

April 21, 2008

Prepared by Jack Barth, Selina Heppell and Craig Young for STAC

## **Marine Reserve Size and Spacing Workshop**

At the request of the Marine Reserves Working Group (MRWG), the Science and Technical Advisory Committee (STAC) of Oregon's Ocean Policy Advisory Council (OPAC) held a workshop on marine reserve size and spacing to address the need for guidelines that can be used in the site nomination process. Thirty-one scientists and advisors, along with 5 support staff, met at the Oregon Institute of Marine Biology (OIMB) in Charleston on April 10 and half the day on April 11. The workshop was open to the public, but public comment was not solicited due to time constraints. Meeting participants included marine biologists, oceanographers, fishermen with nearshore experience, and scientists who were directly involved with the development of marine reserve design recommendations in California (Table 1).

This was a scientific meeting to discuss what we know about nearshore oceanography, habitat, and species. Due to our time constraints, the expertise of the attendees, and specific requests from OPAC's Marine Reserves Working Group, this workshop did not cover issues on specific sites for reserves, nor on ways to minimize social or economic impacts of reserves. Research needs to assess the economic or social impacts of reserves in state waters will be the subject of a future meeting or workshop.

The primary objective of our workshop was to produce a consensus document for OPAC that reviews existing science and provides recommendations for reserve size and spacing guidelines for Oregon. We accumulated a large amount of information at the workshop, and it will take 2-3 weeks to compile it into a complete workshop report. This document serves as a preliminary report to MRWG that addresses the specific questions asked in the request letter (dated February 4, 2008, but received April 5, 2008). We also provide a prioritized list of short- and long-term research needs that may be used in planning discussions.

## **Workshop Format**

The first morning of the meeting (April 10) consisted of presentations of data and models relevant to the development of reserve guidelines (Table 2, Agenda). These talks were highly informative and served to stimulate discussion throughout the meeting. In particular, we received information on the science used to make recommendations in California and the scientific rigor behind those "rules of thumb". We also received information about theoretical tools that can be tailored to Oregon species and habitats to predict potential population-level benefits of reserves that are spaced along the coast. Oceanographic data (water-column temperature, salinity, chlorophyll, currents), output from numerical ocean circulation models, and data on the habitats and species in Oregon's nearshore are more extensive than many people realized. These data will be valuable for making Oregon-specific recommendations about the relative benefits of reserves that are different sizes, include varying level of habitat complexity, or have different current patterns that indicate a lower or higher probability of concentrating or retaining the larvae of some species.

After an extended lunch and small group discussion period, we convened as a single group to discuss three primary issues: size, “shape”, and spacing. Shape is defined as the configuration of a reserve relative to shore and depth.

Friday morning’s discussion was also with the full group, and was a largely successful attempt to synthesize ideas, identify research needs, and specify the level of scientific information that is available to support particular conclusions. The meeting ended at noon after lively discussion and general (although not always unanimous) agreement on several points, which are detailed below. All participants agreed to continue participating in the review of reports and continued synthesis of data and literature. We briefly discussed the need for a follow-up meeting, but left that issue unsettled, pending the outcomes of short-term data synthesis efforts and the needs of STAC and OPAC.

### **Preliminary Response to MRWG letter to STAC**

Based on discussions among STAC members and invited participants at the April 10-11, 2008, Marine Reserve Size and Spacing Workshop, we reply as follows to the February 4, 2008 (received April 5, 2008), MRWG memo to STAC (memo text in italics).

