NMFS Southwest Fisheries Science Center

Draft Agency Report to the Technical Subcommittee

of the Canada-U.S. Groundfish Committee

April 2013

Edited by Xi He and John Field

With contributions from John Hyde,
Andrew Thompson, Cindy Thomson, Susan Sogard, and Mary Yoklavich

A. AGENCY OVERVIEW

The Southwest Fisheries Science Center (SWFSC) conducts fisheries and marine mammal research at three laboratories in California. Activities are primarily in support of the Pacific Fishery Management Council, the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), as well as a number of international fisheries commissions and conventions. The Director is Dr. Francisco Werner and the Deputy Director is Kristen Koch. All three SWFSC laboratories have supported the essential needs of the NMFS and the Pacific Fishery Management Council (PFMC) for groundfish, including as active members of the PFMC's Scientific and Statistical Committee (SSC), the Groundfish Management Team, and other management teams and advisory bodies.

The Center is headquartered in La Jolla, which hosts three divisions that conduct research on a wide range of Pacific and Antarctic fish, marine mammals, sea turtles, and marine habitats; the Antarctic Ecosystem Research Division (led by Dr. George Watters), the Marine Mammal and Turtle Division (formerly the Protected Resources Division, led by Dr. Lisa Ballance), and the Fisheries Resources Division (led by Dr. Russ Vetter). The Fisheries Resources Division (FRD) conducts research on groundfish, large pelagic fishes (tunas, billfish and sharks), and small coastal pelagic fishes (anchovy, sardine and mackerel), and is the only source of groundfish research at the La Jolla facility. The Fisheries Research Division is also the primary source of federal support for the California Cooperative Oceanic Fisheries Investigations (CalCOFI) surveys that have taken place along much of the California coast since 1951. Researchers at FRD have primary responsibility for ichthyoplankton collections, studies of species abundance and distribution (including responses to climate variability), systematics, and the application of early life history information to stock assessments.

The Fisheries Ecology Division (FED), located in Santa Cruz and directed by Dr. Steve Lindley, comprises two research branches. The Fisheries Branch (led by Michael Mohr) conducts research and stock assessments in salmon population analysis, economics, groundfish, and fishery oceanography of salmonids and groundfish. The Ecology branch (led by Dr. Susan Sogard) conducts research on the early life history of fishes, salmonid ocean and estuarine ecology, habitat ecology, and the molecular ecology of fishes. Specific objectives of the FED groundfish programs include: (1) collecting and developing information useful in assessing and managing groundfish stocks; (2) conducting stock assessments and improving upon stock assessment methods to provide a basis for harvest management decisions at the PFMC; (3) characterizing and mapping biotic and abiotic components of groundfish habitats, including structure-forming invertebrates; (4) disseminating information, research findings and advice to the fishery management and scientific communities; and (5) providing professional services (many of which fall into the above categories) at all levels, including inter-agency, state, national and international working groups. An FED economist represents the SWFSC on the Pacific Council's Groundfish Management Team.

The Environmental Research Division (ERD) is led by Acting Director Dr. Steven Bograd and is located at the Pacific Fisheries Environmental Laboratory (PFEL) in Pacific Grove. The ERD is a primary source of environmental information to fisheries researchers and managers along the west coast, and provides science-based analyses, products, and information on environmental

variability to meet the agency's research and management needs. The objectives of ERD are to: (1) provide appropriate science-based environmental analyses, products, and knowledge to the SWFSC and its fishery scientists and managers; (2) enhance the stewardship of marine populations in the California Current ecosystem, and other relevant marine ecosystems, by understanding and describing environmental variability, the processes driving this variability, and its effects on the production of living marine resources, ecosystem structure, and ecosystem function; and (3) provide science-based environmental data and products for fisheries research and management to a diverse customer base of researchers, decision-makers, and the public. The ERD also contributes oceanographic expertise to the groundfish programs within the SWFSC, including planning surveys and sampling strategies, conducting analyses of oceanographic data, and cooperating in the development and testing of environmental and biological indices that can be useful in preparing stock assessments.

