

Environmental Studies Program: Ongoing Study

Study Area(s): Southern California

Administered By: Pacific OCS Region

Title: A Demonstration Marine Biodiversity Observation Network (BON) for Ecosystem Monitoring (NSL #PC-15-05)

BOEM Information Need(s) to be Addressed: BOEM needs biodiversity information in all areas of the OCS acquired through a well-accepted, systematic methodology through a broad-scale, comprehensive, ecosystem-based monitoring of the marine environment. This information will enhance BOEM's environmental impact assessments by enabling accurate characterization of the affected environment, tracking trends of sensitive resources, developing better metrics for cumulative impact analyses, and outcome monitoring of mitigation measures.

Total BOEM Cost: \$1,250,000
Plus joint/partner funding: \$4,000,000+

Period of Performance: FY 2015–2020

Conducting Organization(s): University of California, Santa Barbara

Principal Investigator(s): [Dr. Robert Miller](#)

BOEM Contact(s): [Donna Schroeder](#)

Description:

Background: Biological diversity, or biodiversity, is defined as the variety of life, encompassing variation at all levels of complexity – genetic, species, ecosystems, and biomes – and including functional diversity and diversity across ecosystems. A growing body of research demonstrates that: (1) biodiversity broadly promotes the provision of marine ecosystem functions, including those critical to human survival and well-being; and (2) conserving natural biodiversity increases the likelihood that marine ecosystems can continue to provide such services and serves as a hedge against environmental change, increasing the chance that ecosystems can adapt and recover following disturbance (Palumbi et al. 2009). Thus, managing our marine resources in a way that conserves existing marine biodiversity helps address a broad spectrum of other ocean management objectives. For example, a highly diverse ecosystem may recover more quickly from habitat disturbance, and therefore losses to provisioning ecosystem services, such as fishing, would be less.

It is the policy of the United States to protect, maintain, and restore the health and biological diversity of ocean, coastal, and Great Lakes ecosystems and resources. The Census of Marine Life, which concluded in 2010, greatly enhanced our understanding of the status of marine biodiversity. It also made clear the importance of clear-cut, systematic, and sustainable approaches to observing and monitoring biodiversity across different levels and at a national scale.

In May 2010, the Biodiversity Ad Hoc Group under the Interagency Working Group on Ocean Partnerships convened a workshop of experts to develop a plan and recommendations for attaining an operational marine biodiversity observation network (Marine BON) for the nation. The full workshop report can be found online at http://www.nopp.org/wp-content/uploads/2010/03/BON_SynthesisReport.pdf. In May 2013, workshop steering committee members published a paper in BioScience on the feasibility of establishing a Marine BON (<http://www.jstor.org/stable/pdfplus/10.1525/bio.2013.63.5.8.pdf>).

The assessment of possible adverse risk from offshore energy and mineral development hinges critically on being able to differentiate human-induced effects from natural variability. Given the complexity of marine ecosystems, this often requires making observations over large ocean areas, seasonally, and over multiple years and even decades to acquire reasonable statistical confidence. Towards that end, BOEM conducts long-term monitoring in selected areas. The advantage of ecosystem monitoring to BOEM is identifying which species in a given area are more vulnerable than others and which are more critical for the functioning of the ecosystem as a whole. Knowing that, BOEM can more precisely assess environmental risk and better decide on which mitigation efforts would be most beneficial overall.

Objectives: The objective of this study is to develop a prototype ecosystem-based marine biodiversity network, across a range of habitats, looking at multiple trophic levels and species, and informed by historical data and past modeling efforts to the extent possible. Such a network will include one or more of the following:

1. Integration of and building upon existing monitoring and management programs with new approaches;
2. Assembly and synthesis of existing programs and data to identify trends and gaps in taxonomic, spatial, and temporal coverage;
3. Expand upon planned and recently-launched observing sites, systems, and programs;
4. Employ innovative techniques for data discovery and methods that dynamically interrelate data sets and add value to existing monitoring data;
5. Coordinate with or utilize Smithsonian Institution resources for lab space and lab time, data and observations, and taxonomic or other expertise;
6. Collaborate with the U.S. Integrated Ocean Observing System (U.S. IOOS) participants including the U.S. IOOS Regional Associations for coastal, ocean and Great Lakes observations, infrastructure, data management and modeling capabilities; and
7. Engage NOAA's National Oceanographic Data Center, U.S. IOOS, and/or USGS's Ocean Biogeographic Information System (OBIS-USA) for biological data and metadata management, archiving, discovery, and access.

