack of survey effort for location and condition</li> <li>*potential impact from seafloor contact activities</li> </ul>
16	hazards associated with MA resources	number of vessel wrecks containing oils	12	Do known maritime archaeological resources pose an environmental hazard and how is this threat changing?	<ul style="list-style-type: none"> <li>*wrecks with potential fuel</li> </ul> <p>*see RUST database and RULET project</p>

2008 OCNMS Condition Report			Next OCNMS Condition Report			
#	topic	indicators/metrics	#	question	human activities & pressures	questions/comments/information sources
Human Dimensions			Human Dimensions			
8, 14,	influence of changing levels of human activities		13	What are the levels of human activities that may adversely influence water quality and how are they changing?	*vessel wastewater discharges *airborne contaminant contributions *plastic pollution *shipping traffic (noise) *vessel traffic (spill risk) *Commercial Fishing (crabbing) *Fungicide/pesticide cannisters *US Navy test range sonar use *Cruise ship/others overboard discharge *Sediment input from streams impacted by forest practices	*NWFSC has a variety of spatially explicit time series associated with anthropogenic stressors. See Drivers and Pressures (Andrews et al. 2013) in IEA ( <a href="http://www.noaa.gov/iea/CCIEA-Report/drivers/index.html">http://www.noaa.gov/iea/CCIEA-Report/drivers/index.html</a> ).
			14	What are the levels of human activities that may adversely infuence habitats and how are they changing?	*bottom contact fishing practices *debris loading (crushed cars, cannisters) *Abandoned/lost fishing gear	
Pressures Identified in 2008 Condition Report			15	What are the levels of human activities that may adversely influence living resource quality and how are they changing?	*commercial fishing *recreational fishing *vessel traffic (noise and spill risk) *sensitive marine mammal species *Plastics loading *abandoned/lost fishing gear *US Navy sonor testing *Increased vessel traffic carrying toxic materials (oil)	
	commercial development fishing ballast water and invasive species oil spills		16	What are the levels of human activities that may adversely influence maritime archaeological resources and how are they changing?	*bottom trawl fisheries *Wind farms/wave buoys impacting historical shoreline views *Increased shipping *Shoreline access(recreational)	
	increased human use military activities underwater noise pollution climate change		17	What are the states of influential drivers and how are they changing?	To Be Determined	Definition: Drivers are the ultimate cause of changes in ecosystems, and can be biophysical, human, or institutional in nature. Drivers describe the effect of societal values on different uses of the ecosystem, resulting in pressures that affect the condition, or state, of the environment. Drivers may include specific changes in demographics of an area (age structure, population, etc.), demand for ocean products, economic situations, industrial development patterns, or business trends. Societal values may include levels of conservation awareness, political leanings, or changing opinions about the acceptability of specific behaviors (e.g., littering, fishing). Drivers may be associated with particular pressures, so for each of the pressures described, the states of influential drivers will also be discussed.