B. MULTISPECIES STUDIES

B1. Factors affecting rockfish fecundity

Investigators: Susan Sogard (FED, SWFSC), John Field (FED, SWFSC), Chris Harvey (FRAM, NWFSC), and Sabrina Beyer (UCSC)

The Fisheries Ecology Division has been studying spatial and temporal variability in fecundity for rockfish species residing in the California Current. We have obtained sufficient numbers for analysis of 3 species thus far: chilipepper, *Sebastes goodei*; yellowtail, *S. flavidus;* and speckled rockfish, *S. ovalis*. Females were sampled from four locations spanning the coast of California from Eureka to Santa Barbara during the winter parturition seasons (November through March) of 2009, 2010 and 2011 to assess spatiotemporal effects on fecundity. Summary results were submitted for publication (Beyer et al., in review). Maternal size and age were positively correlated with relative fecundity (Φ_{rel}, larvae per g somatic weight) for all three species, indicating a disproportionately greater reproductive output by older, larger females (Figure B1). Yellowtail rockfish had the highest absolute fecundity and Φ_{rel}, the greatest maternal size effect and produced the smallest eggs. Size-dependent Φ_{rel} relationships were incorporated into published stock assessment models that originally assumed egg production to be directly proportional to spawning biomass. Spawning biomass tended to overestimate egg production of the stock compared to the updated model that explicitly accounted for size-dependent fecundity; especially when larger, older females were removed from the population through exploitation. In addition, fecundity varied spatially among sampling sites (chilipepper and yellowtail) and by year (chilipepper). Speckled rockfish lacked adequate sample size to assess spatiotemporal trends in fecundity. Chilipepper and speckled rockfish produced multiple broods annually in southern California and to a lesser extent in central California, complicating estimates of annual fecundity. Yellowtail, in contrast, have not been found to produce multiple broods. Egg production was positively correlated with female condition, indicating that environmental variability in oceanographic conditions and productivity may drive changes in fecundity and reproductive strategy (i.e. single versus multiple broods) in these species.

A companion project begun in 2012 is comparing capture rates of rockfish and other groundfish species in areas that have been closed to fishing for at least a decade (via Rockfish

Conservation Areas) versus areas that have been open to fishing throughout this time. This project is focused on the central coast of California. We are comparing current CPUE with rates measured by CDFW researchers in the late 1980s/early 1990s, using closely matched fishing methods.

