Monitoring Nearshore Marine Ecosystems in the Gulf of Alaska

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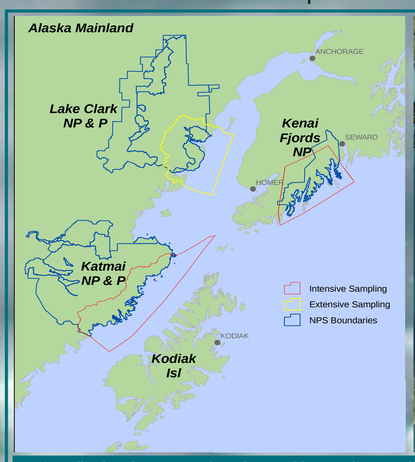
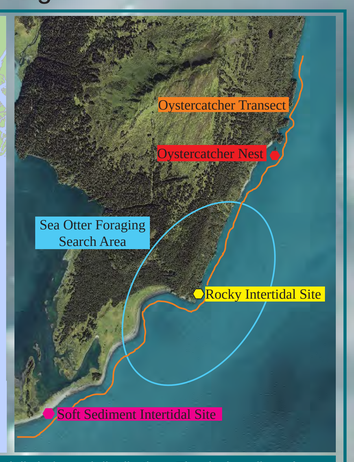
The goal of the SWAN Nearshore Vital Signs Monitoring Program is to understand how nearshore resources within the parks will change over time and the potential causes for change.

The US Geological Survey, the Exxon Valdez Oil Spill Trustee Council, the National Park Service Southwest Alaska Network Inventory and Monitoring Program, and Coastal Resource Associates, with extensive input and evaluation from the public and academia, designed and tested long-term monitoring programs for marine nearshore ecosystems in the Gulf of Alaska. We have adhered to key guiding principles balanced by relevant constraints to keep the program manageable and focused on our goals. This design is balanced in its ability to detect change, provides latitude for adaptive management, allows hypothesis testing, and includes additional parameters such as water quality measurements and contaminant analysis. The program is designed to monitor at a variety of temporal and spatial scales. The sampling design incorporates well known processes and ecological interactions within the nearshore, from primary production to primary consumers to apex predators at spatially balanced, randomly selected sites within the four regions. The variety of temporal and spatial scales as well as the processes and species interactions inherent to the design will help to evaluate causes of change that are anticipated.

Spatial Design





Sampling locations were selected to provide a random, spatially balanced distribution. The design allows for detection of changes on a variety of spatial scales. The NPS portion of the program consists of annual sampling within 2 blocks of approximately 14,000 km^2 within 2 parks (red outline): Katmai NP & P and Kenai Fjords NP. The plan calls for less frequent sampling at Lake Clark NP & P (yellow outline. Discrete sampling sites were selected using a generalized random tessellation stratified (GRTS) sampling scheme. This design provides a random yet spatially balanced distribution of sites within each block and also allows sampling sites to be added or deleted without compromising the statistical or spatial integrity. Once primary producer and primary consumer sites were chosen utilizing GRTS, sampling sites for apex predators were chosen based on their proximity to the GRTS sites. For example, black oystercatcher data is collected along 20 km transects, centered on each GRTS site.

There are six designated nearshore vital signs within the program:

1. Kelp and Seagrass
2. Marine Intertidal Invertebrates
3. Marine Birds
4. Black Oystercatcher (*Haematopus bachmani*)
5. Sea otter (*Enhydra lutris*)
6. Marine Water Chemistry

Goals:
Detect change on varying spatial and temporal scales
Inform cause of those changes

Organizing Guidelines:
Focus on trophic interactions
Focus on NPS vital signs

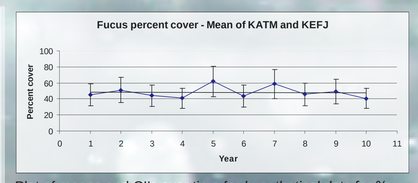
Relevant Constraints:
Budgets
Temporal Scale > 1 year
(water quality temporal scale > 1 hr)
Spatial Scale $10^3 > 10^8$ m^2

Detecting Trends

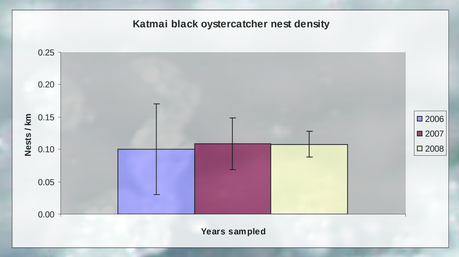
Two types of data used to help identify trends of ecological importance within SWAN:

1. Determining the range in **natural variation** that has been observed in what are considered healthy populations, possibly outside of our study areas

2. Determining the **range in variation that is considered ecologically important,** based on past studies of impacts to nearshore ecosystems



Plot of means and CI's over time for *hypothetical data* for % cover of *Fucus*. In healthy systems in the GOA, it is not un-usual to see inter-annual changes in estimates of percent or abundance of dominant intertidal algae that are 50% or greater (Highsmtih et al 1994, Skalski et al. 2001). At sites impacted by the Exxon Valdez oil spill, only larger changes (on the order of 80 to 90%) were deemed to be of ecological importance. Based on these results, changes in abundance of selected dominant taxa of 80% or greater be of ecological importance.



