Applications of Side-Scan Sonar and In Situ Submersible Survey Techniques to Marine Fisheries Habitat Research

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Interest in the assessment of marine benthic habitats is rapidly growing. As coastal resources are being increasingly modified by combined natural and human disturbances, the direct and indirect impacts on benthic fisheries are of concern and need to be addressed. With the recent reauthorization of the Magnuson Fishery Conservation and Management Act ("Sustainable Fisheries Act"), a congressional mandate now requires identification and implementation of essential habitat for managed fish species. Large concentrations of marine fishes have been associated with banks, seamounts, pinnacles, and other isolated rocky features in deep water. There is relatively little information on the distribution, abundance, and other ecological characteristics of fishes in deepwater rocky habitat.

Rockfishes (Sebastes spp.) are one of the most numerous, diverse, and economically important groups of fishes on rocky outcrops along the west coast from Alaska to California. Diversity, quality, and extent of habitat likely are among the most significant environmental determinants of distribution, abundance, and diversity of adult rockfishes. Because of their close association with rugged heterogeneous bottom substrata of high relief, abundance and use of habitat are difficult to estimate accurately using conventional trawl surveys. Species near deepwater outcrops are particularly inaccessible.

Many species of rockfishes are slow-growing, long-lived, mature at older ages, and have extremely variable recruitment, which leaves them particularly vulnerable to overexploitation. Indeed, declines in abundance and size of economically valuable species now are being noted. Like other coastal fisheries, as local stocks become depleted in shallow water and more effective gear is developed, fishing effort for rockfishes has expanded into deeper and more remote areas. It is now all the more critical to gather information on rockfish populations and the function and value of their habitats in deep coastal waters.

Studies of marine fish assemblages and their habitat requirements are limited by available technology. Mapping habitats and landscape features has been conducted traditionally in either terrestrial or shallow aquatic settings, where sampling and surveying are much easier to perform than in deep ocean environments. Over the past three years, an interdisciplinary team of marine fishery biologists, geologists, and ecologists from federal and state resource management agencies and academic institutes has been pioneering the research on bottom-dwelling rockfishes associated with deepwater shelf and canyon habitats. With funding from NOAA's West Coast National Undersea Research Center, NOS Sanctuary and Reserves Division, and now California Sea Grant, we have combined the use of side-scan sonar, bottom profiling, and manned submersible operations to effectively identify and characterize large- (i.e., 100's of meters to kilometers) and small-scale (i.e., 1 meter to 10's of meters) habitats that support adult rockfishes in deep water (i.e., 50-300 m water depth), and to compare abundance, size, and small-scale distribution and habitat specificity for rockfishes at both lightly- and heavily-fished sites. Because benthic habitats are defined by their geologic attributes, geophysical techniques are critical in determining habitat structure and lithology. These geologic descriptions can be applied to associated biological assemblages.

Side scan sonar is a suitable method for differentiating blocks of hard substrata from surrounding soft sediments based on differences in intensity of reflected sound. Seafloor morphology is imaged on a sonograph that resembles the negative of a black and white photograph. Topographic features such as ledges, vertical walls and boulders produce dark and light images on the records, depending on the orientation of the feature. A strong signal (dark) is received from the side of the feature facing the transducer while a weak signal or shadow (light) is received from the side sloping away from the transducer. The sonographs along each track line are combined with Global Positioning System (GPS) navigational data to form accurate mosaics of benthic habitats. These seafloor mosaics are used to quantify the amount of various hard substrata (e.g., rock ridge, boulder or cobble fields, sand waves, etc.) available at depths suitable to rockfishes.

Interpretations from the remotely sensed sonographs are verified from direct observations made during dives in a manned-submersible. Type, relief, size and depth range of features are described; these field descriptions assist in planning dives at each site and for post-cruise assessment of habitat.

We have successfully used a small manned submersible to groundtruth the remotely-sensed acoustic images, as well as to identify and quantify fish assemblages and associated habitats. Parallel lasers mounted on either side of an external video camera were used to accurately estimate the size of fishes, distance traveled along a transect, and size of habitat patches. These *in situ* observations are especially critical when focusing on benthic habitats of extreme heterogeneity and biological assemblages of high diversity. Much of the biological and habitat information is entered into a Geographic Information System, which is useful to other researchers addressing related topics in spatial management of coastal resources.

We are now applying these techniques to an evaluation of harvest reserves as alternate management tools for marine fisheries. Characterizing and quantifying attributes of available habitat are critical in evaluating the effectiveness of harvest reserves in maintaining regional fish resources. Information on distribution and abundance of fishes living near their maximum depth range should contribute to our understanding of the role that deepwater habitats play in maintaining the health of populations being harvested in more accessible habitats.

Our approach and methodologies are currently being introduced to the South Pacific Applied Geoscience Commission (SOPAC). Using habitat studies in temperate regions as a template, we are suggesting new uses, interpretation, and evaluation of coastal and seafloor geological data in terms of identifying and describing significant fisheries habitats in the SOPAC region. These techniques also are being used successfully by investigators in southeastern Alaska to more accurately estimate densities of commercially important fishes on a habitat-specific basis, thereby improving the management of demersal shelf rockfishes within the region. *In situ* submersible surveys and geophysical remote sensing of the seafloor are a unique combination of techniques that are essential in appraising and managing our deepwater coastal resources.

Ocean Currents and the Distribution of Pacific Whiting (Merluccius productus) along the Pacific Coast during Summer, 1995

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Acoustic-trawl surveys have been conducted triennially since 1977 by the Alaska Fisheries Science Center (AFSC) to assess the abundance and distribution of Pacific whiting (Merluccius productus) along the US and Canadian west coasts. The most recent AFSC acoustic-trawl survey was conducted during 1 July - 1 September 1995 over the continental shelf and upper slope from near Point Conception, California (34°30'N) to Dixon Entrance, Alaska (54°30'N).

Because significant interannual differences have been observed between 1977-1992 in the distribution of Pacific whiting based on the AFSC survey results (Dorn 1995, CalCOFI Rep. 36: 97-105), efforts were initiated in 1995 to directly measure several biological and physical processes that likely influence the spatiotemporal distributional patterns of Pacific whiting. Thus, two frequencies (38, 120 kHz) rather than one (38 kHz on earlier surveys) were used to collect echo integration data to describe the biological scattering. Two frequencies can increase the ability to identify different sound scatterers on the basis of their acoustic signatures. The added frequency may enable back-scattering from the principal prey (i.e., euphausiids) of Pacific whiting to be identified. An acoustic Doppler current profiler (ADCP) was also used for the first time in 1995 to describe ocean currents during the entire survey. This work reports on the progress in determining the distributions of Pacific whiting and their principal prey (i.e., euphausiids), as well as a description of the near-surface currents along the Pacific coast based on the 1995 survey data.

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CHANGING OCEANS AND CHANGING FISHERIES: ENVIRONMENTAL DATA FOR FISHERIES RESEARCH AND MANAGEMENT A WORKSHOP

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