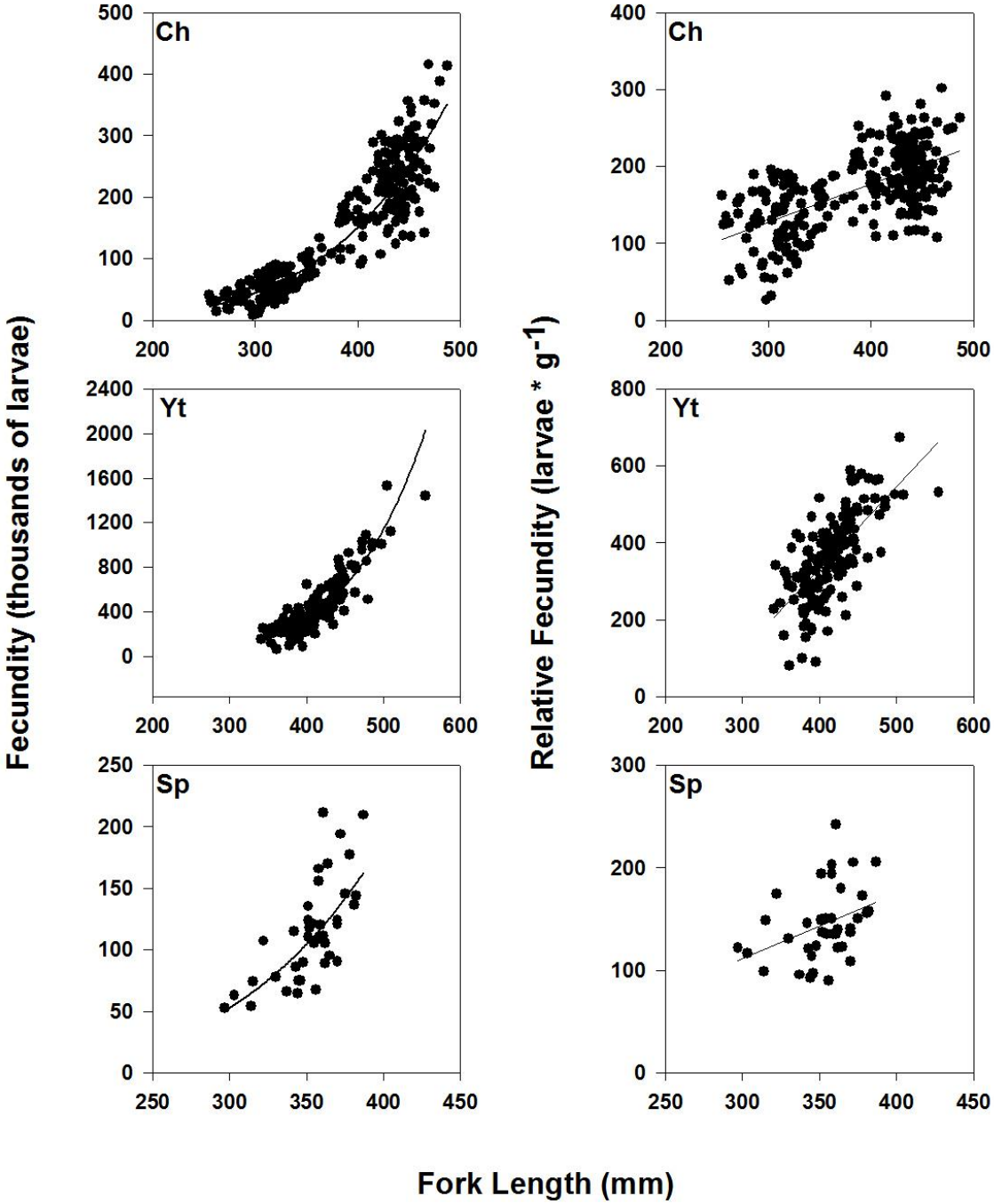

Figure B1. Relationship of maternal size with absolute fecundity (left) and Φ_{rel} (right) for chilipepper (Ch), yellowtail (Yt), and speckled (Sp) rockfish.

B2. Juvenile Surveys

The Fisheries Ecology Division of the SWFSC has conducted an annual midwater trawl survey for juvenile rockfish and other pelagic micronekton along the Central California coast in late spring (May-June) since 1983. The survey targets pelagic juvenile (pelagic age 0) rockfish for fisheries oceanography studies and stock assessments, while simultaneously monitoring the micronekton forage assemblage (including other juvenile fishes, krill, coastal pelagic species, and mesopelagic species) and collecting oceanographic information. The results here summarize trends in the core area since 1990, as not all species were consistently identified in earlier (1983-1989) years of the survey. The standardized anomalies from the log of mean catch rates are shown by year for six key forage species and assemblages that are sampled in this survey (Figure B2). Trends in 2011 and 2012 were of higher productivity for the species and assemblages that tend to do better with cool, high transport conditions, including juvenile rockfish, market squid and krill (see also Santora *et al*. 2012). In 2011, juvenile rockfish were more abundant then they had been since the early 2000s, and juvenile abundance remained relatively high in 2012. Market squid and krill were at above average levels in 2011, and very high levels in 2012; with market squid in particular estimated to be at the highest relative abundance in the time series. Other coastal pelagic species (adult northern anchovy and Pacific sardine) continued to be encountered at low levels, although this is likely a greater reflection of their local availability and ocean conditions rather than their coastwide or regional abundance. Notably, in 2012 the abundance of several types of gelatinous zooplankton was extraordinarily high, particularly that of several species of salps (pelagic tunicates), as well as pyrosomes and heteropods. The abundance was sufficiently great that the mass of gelatinous zooplankton damaged sampling gear, and resulted in some offshore trawl stations being abandoned for the first time in the 30 year history of this survey.

Several publications from this survey were completed or are in press related to this survey. Ralston et al. (in press) report on nearly three decades of interannual variability in pelagic juvenile rockfish abundance, and evaluate the relationship between indices of abundance and both physical environmental correlates as well as the results of age structured stock assessments. They found that juvenile rockfish abundance is strongly correlated with relative sea level height anomalies, suggesting that although basin scale climate indices (such as MEI, PDO, NPGO, and NOI) are poorly correlated with abundance, large scale processes (transport) are important drivers of year-to-year variability in recruitment. A comparison of the shared trend in juvenile abundance with recruitments from five rockfish stock assessments shows that the time series are significantly correlated, although there are indications that indices from a broader spatial scale will be more appropriate. Another study evaluated catch data of a wide range of micronekton species, together with physical data from CTD casts and satellite and other observational data, to characterize pelagic habitat structure (Santora *et al*. 2012). This study found strong correlations between environmental (physical, primary productivity) conditions and micronekton community (krill, coastal pelagics, juvenile groundfish, mesopelagic species), indicative of significant coupling between physics and productivity (phytoplankton), secondary consumers (micronekton/forage species) and higher trophic level predators (seabirds, marine mammals).

