Using Video Observations From Submersibles and Laser Line Scanners to Survey Benthic Fishes, Macro-Invertebrates and Habitat Types in Deepwater off California

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The Southwest Fisheries Science Center's (SWFSC) Santa Cruz Laboratory has developed a research program to effectively respond to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) mandates with respect to West Coast groundfishes. Several West Coast groundfish species have been designated as overfished; it is especially important to characterize and protect essential fish habitat (EFH) of these species and to improve our assessments of these stocks. From past research, we know that adults of many species of rockfishes, in particular, are difficult (or impossible) to accurately appraise with traditional survey methodologies such as surface-based fishing and acoustic gear. This is due to the close association between many of these species and their rugged, rocky heterogeneous habitats. Additionally, classification of habitat attributes on scales pertinent to animal distributions and ecological problems in deepwater marine environments is difficult because of the restricted access to this system. Consequently, we have been developing new tools, technologies, and partnerships to characterize deepwater fishes and habitats since 1992.

We are using direct observation and video transects from occupied submersibles, together with geophysical seafloor mapping techniques, to improve assessments and track the recovery for some groundfish species and their associated habitats. We have applied this approach to de facto marine reserves, in and adjacent to marine protected areas, submarine canyon heads, and rocky areas elsewhere along California. Several funding opportunities for marine groundfish habitat research both within Fisheries and from other NOAA offices (Sea Grant, Undersea Research Program (NURP), Ocean Exploration, NOS), USGS, state agencies, and private foundations have been successfully pursued in implementing our program. Our general research goals are to describe and conserve EFH, identify areas in need of additional protection, and improve assessments of groundfish populations. Our approach is especially critical when focusing on benthic habitats of extreme heterogeneity and biological assemblages of high diversity.

Current Projects

Cowcod Conservation Areas Surveys

In collaboration with Milton Love (University of California Santa Barbara) and researchers from Moss Landing Marine Labs and the California Department of Fish and Game, and with funding from NMFS' Offices of Protected Resources and Habitat Conservation, NURP, NOAA Center For Marine Protected Areas (MPA) Science, and the David and Lucile Packard Foundation, we have initiated a monitoring protocol for fish, macroinvertebrates, habitats, and incidence of fishing gear disturbance on offshore banks in and around the Cowcod Conservation Areas (CCA) off southern California. Underwater surveys of groundfish populations and their habitats were conducted off southern California using non-extractive video-transect methodologies and direct observations from an occupied research submersible (*Delta*; Figs. 1,2).

We asked two fundamental questions of our research: (1) are the CCAs meeting their objective to protect and rebuild the cowcod population? and (2) can we effectively survey cowcod (and, by extension, other benthic fishes) by direct observation rather than by conventional techniques such as hook and line or bottom trawl?

Digital geo-referenced maps of the seafloor acquired from available side-scan sonar, multibeam bathymetry, seismic reflection, and other past geophysical surveys were used to identify and select sites of appropriate bottom type and depth. Past and recent groundfish catch and effort records were also used to assist in locating appropriate survey sites. We tracked the submersible in real-time in relationship to depth and seafloor habitats. We used line transect methodology to estimate densities (and associated CVs) of cowcods on the rocky banks within the CCAs. Absolute abundance of cowcods (juvenile and adults separately) was estimated by expanding the density estimates by the total area represented by the habitats surveyed on each bank.

We also used video transects from this survey to quantify structure-forming invertebrates as components of benthic habitat in the CCAs. There is increasing interest by science and conservation communities in the potential impacts that fishing activities have on megafaunal benthic invertebrates, such as sponges and corals, occurring in continental shelf and slope ecosystems, and the role these large invertebrates have in enhancing the diversity and structural component of fish habitat. We are collaborating with Brian Tissot (Washington State University, Invertebrate Ecologist) to describe patterns in the density, distribution, and size of structure-forming megafaunal invertebrates on the deep rocky banks and outcrops in the CCAs. Our specific objectives are to identify structure-forming invertebrates, quantify their density and size distributions specific to depth and substratum types, and quantify associations between

Figure 1. The *Delta* research submersible accommodates one scientific observer and one pilot, has a maximum operating depth of about 350 m, and a cruise speed of 1.5 knots. We equipped the submersible with three video cameras: a low-light, wide-angle black-and- white CCD camera positioned externally on the bow; a High-8 color video camera and associated lights externally positioned on the starboard side and flanked by paired lasers at a distance of 20 cm apart; and a hand-held digital video camera positioned inside the submersible in the lower port on the starboard side. (photo credit: M. Yoklavich)

large, structure-forming invertebrates and other organisms, particularly fishes. About 520,000 megafaunal invertebrates of 15 taxa were observed in the video footage. Deep-sea corals and sponges were the largest structure-forming invertebrates but were relatively uncommon. The corals were patchy in distribution and were found in low-relief mixed cobble-boulder- sand habitats at 100-225 m depths. Few large invertebrates and almost no fishes appeared to be associated with these animals. Our comprehensive survey and analysis of the distribution, abundance, and species composition of large invertebrates in the Southern California Bight is unique and contributes new and significant information to our understanding of biodiversity, indicators of environmental conditions, and components of essential fish habitats.