Very little annual variation is evident in regards to black oystercatcher nest density, which would allow us to assume changes in nest density on the order of 50% or more as ecologically and biologically significant. Coefficients of variation (CVs) also support this level of change as detectable on an annual basis through our monitoring design.

Primary Producers

Metrics:
Abundance
Distribution
Species Composition

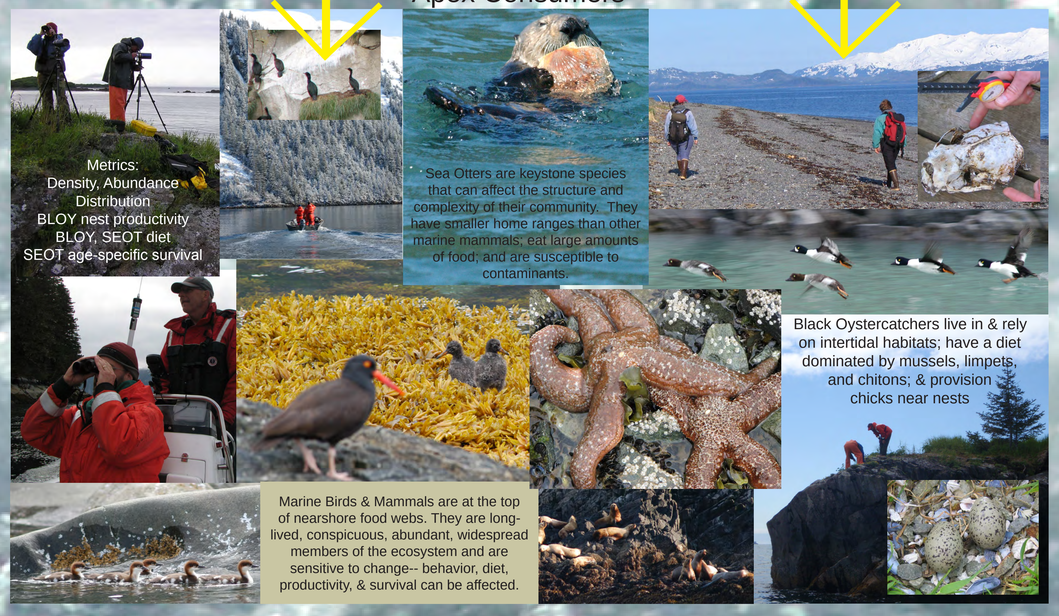
Kelp and seagrass are the major primary producers, serve as a nutrient filter, provide habitat for fish, clams, & urchins, and are a physical substrate for other invertebrates and algae. Intertidal algae provides food for ducks and fish as well as spawning and nursery habitats for forage fish and juvenile crustaceans.

Primary Consumers

Metrics:
Density, Abundance
Species Composition
Size Distribution
Growth Rate
Contaminants

Intertidal grazers and filter feeders provide critical food resources for shorebirds, ducks, fish, bears, sea otters, and invertebrate predators. They serve as conduits for primary productivity across the nearshore food web.

Apex Consumers

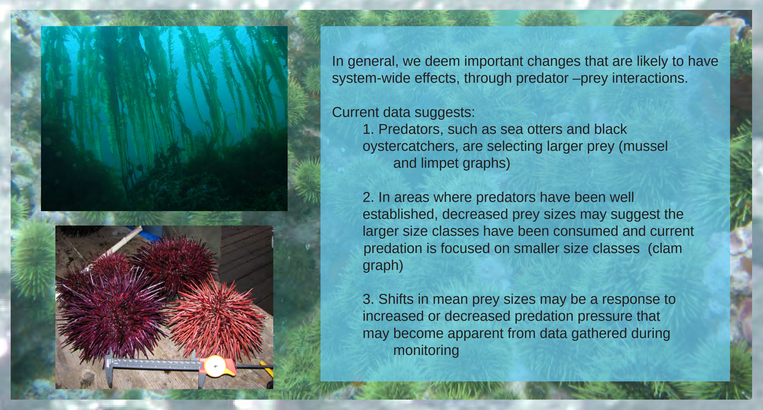


Metrics:
Density, Abundance
Distribution
BLOY nest productivity
BLOY, SEOT diet
SEOT age-specific survival

Sea Otters are keystone species that can affect the structure and complexity of their community. They have smaller home ranges than other marine mammals; eat large amounts of food; and are susceptible to contaminants.