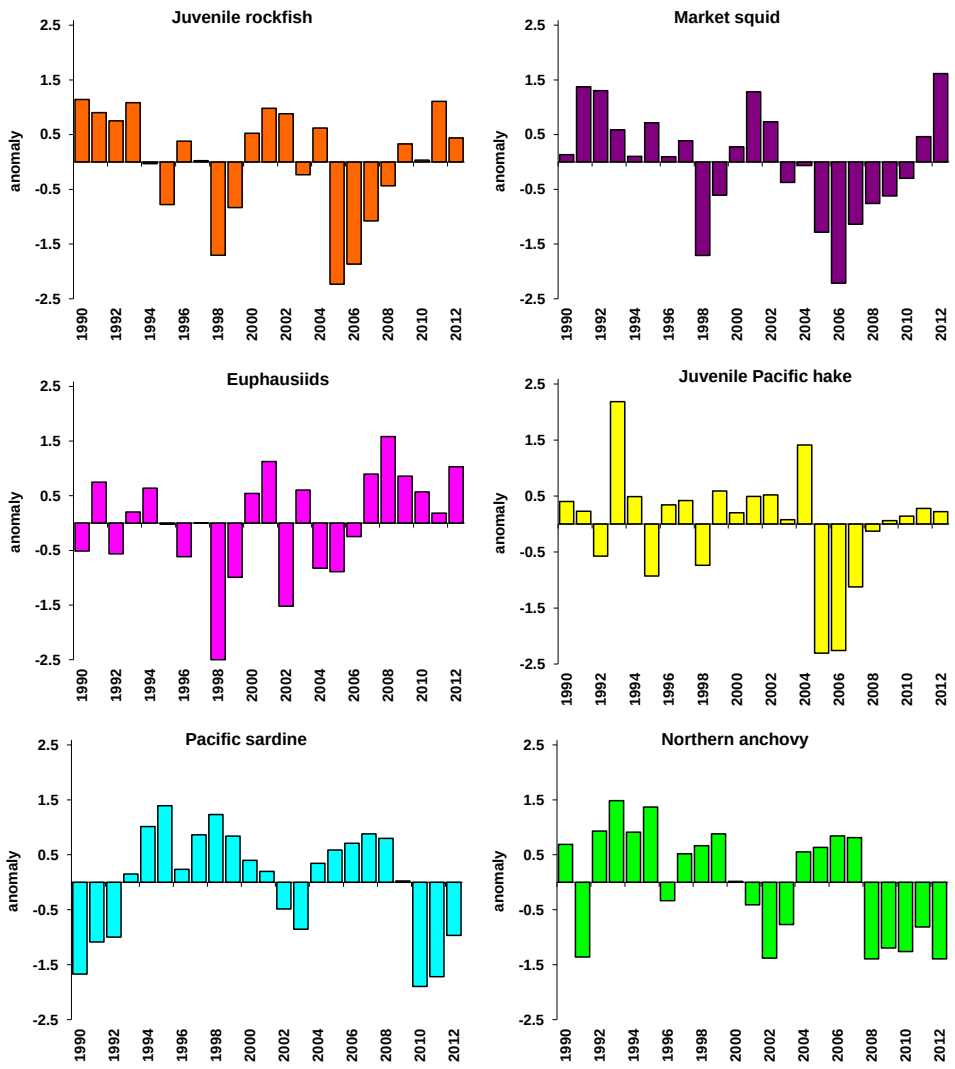

Figure B2: Long-term standardized anomalies of several of the most frequently encountered pelagic forage species from the central California rockfish recruitment survey in the core region (1990-2012).

B3. Ichthyoplankton and larval Rockfish Research (Fish Ecology group, FRD)

During the past year FRD scientists conducted research on larval rockfishes in two areas. First, they completed genetic identification of rockfish larvae collected from approximately 98 bongo samples within and around the Cowcod Conservation Area in February, 2005. Staff are currently in the process of analyzing and writing up the results of this work. Preliminary results identified 34 different species of rockfishes and revealed potential biogeographic breaks within the Southern California Bight as the rockfish assemblage differed significantly east and west of the Santa Rosa ridge and north and south of the Channel Islands. Second, researchers made significant progress sorting larval rockfishes from ethanol-preserved CalCOFI bongo samples. CALCOFI samples have been stored in ethanol since 1997, and our goal is to develop a species-specific rockfish time series. Currently, we have sorted samples from 2002-2005 and are working on 2011. During the next year we plan to begin using genetic tools to identify the CALCOFI rockfish larvae to test whether the assemblage has changed over the past 15 years in the Southern California Bight.

C. BY SPECIES, BY AGENCY

C1. Shelf Rockfish

C1.1. Rockfish barotrauma and behavior research (Fish Ecology group, FRD)

The SWFSC Genetics and Physiology program continues to evaluate post-release survival of rockfish (*Sebastes* spp.) suffering from barotrauma and released using recompression devices. This work relies upon the use of externally attached acoustic tags equipped with depth and accelerometer sensors to send data to a receiver array that allows us to determine survival and behavior of released fish. Building upon previous work we expanded our receiver array at the 43 fathom bank to allow us to incorporate 3D tracking of individual fish in addition to the basic behavior and survival data that we were previously collecting. These tracking data will provide a rare insight into natural movements (horizontal and vertical) at fine temporal (~ 4min data points) and spatial (+/- a few meters) scales, allowing us to better understand habitat and foraging behavior which ultimately will inform capture probabilities in visual and acoustic based surveys. In addition to fish tracking, 2 oxygen loggers were deployed at ~80m and ~180m to characterize the seasonal incursion of hypoxic water into this important depth habitat for rockfishes in southern California and allow us to monitor behavior of fish in relation to oxygen saturation.