We will use these established baselines of groundfish species, megafaunal invertebrates, and associated habitats to monitor changes within the CCAs by conducting direct observation surveys of abundance, size structure, and diversity on a routine basis.

Intercalibration of Direct Observation and Extractive Survey Methods

We are using direct observation methods and video transects from an occupied submersible to survey fishes and habitats in 100 m water depth at the location of longline surveys conducted off central California. Our objective is to compare occupied submersible quantitative transect methods with bottom longline methods for determining abundance, size and species composition, catchability coefficients and selectivity, and appropriate conversion factors for relative and absolute abundance. Quantitative transect methods, collection of accurate visual observation and navigation data, database management and analysis follow protocols based on our past experience with in situ methods. This study includes participation by a commercial longline fisherman in the submersible operations. Our results should contribute to improved assessments of groundfish stocks in untrawlable habitat off California.

Fish and Habitats at Varying Spatial Scales

Many species of groundfishes are strongly associated with specific substratum types. A predictable relationship between organism and habitat presents the possibility of using habitat as a proxy for distribution and abundance of fish species over large areas. The ability to extrapolate up to large scales relies on the capability to map the seafloor, over areas of interest and calculate the availability of benthic habitats. Acoustic systems such as sidescan and multibeam sonars collect wide swaths of seafloor data and thus can map large regions quickly. The interpretation of acoustic data into seafloor classifications however is complex, and requires reliable and accurate groundtruthing to transform the acoustic signal into biologically meaningful information.

In a collaborative effort between USGS, National Marine Fisheries Service, and NOAA's National Marine Sanctuaries Program off California (Cordell Bank, Channel Islands, and

Figure 2. A vermilion rockfish (*Sebastes miniatus*) viewed from the porthole of the *Delta*. (photo credit: M. Nishimoto).

Monterey Bay), Tara Anderson (a post-doctoral fellow) is testing a novel application of a video camera sled to groundtruth seafloor habitat maps in real time. To characterize abiotic and biotic aspects of the seafloor, a series of multidirectional transects are conducted using a mini video camera sled. Video observations are annotated in real time every 30 seconds using an electronic programmable keypad integrated with navigational software. These seafloor characterizations adequately describe substratum types, bedform, relief, and presence of benthic macro-organisms. These data are used to groundtruth acoustic mosaics of the seafloor within hours of its collection, providing an initial description of seafloor habitats and some aspects of their communities. This approach is ideal for those projects that require rapid feedback.

Laser Line Scan Development

One of our challenges is to efficiently relate small-scale observations and assessments of animal-habitat associations to the large geographic scales on which benthic fisheries operate. Laser line scan (LLS) systems potentially can serve as a bridge between fine resolution, low coverage video survey tools (e.g., remotely-operated vehicle (ROV), occupied submersible, towed sled) and coarse resolution, high coverage acoustic technologies (e.g., multibeam and sidescan sonar). In an evaluation of LLS for fishery habitat assessments, the Habitat Ecology Team conducted a survey off the central coast of California using a Northrop-Grumman SM-2000 LLS. A video survey also was conducted using an ROV across parts of the study area to groundtruth the LLS data and to compare observations made from a forwardlooking video camera with those from LLS reflectance imagery. The LLS was successful in generating high resolution (1-2 cm across-track) imagery of rock outcrops, sand waves and ripples, drift kelp, patches of large anemones, groups of fishes off and on the seafloor, starfish, sea pens, and salp chains. As expected, the LLS system provided imagery of higher areal coverage but with a lower degree of taxonomic identification than the ROV video.

Developing the capability to process and mosaic imagery and produce seafloor maps is a significant step in advancing the efficient application of LLS technology. To assess the mapping capabilities of the system, we generated a tiled-image mosaic of georeferenced LLS data with 2-cm pixel resolution across the survey area. The data acquisition hardware down-sampled or did not log all sensor data, which made an accurate expression of the LLS configuration (i.e., instrument settings) difficult to achieve. As a result, a large degree of detail and object recognition observed in the original LLS imagery was lost upon geometric translation. However, combined with information obtained from reviewing the original imagery, the mosaic representation did demonstrate spatial configuration and context of organisms and geologic features at varying spatial scales. This system has been newly revised based on results from our field studies and is now ready for further evaluation as an advanced imaging technology for EFH and improved stock assessments**.**

For Further Reading

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Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis

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