Black Oystercatchers live in & rely on intertidal habitats; have a diet dominated by mussels, limpets, and chitons; & provision chicks near nests

Marine Birds & Mammals are at the top of nearshore food webs. They are long-lived, conspicuous, abundant, widespread members of the ecosystem and are sensitive to change-- behavior, diet, productivity, & survival can be affected.



In general, we deem important changes that are likely to have system-wide effects, through predator –prey interactions.

Current data suggests:

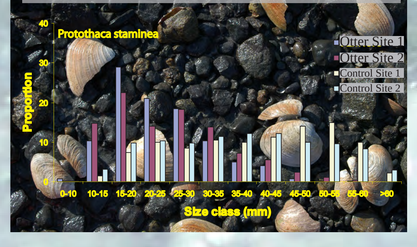
1. Predators, such as sea otters and black oystercatchers, are selecting larger prey (mussel and limpet graphs)

2. In areas where predators have been well established, decreased prey sizes may suggest the larger size classes have been consumed and current predation is focused on smaller size classes (clam graph)

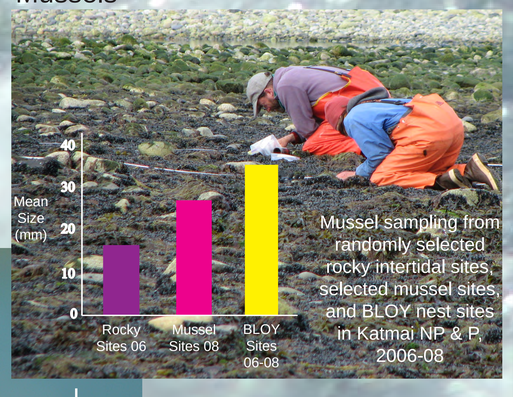
3. Shifts in mean prey sizes may be a response to increased or decreased predation pressure that may become apparent from data gathered during monitoring

Clams

Clam size distribution from areas with long established sea otter populations and areas with only a recent presence of sea otters

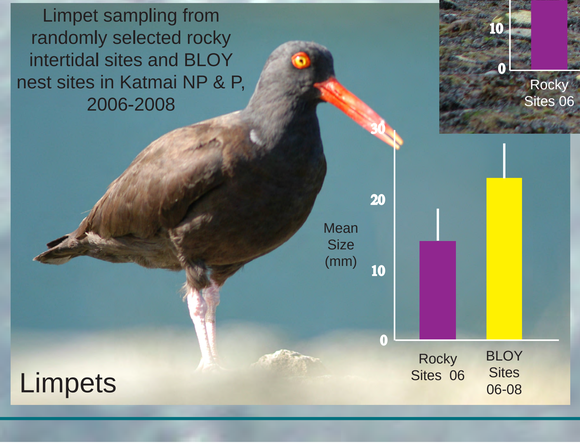


Mussels



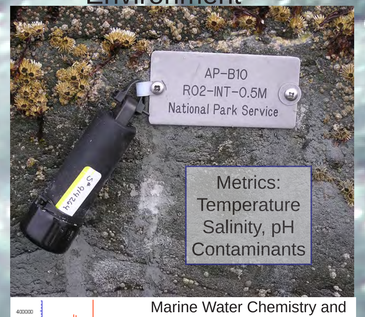
Mussel sampling from randomly selected rocky intertidal sites, selected mussel sites, and BLOY nest sites in Katmai NP & P, 2006-08

Limpet sampling from randomly selected rocky intertidal sites and BLOY nest sites in Katmai NP & P, 2006-2008

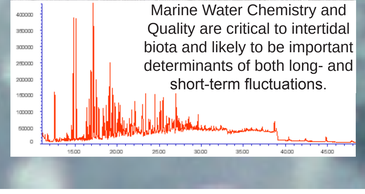


Limpets

Environment



Metrics:
Temperature
Salinity, pH
Contaminants



Marine Water Chemistry and Quality are critical to intertidal biota and likely to be important determinants of both long- and short-term fluctuations.

We expect to add Lake Clark NP & P to our sampling universe in 2009, to continue sampling there and at existing sites indefinitely, and to explore the option of expanding the geographic scope of the program if warranted. As part of the monitoring program, we also advocate hypothesis-driven process studies and more focused studies of events of particular importance. We anticipate that such studies will not be initiated until after the first 5 years or more of monitoring has been completed. This will allow identification of particularly compelling trends and development of hypotheses regarding causes for change, and will allow funding to be built to a sufficient level to support meaningful studies.

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