In FY13 we have deployed 12 tags on bocaccio (*S. paucispinis*) and 20 on cowcod (*S. levis*) and plan to deploy an additional 20 tags on cowcod in coming months. The survival estimates from our FY12 project are currently being considered by the management council for incorporation into management decisions. However, as sample size for most species was ~ 12 animals (n=9 cowcod) there is a need to gather more data to refine these estimates and hopefully the FY13 efforts will satisfy this need for cowcod.

Though precision of these mortality estimates needs to be improved, there is no question that in situ recompression confers a higher probability of survival than surface releases. As a proactive measure we have been working with CPFV captains and industry representatives to encourage the use of descending devices aboard all CPFV boats in California that target rockfish. As part of the outreach component we have partnered with other groups to produce a humorous and educational outreach video (https://www.youtube.com/watch?v=EiZFghwVOyI) which has been disseminated widely on the internet and used as an outreach video at several fishing trade shows.

C1.2. Stock assessments

FED staffs are currently developing a number of stock assessments for shelf and nearshore rockfish for the 2013 PFMC stock assessment cycle. Bocaccio rockfish (*Sebastes paucispinis*) will undergo an update assessment in 2013, and preliminary results suggest that the 2010 year class continues to be a strong presence in both fisheries and survey data, while the 2012 year class is also likely to be fairly strong. Both of these year classes should accelerate progress towards rebuilding the stock. A full cowcod stock assessment will also be developed in 2013. Finally, a series of data-moderate assessments are currently under development by E. J. Dick and Alec MacCall, working with UCSC/CSTAR student Braden Soper. These models, and a similar set of models developed by NWFSC staff, were developed for brown rockfish, China rockfish (two areas), copper rockfish, sharpchin rockfish, stripetail rockfish, nominal

vermilion rockfish (two areas), and yellowtail rockfish (two areas). Models for two flatfish species, English sole and rex sole, are also being developed. The common feature of these data-moderate assessments was that they used only indexes of abundance, and do not use information on age or length compositions. The FED team took a Bayesian approach developed as an extension of Depletion-Based Stock Reduction Analysis, and the NEFSC team used Stock Synthesis, a maximum likelihood approach. These models will be reviewed in April of 2013.

C.1.2 Flatfish

A stock assessment of Pacific sanddab (*Citharichthys sordidus*) is currently under development for review in the summer of 2013. To improve on available age, reproductive ecology and other life history data, field data collection and laboratory examinations for Pacific sanddab have been conducted since early 2012, including estimation of spawning season and relationships between maturity and fecundity to fish size. The data were important inputs for the stock assessment since the species is being assessment in the first time. In addition, over ten thousand otoliths of Pacific sanddab from commercial fisheries and surveys were processed and provided to the stock assessment team. Finally, a series of data-moderate assessments are currently under development; although most of these represent assessments of rockfish (Sebastes) species, data-moderate assessments are also being conducted for English sole and rex sole.

D. OTHER RELATED STUDIES

D1. SWFSC FED current habitat activities

The SWFSC/FED Habitat Ecology Team conducts research in response to the mandates of the Magnuson-Stevens Reauthorization Act of 2006, with a focus on deep-water California demersal communities. Our goal is to provide sound scientific information to ensure the sustainability of marine fisheries and the effective management of marine ecosystems, with objectives to: (1) improve stock assessments, especially of overfished rockfish species in complex habitats; (2) characterize fish and habitat associations to improve EFH identification and conservation; (3) contribute to MPA design & monitoring and to Coastal and Marine Spatial Planning; and (4) understand the significance of deep-sea coral as groundfish habitat. The habitat team uses a variety of survey tools and approaches to improve assessments of demersal fishes, macro-invertebrates (including members of deep-water coral communities), and associated seafloor habitats in water depths from 20 to 900 meters off central and southern California. Habitat-specific distribution and densities of juvenile and adult life stages of numerous Pacific Coast demersal species have been determined from non-extractive, visual surveys conducted with remotely operated vehicles (ROV), manned submersibles, scuba, and towed cameras, coupled with seafloor maps of the continental shelf and upper slope off California. These surveys have resulted in habitat-specific assemblage analyses on multiple spatial scales; fishery-independent stock assessments; baseline monitoring of MPAs; documentation of marine debris on the seafloor; and predictive models of the distribution and abundance of deep sea coral communities.