*The MRWG is requesting the STAC to recommend guidelines for the marine reserve nomination process based on available biological and ecological data at your next planned workshop. In recognition of the limited time available before the nomination process for marine reserves, the MRWG requests the STAC provide their best guidance on the following questions:*

- *How do we identify "special places" in nearshore Oregon, such as biodiversity hotspots, unique habitat features etc. using available habitat maps and biological information.*

“Special places” in Oregon waters include areas with high biological diversity, rare or specific oceanographic characteristics, and rare or distinctive habitats. Because we have excellent descriptive data on the types of habitat and depths where species are found, we can confidently use each type of habitat to represent a list of species that are likely to be found there. Thus, as a “first cut” for evaluating the likely diversity of organisms found in a proposed reserve site, we can use the amount and diversity of habitat types found in an area. Regions with high variability in habitat-types and/or depths may be considered “special” for diversity reasons. These regions can be determined from existing bottom habitat maps and from future surveys. Rocky outcrops, headlands and submarine banks and canyons are also “special regions,” because of their influence on biological diversity, coastal circulation and productivity, and their role as boundaries between biogeographic regions. In state waters, these areas include, but are not limited to, Simpsons Reef and Cape Arago, the lee of Cape Lookout, the inshore side of the Heceta and Stonewall Banks complex, and inshore areas to the south of Cape Blanco including the reefs near Port Orford. A unique feature of the Oregon coast that is likely to affect the distribution of organisms is the long stretch of sandy bottom between Florence and Coos Bay (60 nautical miles, 75 km). Another region of sandy bottom, although much shorter, is between Seaside and the Columbia River (15 nautical miles, 28 km). Other natural features of special interest are regions where seasonal hypoxic bottom waters are found (over and inshore of Heceta Bank) (Grantham et al. ’04; Chan et al., 2008) and where Harmful Algal Blooms are generated or persist (Heceta Bank) (Trainer et al., 200X). Lastly, proximity to state or federal

protected areas on land makes adjacent ocean areas distinctive, as they may have reduced pollution or sedimentation compared to areas that are adjacent to highly populated ports, towns or agriculture.

- *What guidelines should we use for minimum size and spacing for reserves (i.e. networks or systems) to meet our stated goals and objectives, and what is the relationship between reserve properties (size, configuration, habitat-types, depths) and the likelihood of meeting those objectives?*

Each potential place for a marine reserve is unique and the size, shape and design should be tailored to each site. To the extent practicable, we recommend that proposed sites be placed or sized to maximize the habitat types and depth ranges available in the chosen area.

Some of the criteria suggested here are consistent with and patterned after those developed during the California Marine Life Protection Act. These were developed based on a set of species, most of which are found in Oregon waters. The STAC and California colleagues are checking the species lists used in the MLPA process and contained in the Oregon ODFW Nearshore Plan. The general consensus of the group was that the process of developing the guidelines for reserve size in California was applicable to Oregon and that the final results were not likely to change when the species list was refined to include only Oregon species. There was also consensus on the need for multiple reserve sites distributed along the entire coast to assure replication for scientific evaluation and to have some insurance against natural or man-made catastrophes that might damage habitats in particular areas. There was less agreement on using particular spacing guidelines.

#### Size:

- Based on a synthesis of data from marine protected areas worldwide, long-term studies of multiple reserves in temperate regions, and recent data from reserves in California, as the size of the protected area is increased, the number of species that can achieve their natural densities and size structure is increased. The species that benefit most are those that are fished heavily, top predators, and species with small home ranges. We are compiling a table of Oregon species and habitats to show the expected relationship between reserve size and potential benefits to species, as shown in Table 3.
- To maximize benefits to fished species, reserves should have an alongshore span of 5-10 km of coastline and preferably 10-20 km, based on adult neighborhood sizes and movement patterns analyzed for the Central California system.
- To maximize benefits to diversity, a reserve should be of sufficient size to contain 90% of species characteristic of the habitats therein. The area of habitat required to do that can be determined from species-area curves developed for various west-coast ocean habitats (California examples in Figure 1).
- For the objective of protecting the greatest diversity of species, marine reserves should include a range of habitat-types and depths. However, there is not a strong pattern of increasing species diversity with reserve size in an analysis that combines results of reserves worldwide.