Methods: Using a two-part approach, the core of MBON research focuses on (1) Integrating and building upon existing programs in the region using both underutilized and new technologies, and (2) Developing a more spatially and taxonomically comprehensive and cost-effective sampling strategy for two major habitats, the subtidal benthos (shallow and deep) and the pelagic, to better define biodiversity in the Santa

Barbara Channel. Specific research techniques include Data Integration, Genomics, Imagery, Optimization Modeling, and Remote Sensing. Details regarding specific methodology are outlined at <http://sbc.marinebon.org/research/>.

Reference:

Palumbi, S.R., P.A. Sandifer, J.D. Allan, M.W. Beck, D.G. Fautin, M.J. Fogarty, B.S. Halpern, L.S. Incze, J.A. Leong, E. Norse, J.J. Stachowicz, and D.H. Wall. 2009. *Managing for ocean biodiversity to sustain marine ecosystem services*. *Frontiers in Ecology and the Environment* 7:204-211.

Current Status: There are several diverse Marine Biodiversity Observation Network (MBON) projects ongoing on the U.S. Outer Continental Shelf, including this Santa Barbara Channel (SBC) effort and an Arctic and Florida Keys effort. The objectives in the SBC-MBON are being met and preliminary results from Years 1–3 have been compiled and shared with NOAA, NPS, BOEM, NASA, and USGS collaborators and partners. The Year 3 Annual Report was delivered in May 2017. This is a multi-dimensional study across state and federal groups and several separate universities and departments within campuses. Coordination has been successful and has established enduring pathways for the needed collaboration.

Final Report Due: June 30, 2020

Publications Completed: Over 27 conference presentations, 9 publications in scientific journals, and one dissertation.

Catlett, D., and D.A. Siegel. 2018. Phytoplankton pigment communities can be modeled using unique relationships with spectral absorption signatures in a dynamic coastal environment. *Journal of Geophysical Research: Oceans* 123(1):246-264.

Gassmann, M., S.M. Wiggins, and J.A. Hildebrand. 2016. Underwater sound directionality of commercial ships. *The Journal of the Acoustical Society of America* 139 (4): 2147.

Henderikx Freitas, F., D.A. Siegel, L. Washburn, S. Halewood, and E. Stassinis. 2016. Assessing controls on cross-shelf phytoplankton and suspended particle distributions using repeated bio-optical glider surveys. *Journal of Geophysical Research: Oceans* 121(10):7776-7794.

Hildebrand, J.A. 2016. Characterizing ambient noise in marine and terrestrial settings. *The Journal of the Acoustical Society of America* 139 (4): 2089.

Lamy, T., D.C. Reed, A. Rassweiler, D.A. Siegel, L. Kui, T.W. Bell, R.D. Simons, and R.J. Miller. 2018. Scale-specific drivers of kelp forest communities. *Oecologia* 186(1):217-233.

Miller, R.J., K.D. Lafferty, T. Lamy, L. Kui, A. Rassweiler, and D.C. Reed. 2018. Giant kelp, *Macrocystis pyrifera*, increases faunal diversity through physical engineering. *Proceedings of the Royal Society of London B* 285(1874):20172571.

Muller-Karger, F.E., E. Hestir, C. Ade, K. Turpie, D.A. Roberts, D. Siegel, R.J. Miller, D. Humm, N. Izenberg, M. Keller, and F. Morgan. 2018. Satellite sensor requirements for monitoring essential biodiversity variables of coastal ecosystems. *Ecological Applications* 28(3):749-760.

Reed, D., L. Washburn, A. Rassweiler, R. Miller, T. Bell, and S. Harrer. 2016. Extreme warming challenges sentinel status of kelp forests as indicators of climate change. *Nature Communications* 7:13757.