D1.1 Underwater technologies to survey west coast groundfishes

The FED Habitat Ecology Team completed a final report (Yoklavich *et al*. 2013) of demersal fishes in southern California using Nuytco's occupied *Dual Deepworker* submersible (Figure D1). This survey is part of a "calibration study" to understand the capabilities of various technologies and methods to assess West Coast groundfishes. In addition to abundance and biomass estimates for demersal fishes surveyed with a manned submersible, preliminary comparisons are made between these data and those from an ROV survey conducted close to this time period at the same study site. The accuracy and precision of

such results, and the extent of associated ecosystem information collected during such a survey, will be more fully evaluated in consideration of results from the NWFSC/PIFSC Seabed AUV and the SWFSC COAST methodologies, both of which were part of this study. Results from this comparative study will be useful in future surveys of groundfishes in habitats that are not adequately surveyed by bottom trawls, and can be used to develop long-term plans to assess some west coast groundfish species.

Figure D1. Two-person submersible *Dual Deepworker* being launched off the F/V *Velero* during a survey of demersal fishes and habitats on the Footprint seamount in the Southern California Bight.

D1.2. Development of Predictive Models to Relate Population Abundance of Rockfishes and Habitats

FED Habitat Ecology Team members are developing statistical models that predict densities and biomass of demersal fish species in untrawlable areas, and are coupling these models with broad-scale seafloor habitat maps in a geographical-information-systems (GIS) environment to spatially predict fish densities/biomass on a regional basis. We are basing these models on fish data (identification, counts, sizes) collected during visual surveys conducted from manned submersibles off central California (Figure D2), and on a number of associated habitat variables (e.g., depth, substratum type, patch size and configuration). Spatial data sets are being compiled and the most up-to-date multibeam sonar data sets are being synthesized to provide a bathymetric base layer to support the spatially predictive models. These results will provide managers, policy makers, and the public with information that can be used in the conservation and management of sustainable marine resources (both the fisheries and associated habitats). Development of models of co-occurring species and associated habitats will have application to ecosystem-based management, providing information needed to manage a more complete demersal fish community. By including measures of spatial variability, this work will advance our understanding of the ecological processes that influence demersal fish distribution and abundance.