### Spacing:

- The unique geomorphology of the Oregon coast and alongshore differences in bottom habitat and water-column characteristics (currents, stratification, primary production) should be taken into account when deciding the spacing of marine reserves.
- For the objective “to protect key types of marine habitats in multiple locations along the coast to enhance resilience of nearshore ecosystems to natural and human-caused effects,” marine reserves should be distributed along the full Oregon coast and in each biogeographical region.
- For the objective of providing larvae to Oregon waters, based on currently known scales of larval dispersal, marine reserves containing a particular habitat type should be spaced no more than 50-100 km apart. Larvae released from a reserve will be dispersed up and down the coast. Larvae with short planktonic larval durations (PLD), up to about one week, will tend to reseed reserves of 5-10 km size, while larvae with longer pelagic larval durations, for example around 30 days, will seed greater than or equal to 25 km to either side of the reserve (Shanks et al., 2003).

### Shape (configuration):

- The design and shape should take into account the adjacent habitat types and the cross-shelf extent of habitat types.
  - Shape should be such to maximize habitat complexity.
  - Minimizing the perimeter-to-area ratio will maximize protection within a reserve, and minimize vulnerability to edge effects and spillover loss, for a homogenous habitat (Acosta, 2002; Walters, 2000; Fogarty, 1999; DeMartin, 1993).
  - To enhance protection of species that move to deeper depths as they grow, which includes approximately 2/3 of managed groundfish species that occur in state waters, reserves should extend from the intertidal zone to deep waters offshore (potentially extending beyond state boundaries).
- *What research data is available and what is known and not known with respect to physical, biological and ecological information that contributes to these recommendations?*

We are in the process of compiling a complete list of references to document species information, ecology and oceanography that supports this list of recommendations, which should not be considered final until we submit our workshop report.

We recommend that resources be identified to support the following short-term data synthesis needs, which have direct relevance to refining the guidelines listed here:

- Update the list of habitat affinities and home-range sizes for Oregon nearshore species (in progress)
- Complete table(s) showing the relationship between reserve size and potential benefits to species
- Conduct initial “ground-truthing” of habitat maps with assistance from local agency scientists, fishermen, divers, and other resource users
- Develop “species-area curves” for habitats under consideration, using Oregon-specific data where available

- Identify potential “retention areas” for fish and invertebrate larvae, based on ocean circulation models
- Evaluate the utility of incorporating spatially-explicit models of species dispersal and fishing activity into coastwide protected area planning
- *Can you provide us with other supporting information which the STAC considers relevant for the placement of marine reserves, development of coastwide reserve planning guidelines, or evaluation of publicly nominated sites?*
  - We reiterate that the biogeographical region represented by the Oregon territorial sea south of Cape Blanco extends into northern California.
  - Marine reserves in state waters would benefit from being linked to protected areas in deeper federal waters immediately offshore.
  - To buffer against catastrophic loss of a marine reserve and to provide sufficient statistical power for analyzing their effects, 3-5 replicates should be designed for each habitat type within a biogeographical region.
  - To analyze the effects of marine reserves, each site should be paired with nearby reference sites with similar habitat content in unprotected regions.

#### **References (preliminary)**

Acosta '02 ICES J Mar Sci  
Chan et al., 2008  
DeMartin '93 Fish Bull  
Fogarty '99 TREE  
Grantham et al., 2004.  
Shanks et al., 2003  
Trainer et al. (200X)  
Walters '00 Bull Mar Sci

**Table 1. Size and Spacing Workshop Attendee List**

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## Table 2. Final Workshop Agenda (updated 04/10/08)

