Olympic Coast National Marine Sanctuary (OCNMS) research prospectus

**Summary of current work and motivation**

Kelp forests are among the most productive habitats on earth and support complex natural communities along the US west coastal. Both invertebrate and fish species targeted by fisheries (recreational and commercial) occur in kelp forests. Despite their important role in coastal systems, there are no surveys conducted in coastal kelp forest systems on the Washington Coast.

Since 2015, research divers from the NWFSC in collaboration with OCNMS staff have conducted annual dive surveys at kelp forest sites in OCNMS. Each August, we have visited at least 5 sites and surveyed kelp, benthic invertebrates, and fish at shallow depths (<10m). This document is a brief description of motivation and direction for future research.

**Motivation for continued surveys in OCNMS and connections to NMFS priorities.**

1. Coastal habitats that support productive marine ecosystems
2. Connections between coastal and oceanic ecosystems.
3. Efficiency. Coastal surveys may provide a relatively low cost method for surveying recruitment of species that are only detectable months or years later.

**Connections to NMFS priorities.**

*EBFM roadmap* (selected appropriate guidelines that seemed relevant to Ole):

**Advance our understanding of ecosystem processes**

* Conduct science to understand ecosystems
* Provide Ecosystem Status Reports for each Large Marine Ecosystem

**Incorporate ecosystem considerations into management advice**

* Develop and monitor ecosystem-level reference points
* Incorporate ecosystem considerations into appropriate LMR assessments, control rules, and management decisions
* Provide integrated advice for other management considerations, particularly applied across multiple species within an ecosystem

**Potential research topics**

1. **Nearshore fish communities and kelp forests.**

Multiple commercially important fish species utilize kelp forests during their life cycle. Some use the habitat during early life-stages as recruits, while others visit or inhabit it as adults.

For species that recruit to nearshore habitats, we have reasonable information from the NMFS trawl survey on the abundance and distribution of mature life-stages on the deeper waters of the shelf and slope, and information from pelagic surveys of larval and juvenile fish (Brodeur, Burke, et al.). Nearshore environments are an unsampled link connecting reproduction and later adult stages.

For adults that inhabit kelp forests (e.g. black rockfish, others), dive surveys may provide one of the few fisheries independent sources of information.

Questions:

* What are the spatial and temporal patterns of occurrence and variation in recruitment of rockfish in OCNMS kelp forests?
  + subquestions
* How do patterns of recruitment in OCNMS compare torecruitment patterns inside Puget Sound? To offshore pelagic surveys? To California / Oregon recruitment information?
* Are localized patterns of recruitment related to attributes of the kelp forest?

Approaches:

Data collection

* Visual surveys of fish and habitat variables
* Passive recruitment devices (SMURFs or similar)
* Other stuff.

Collaboration with Puget Sound surveys (REEF, WDFW, others), pelagic surveys (NOAA), coastal dive surveys in Oregon and California (PISCO, REEF).

Time-series and spatial analyses of fish occurrence and abundance.

Outputs:

Indices of abundance for fish species of interest (primarily rockfish)

Data to examine connections between fish communities in space and in time

1. **Kelp forest dynamics in a changing ocean.**

There are range of drivers of kelp forests in coastal oceans. A major question is how ocean acidification will changes to ocean ecosystems. Algae, along with other primary producers like seagrasses, are directly affected by changing levels of dissolved carbon in the ocean and are expected to respond strongly to changes in ocean carbon chemistry. Beyond direct effects of ocean chemistry, ocean productivity driven by temperature and nutrient availability may also shift kelp success. Finally, top down effects of grazing are well documented in kelp forests, with the presence and abundance of sea otters mediating invertebrate herbivore abundance which can suppress kelp abundance. It is unclear how these substantially different processes will affect kelp forest dynamics moving forward.

Main Questions:

* How do kelp forests respond to changes in ocean acidification, oceanic variability, and top down forces? What is the relative contribution of each and can they be separated?
* What are predicted distributions and abundance of kelp forests in a future ocean?

More focal questions

* How do local measures of kelp density map connect with aerial surveys conducted by WDNR?
* Has there been a shift Species composition of kelp- shift between annual (Nereo) and more perennial (Macro) kelp species? What does this mean for fish and invertebrate communities?

Approaches:

Data collection

* Visual surveys of kelp densities and invertebrates.
* Detailed measurements of kelp biomass and ways to translate kelp surveys into biomass and/or carbon units.
* Other...

Outputs:

* Kelp forest indicator for OCNMS that can be connected to / compared with parallel California metrics.
* Information that could be combined with ocean chemistry information to provide estimates of buffering services provided by kelp forests.

**Connections and collaborators**

List of existing data and surveys that are relevant to future work.

Within OCNMS

* Otter surveys conducted annually or bi-annually by Washington Department of Fish and Wildlife
* Kelp survey flights conducted by Washington Department of Natural Resources
* Series of inshore buoys monitored by OCNMS
  + What are these measuring?
* Tatoosh Island research (U. Chicago by C. Pfister, T. Wootton, and associates)
* Makah tribal biologists.
* Commercial and recreational catches from WDFW.

Offshore work by NMFS

* Rockfish recruitment surveys (SWFSC, John Field)
* Offshore juvenile salmon and forage surveys (NWFSC, Rick Brodeur, Brian Burke)
* FRAM trawl survey.

Other surveys to the south

* PISCO, REEF.