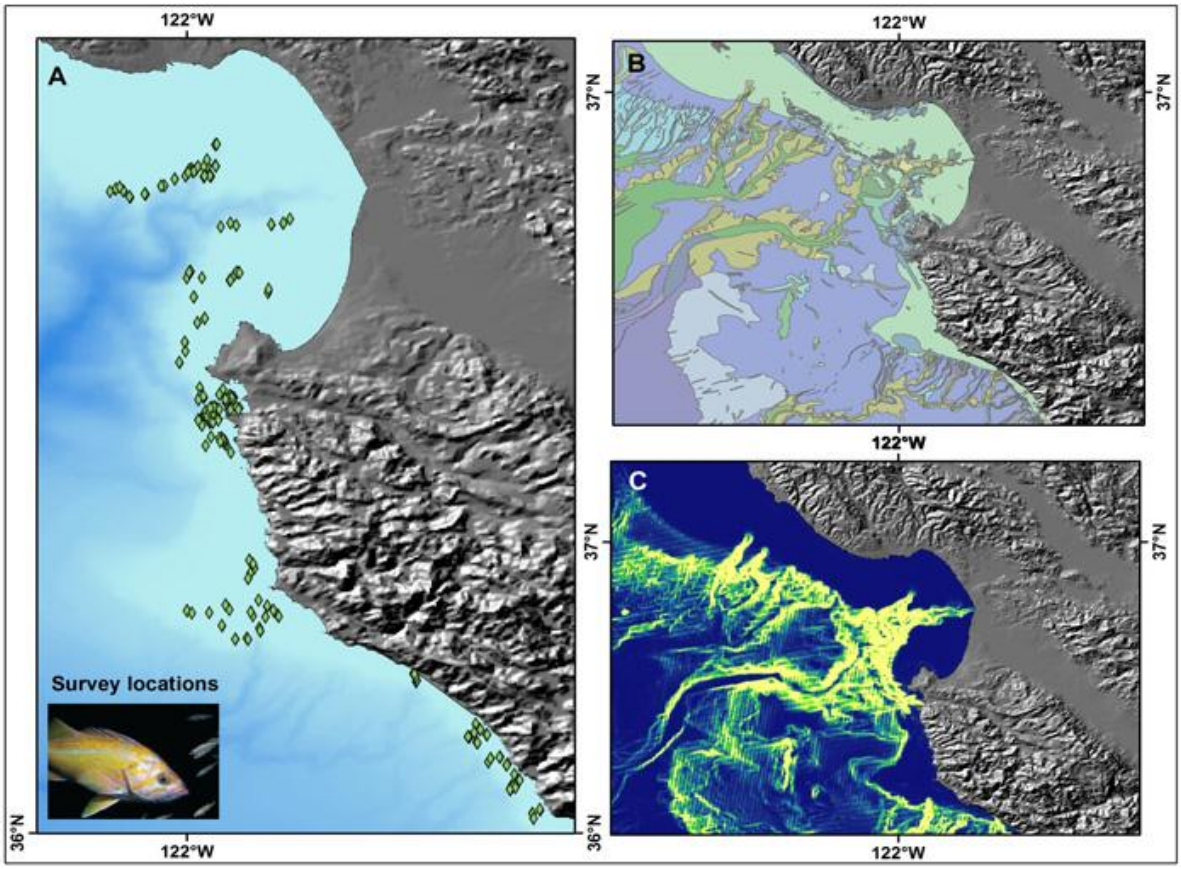

Figure D2. Spatial data sets compiled to support predictive modeling, including (A) map of submersible survey locations, (B) benthic habitat map, and (C) multibeam-derived product (e.g., habitat complexity, or rugosity).

D1.3. Predicting Distribution of Benthic Macro-invertebrates

As part of the California Seafloor Mapping Project (CSMP), the FED Habitat Ecology team continues to collaborate with USGS and others to create a suite of maps detailing seafloor morphology and geology and characterizing potential benthic habitats derived from high-resolution multibeam sonar data. These efforts are being conducted coastwide, from the Oregon-California border to Mexico. We have used a towed camera sled to groundtruth these data and to survey biological components of the habitats. From presence/absence of macro-invertebrates associated with specific sediment types, depth, and latitude, we have developed multivariate models using logistic regression to predict the distribution of various species. Coupling these results with spatial information on bottom type and depth, we have created maps of probability of occurrence of these important components of seafloor communities (Krigsman *et al*. 2012). These maps will provide managers, policy makers, and the public with information that can be used in the conservation and management of sustainable marine resources. Members of the FED Habitat Ecology Team have completed a draft manuscript describing models that predict distribution of density and sizes of the black coral (Anthipathes dendrochristos) using covariates of ocean currents, water depth, and primary productivity. Describing the relationships of these corals and environmental factors helps in understanding the demersal community structure and function.

D2. SWFSC FED Economics Team Activities

The FED's Economics Team hosted a Workshop on Productivity Measurement on June 11-13, 2012 in Santa Cruz. Productivity is a key metric for understanding profitability change, and has been identified as an indicator of economic performance in commercial fisheries for NMFS national reporting purposes. The major fishery on the Pacific coast for which such indicators are needed is the groundfish fishery. The Workshop was organized by FED and NEFSC economists and funded by NMFS Economics and Social Analysis Division. Workshop attendees included NMFS economists and other productivity experts from academia and federal agencies (U.S. Department of Agriculture, Environmental Protection Agency). The Workshop Proceedings (Mamula and Walden 2013) provide a compendium of the papers presented at the meetings.

The FED's Economics Team plans to conduct an economic survey of California anglers that focuses on recreational groundfish regulations as they relate to angler preferences and behavior. The survey is being designed in coordination with the California Department of Fish and Wildlife and groundfish biologists from FED and University of California, Santa Barbara. The survey will be conducted in early 2014, contingent on approval by the Office of Management.

E. GROUNDFISH PUBLICATIONS OF THE SWFSC, 2012 – PRESENT

E1. Primary Literature Publications

Beyer, S.G., Sogard, S.M., Harvey, C.J., and J.C. Field. In review. Variability in rockfish (*Sebastes* spp.) fecundity on the California coast: species contrasts, maternal size effects, and spatial differences. Mar. Ecol. Prog. Ser.

Butler, J. L., M. S. Love, and T. E. Laidig. 2012. A guide to the rockfishes, thornyheads, and scorpionfishes of the northeast Pacific. University of California Press. 185 p.

Field, J.C., C. Elliger, K. Baltz, G. Gillespie, W.F. Gilly, I. Ruiz-Cooley, D. Pearse, J.S. Stewart, W. Matsubu and W. Walker. In press. Foraging ecology and movement patterns of the Humboldt squid in the California Current. Deep Sea Research II.

Haltuch, M. A., O. S. Hamel, K. R. Piner, P. McDonald, C. R. Kastelle, and J. C. Field. 2013. A California Current bomb radiocarbon reference chronology and petrale sole (*Eopsetta jordani*) age validation. Canadian Journal of Fisheries and Aquatic Sciences 70(1):22-31.

Krigsman, Lisa M., Mary M. Yoklavich, E.J. Dick, and Guy R. Cochrane. 2012. Models and maps: predicting the distribution of corals and other benthic macro-invertebrates in shelf habitats. Ecosphere 3(1).

Laidig, Thomas E., Lisa M. Krigsman, and Mary M. Yoklavich. 2013. Reactions of fishes to two underwater survey tools, a manned submersible and a remotely operated vehicle. Fishery Bulletin 111(1):54-67.