April 9 (Wednesday) EVENING SOCIAL starts at 7pm in the Dining Hall

### Day 1 Thursday, April 10

Breakfast in the Dining Hall and coffee provided

8:30 am Welcome, Introductions and Overview of our task at hand

Welcome to OIMB

OPAC process: how we got here

STAC roles and current requests from Marine Reserves Working Group

Review of draft goals and objectives approved by OPAC

Work Plan for this meeting

Questions, discussion

Craig Young, OIMB

Greg McMurray, OPAC

Selina Heppell, OSU

Jack Barth, OSU

BREAK to load presentations

9:30 am Short presentations – please limit to 20 minutes

Review of the “rules of thumb” developed for reserve siting in CA

Rick Starr, Moss Landing

Marine Lab and Mark

Carr, UCSC

Review of theoretical approaches

Will White, UC Davis

Review of data on invertebrates and larval dispersal

Alan Shanks and Craig

Young, U Oregon

Review of available data and maps

Physical oceanography: chemistry, currents  
and dispersion models

Mike Kosro, Hal

Batchelder and Jack

Barth, OSU

Fine-scale habitat mapping and species associations

Dave Fox, ODFW

Habitat Maps

Chris Goldfinger, OSU

LUNCH at OIMB

2pm – Work Session begins

Issue #1: Size and configuration?

- Review of existing synthesis documents on relationship between reserve size and biological response – what responses can be expected for reserves of different size?
- Review available data on home range, movement of adults and juveniles of local species
- Review habitat types and maps, discuss need to extend shore-based reserves to deeper water

- Discuss approaches, recommendations that can be made with existing data, certainty of those recommendations, and what additional synthesis or research could be done over the short- and longer-term

BREAK

Issue #2: Spacing?

- Review data and theory on network concepts, connectivity
- Review dispersal information, habitat distribution, and physical oceanography of the Oregon coast
- Discuss approaches, recommendations that can be made with existing data, certainty of those recommendations, and what additional synthesis or research could be done over the short- and longer-term

Additional discussion as needed. Break around 5:30.

DINNER at OIMB 6:30 pm

## **Day 2 Friday, April 11**

Breakfast in the Dining Hall and coffee provided

8:30 am Synthesis: Matching Oregon's objectives to what we know

- What can be recommended, based on available information?
- Is there short-term (< 1 year) data gathering or synthesis that could contribute?
- How do size and spacing recommendations vary according to goals and objectives?
- Develop consensus statements for report to OPAC

BREAK

Continue Synthesis Discussion and outline report to OPAC

Next Steps

Conclusion of the Workshop – noon on April 11.

**Table 3. Adult species movement table (CA species).**

0 – 1 km	1 – 10 km	10 – 100 km	100 – 1000 km	> 1000 km
<b>Invertebrates</b> Abalone Mussel Octopus Sea Star Snail Urchin <b>Rockfishes</b> Blk. & Yellow China Gopher Grass, Kelp <b>Other Fishes</b> Sheephead Greenling Surf perches Eels	<b>Rockfishes</b> Black Brown Copper Greenspotted Olive Vermilion <b>Other Fishes</b> Cabezon Ca. Halibut Lingcod	<b>Invertebrates</b> Dung. Crab* <b>Rockfishes</b> Bocaccio Canary Yellowtail Widow <b>Other Fishes</b> Anchovy Herring Sardine <b>Birds</b> Gulls Cormorants <b>Mammals</b> Harbor Seal Otter	<b>Fishes</b> Big Skate Pacific Halibut Sablefish* Salmonids* Sturgeon Whiting* <b>Birds</b> Gulls* <b>Mammals</b> Porpoises Sea Lions*	<b>Invertebrates</b> Jumbo Squid* <b>Fishes</b> Sharks* Tunas* <b>Turtles*</b> <b>Birds</b> Albatross* Pelican* Shearwater* Shorebirds* Terns* <b>Mammals</b> Dolphins Sea Lions* Whales*
				* Seasonal Migration

**Table 4. Results of a species-area curve analysis in California.**

Habitat	Representation needed to encompass 90% of biodiversity	Data Source
Rocky Intertidal	~0.5 linear miles	PISCO Biodiversity
Shallow Rocky Reefs/Kelp Forests (0-30 M)	~1 linear miles	PISCO Subtidal
Deep Rocky Reefs (30-100 M)	~0.1 square miles	Starr surveys
Sandy Habitat (30-100 M)	~10 square miles	NMFS triennial trawl surveys 1977-2007

**Figure 1. Estimated proportion of species per area or linear distance of habitat – California**