Viola, S., H.M. Page, S. Zaleski, R.J. Miller, J.E. Dugan, B. Doheny, D.M. Schroeder, and S.C. Schroeter. 2017. Anthropogenic disturbance facilitates a non-native species on offshore oil platforms. *Journal of Applied Ecology* 55(4):1583-1593.

Wear, E.K. 2017. Bottom-up drivers of bacterial community composition and metabolism of dissolved organic carbon in the Santa Barbara Channel, CA. Dissertation. ProQuest accession no. 10230939.

Integrated Datasets:

Love M., L. Snook, M. Nishimoto, and L. Kui. 2017. Santa Barbara Channel fish surveys at deep reefs: Footprint, Piggy Bank, Anacapa Passage. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/59d44ccc0d08bb8735a564aca91e5009>.

Love M., L. Snook, M. Nishimoto, and L. Kui. 2017. Santa Barbara Channel fish and invertebrate surveys at oil and gas platforms. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/2dc1e7a1ce14e0f3f070076fc4a85e43>.

Love M., M. Nishimoto, L. Kui, and D. Schroeder. 2017. Santa Barbara Channel fish surveys at shallow regions of oil and gas platforms (SCUBA). Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/af1f2c8a402c84b0b6fc17b73a950988>.

Love M., M. Nishimoto, L. Kui, and D. Schroeder. 2017. Santa Barbara Channel fish surveys at shallow outcrops. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/618ae46a11a00fcd8c220748d54281fc>.

Miller R., A. Rassweiler, D. Reed, K. Lafferty, L. Kui, and M. O'Brien. 2017. Santa Barbara Channel Marine BON: Integrated fish. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/1345f0148e6dfe4df9065e223b4dd783>.

Miller R., A. Rassweiler, D. Reed, K. Lafferty, L. Kui, and M. O'Brien. 2016. Santa Barbara Channel Marine BON: Integrated benthic cover. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/bf143fa962e1edb822847bc0ee90c2f7>.

Miller R., A. Rassweiler, D. Reed, K. Lafferty, L. Kui, and M. O'Brien. 2016. Santa Barbara Channel Marine BON: Integrated quad and swath cover. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/51d2db26e90d4b8687db81fb40bc58c4>.

Miller R., A. Rassweiler, D. Reed, K. Lafferty, L. Kui, and M. O'Brien. 2017. Santa Barbara Channel Marine BON: Integrated taxa. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/d09d4bfd54e6d4e490b4cc34731d808e>.

Thompson A., R. Miller, and L. Kui. 2017. CALCOFI fish larvae at 66 standard stations, 1966 - ongoing. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/a643973f04a72b855a60944c306a789c>.

Wear E., C. Carlson, E. Wilbanks, and C. Nelson. 2017. Santa Barbara Channel Marine BON: genomics study on 16S primer comparison. Environmental Data Initiative. <http://dx.doi.org/10.6073/pasta/b79f6653c03a9017324f9961adfaaa3b>.

Affiliated WWW Sites:

BOEM Environmental Studies Program Information System study information:

<https://marinecadastre.gov/espis/#/search/study/100092>

Marine Biodiversity Observation Network, Santa Barbara Channel webpage:

<http://sbc.marinebon.org/>

Marine Biodiversity Observation Network webpage:

<http://www.marinebon.org/>

Marine Biodiversity Observation Network Data Portal:

<http://mbon.ioos.us/>

GeoBon: Group On Earth Observations Biodiversity Observation Network:

<https://geobon.org/>

BisQue (Bio-Image Semantic Query User Environment) webpage:

<http://bioimage.ucsb.edu/bisque>

UCSB press releases:

<http://www.news.ucsb.edu/2014/014463/one-giant-step-ocean-biodiversity>

<http://www.news.ucsb.edu/2014/014428/ocean-s-future>

<http://www.news.ucsb.edu/2016/017468/kelp-beats-heat>

<http://www.news.ucsb.edu/2018/018791/lesson-darwin>

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