Link, J.S., T.F. Ihde, C.J. Harvey, S.K. Gaichas, J.C. Field, J.K.T. Brodziak, H.M. Townsend, and R.M. Peterman. 2012. Dealing with uncertainty in ecosystem models: The paradox of use for living marine resource management. Progress in Oceanography 102:102-114.

MacCall, A. D. 2012. Data-limited management reference points to avoid collapse of stocks dependent on learned migration behaviour. ICES Journal of Marine Science 69(2):267-270.

Mangel, M., A. MacCall, J. Brodziak, E.J. Dick, R. Forrest, R. Pourzand, S. Ralston . in press. A Perspective on Steepness and Its Implications for Strategic Fishery Management and Stock Assessment. Canadian Journal of Fisheries and Aquatic Sciences.

Mamula, A. T., and J. B. Walden (eds.). 2013. Proceedings of the National Marine Fisheries Service Workshop on Productivity Measurement. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-503, 262 p.

Mason, J., R. Kosaka, A. Mamula, and C. Speir. 2012. Effort changes around a marine reserve: The case of the California Rockfish Conservation Area. Marine Policy 36(5):1054-1063.

Ralston, S., K.M. Sakuma and J.C. Field. In press. Interannual Variation in Pelagic Juvenile Rockfish Abundance– Going With the Flow. Fisheries Oceanography.

Santora, J.A., J.C. Field, I.D. Schroeder, K.M. Sakuma, B.K. Wells and W.J. Sydeman. 2012. Spatial ecology of krill, micronekton and top predators in the central California Current: implications for defining ecologically important areas. Progress in Oceanography 106: 154-174.

Santora, J. A., W. J. Sydeman, I. D. Schroeder, C. S. Reiss, B. K. Wells, J. C. Field, A. M. Cossio, and V. J. Loeb. 2012. Krill space: a comparative assessment of mesoscale structuring in polar and temperate marine ecosystems. ICES Journal of Marine Science 69(7):1317-1327.

Shelton, O., E. J. Dick, D. Pearson, S. Ralston, and M. Mangel. 2012. Estimating species composition and quantifying uncertainty in multispecies fisheries: hierarchical Bayesian models for stratified sampling protocols with missing data. Canadian Journal of Fisheries and Aquatic Sciences 69: 231–246.

Woodson, L. E., B. K. Wells, C. B. Grimes, R. P. Franks, J. A. Santora, and M. H. Carr. 2013. Water and otolith chemistry identify exposure of juvenile rockfish to upwelled waters in an open coastal system. Marine Ecology Progress Series 473:261-273.

Yoklavich, M., and H. G. Greene. 2012. The Ascension-Monterey Canyon System: Habitats of demersal fishes and macroinvertebrates along the central California coast of the USA. In: Peter T. Harris and Elaine K. Baker (eds.), Seafloor geomorphology as benthic habitat: GeoHAB atlas of seafloor geomorphic features and benthic habitats, p. 739-749.

E2. Other Publications

Blackhart, K, S. K. Brown, B. Chesney, E.J. Dick, K. Larsen, M. O'Farrell, K. Schaeffer, B. Spence, K. Stierhoff, D. Sweetnam, and M. Yoklavich. 2012. Regional habitat assessment prioritization for California stocks. Report of the Southwest Regional Habitat Assessment Prioritization Working Group. U.S. NOAA National Marine Fisheries Service. 36 p.

Dick, E.J., A. MacCall, B. Soper, and M. DeYorio. 2012. Exploration of Bayesian stock reduction analysis for assessment of West Coast groundfish. Report submitted to the Review Panel Meeting on Assessment Methods for Data-Moderate Stocks (26-29 June 2012, Seattle, Washington). Pacific Fishery Management Council, Portland, Oregon. 27 p.

MacCall, A. D. 2012. A data-poor assessment of the US wreckfish fishery. Briefing book report to the Scientific and Statistical Committee Meeting, October 23-25, 2012. South Atlantic Fishery Management Council, North Charleston, South Carolina. 10 p.

MacCall, A., E.J. Dick, B. Soper, and M. DeYorio. 2012. Sources of abundance information for 65 unassessed stocks of West Coast groundfish. Report submitted to Review Panel Meeting on Assessment Methods for Data-Moderate Stocks (26-29 June 2012, Seattle, Washington). Pacific Fishery Management Council, Portland, Oregon. 63 p.

Yoklavich, M., T. Laidig, D. Watters, and M. Love. 2013. Understanding the capabilities of new technologies and methods to survey west coast groundfishes: results from a visual survey conducted in 2011 using the Dual Deepworker manned submersible at Footprint and Piggy Banks off Southern California. Final report to NMFS F/ST (R. Methot). 28 p.