

Part I

REPORTS, REVIEW, AND PUBLICATIONS

REPORT OF THE CALCOFI COMMITTEE 2008

CDFG HIGHLIGHTS

Marine Life Protection Act Project

The Marine Life Protection Act mandates the reexamination and redesign of a network of Marine Protected Areas (MPAs) for the state of California. The Act is being implemented in five planning regions encompassing the California coastline, including San Francisco Bay, and is expected to be completely implemented by 2011. The planning process includes input from a broad-based Regional Stakeholder Group (RSG) in each planning region and oversight by a Blue Ribbon Task Force (BRTF) appointed by the Secretary for Resources and the California Fish and Game Commission (Commission), the final decision-making body in the process. The first planning region was the Central Coast study region—Pigeon Point in San Mateo County southward to Point Conception in Santa Barbara County. Planning for this region was completed in April 2007.

Planning for the second region, the North Central Coast study region—from Pigeon Point, north to Alder Creek, near Point Arena, Mendocino County—commenced in the summer of 2007. The BRTF crafted an Integrated Preferred Alternative (IPA) in April 2008 by incorporating ideas from all three final proposals generated by the North Central Coast RSG. In October 2008, the Commission identified the IPA as its preferred alternative for regulatory review. The Commission is currently considering adopting MPAs proposed for the North Central Coast study region, expected to occur in late summer 2009.

The third planning region is the South Coast study region—from the U.S.-Mexico international border, north to Point Conception. Planning for this region commenced in the summer of 2008 and is ongoing. Final recommendations from the BRTF on MPAs proposed for the South Coast study region will be presented to the Commission in November 2009. See www.dfg.ca.gov/mlpa for more information.

State Finfish Management Project

The State Finfish Management Project manages recreational and commercial finfish regulated by the State of California. Species examined within this pro-

ject reside primarily in nearshore habitats but may range throughout state waters. Included in these species are California halibut (*Paralichthys californicus*). Project staff completed fishery-independent trawl surveys and collaborated with commercial fishers to collect data on California halibut for an upcoming stock assessment to begin January 2009. Staff worked on a commercial fishing vessel to tag sub-legal halibut and collect growth and mortality information. These data, coupled with sampling by the commercial California halibut fishery and historical survey information, will be used in the statewide assessment.

The Project also began a hooking mortality study of California halibut in San Francisco Bay. This study was undertaken in part due to concerns about unusually high recreational and commercial fishing effort and catch in 2008, potentially as a result of the ocean salmon fishery closure. Average catch rates were around one legal halibut per recreational boat angler during the summer. Project staff monitored and sampled the recreational skiff fishery during this period, supplementing efforts by the California Recreational Fisheries Survey (CRFS).

In 2008, the Pacific hagfish (*Eptatretus stoutii*) commercial fishery continued its resurgence. Landings exceeded 1.5 million pounds in California for the second consecutive year after a 17-year period of low landings. Primary ports for hagfish landings were Eureka, Morro Bay, Los Angeles, and San Diego. The Project continued to track fishery landings statewide and sampled the fishery for size composition.

Recreational Fisheries

CRFS began in January 2004 to provide catch and effort estimates for marine recreational finfish fisheries. This survey is an updated version of the Marine Recreational Finfish Fisheries Statistical Survey (MRFSS), which started in 1980. CRFS generates monthly estimates of total recreational finfish catch for four fishing modes (private and rental boats, beaches and banks, man-made structures such as piers, and commercial passenger fishing vessels) within six geographic regions along California's coast. These data are used by state and federal regulators to draft regulations to protect fish stocks and provide recreational fishing opportunities.

CRFS incorporates field sampling and telephone surveys. In 2008, approximately 45 samplers worked statewide to gather field-sampling data. CRFS samplers interviewed more than 61,400 anglers at more than 400 sites, and examined nearly 190,000 fish. In addition, the telephone survey conducted nearly 26,000 interviews with licensed anglers in 2008.

In 2008, the CRFS program started two pilot studies to improve current sampling methodology. The first study examined methods of determining catch and effort for anglers returning from private marinas, moorings, and docks that CRFS field samplers cannot access. This study used field-based counts of the number of recreational fishing boats that return from seven southern California marinas to generate monthly estimates of private-access fishing effort. The estimates will be compared to current estimates generated from the licensed angler telephone survey. The second study, the Saltwater Angler Logbook Study, works with volunteers from both public and private access sites to compare catch and discard rates between the two groups. The study will compare public and private fishers to better refine methods for estimating catch and effort. For more information: <http://www.dfg.ca.gov/marine/crfs.asp>

Fishery-Independent SCUBA Assessment Project

This project is a collaborative marine research and monitoring program that works with other agencies and academic institutions to conduct surveys of fishes and invertebrates in nearshore subtidal habitats. In southern California, the project is working on surfperch and other nearshore sandy beach fishes using beach seining and mark-recapture methods. Data are being collected on the movement patterns of barred sand bass (*Paralabrax nebulifer*) in relation to their spawning behavior.

In central California, the abundance, mortality, and movement patterns of rocky reef fishes listed in CDFG's Nearshore Fishery Management Plan are being investigated using trapping, hook-and-line, and mark/recapture methods. Estimates of the age, growth, and size at maturity of kelp greenling (*Hexagrammos decagrammus*) are also being investigated using SCUBA surveys.

Ocean Salmon Project

In 2008, counts of Sacramento River Fall Chinook (SRFC) salmon (*Oncorhynchus tshawytscha*) returning to spawn in the Central Valley were the lowest (66,200 salmon) in the 40-year record of escapement surveys. This was also the second consecutive year that SRFC failed to meet the Fishery Management Plan conservation objective of at least 122,000 adult spawners. Due to this decline, California Department of Fish and Game (Department) staff on the Pacific Fisheries Management Council's Salmon Technical Team developed a new

Sacramento Index model which examined the ocean harvest of SRFC along the West Coast. This model was a significant improvement over the Central Valley Index, which only used the ocean harvest south of Point Reyes and included all Central Valley salmon stock runs (fall, late-fall, winter, and spring). Using the Sacramento Index, only 122,200 SRFC adults are forecasted to remain in the ocean during the 2009 season.

The Commission and Pacific Fishery Management Council voted to continue the closure of all commercial and recreational Chinook salmon fishing in state and federal ocean waters south of Cape Falcon, Oregon. SRFC generally account for 80%–95% of the ocean salmon catch off California. One exception to this closure will be a 10-day recreational salmon fishery (29 August through 7 September 2009) in the waters north of Horse Mountain to the California/Oregon border designed to target the more abundant Klamath River Fall Chinook. In addition, the Department recommended that all river fishing for Chinook salmon within the Central Valley be closed during 2009 except for a 16 November–31 December fishery in the upper Sacramento River designed to target late-fall run Chinook.

Invertebrate Fisheries Management Project

Invertebrate Fisheries Project biologists completed a number of studies working primarily with spiny lobster (*Panulirus interruptus*), abalone (*Haliotis* spp.), Dungeness crab (*Cancer magister*) and a variety of bivalves. A spiny lobster study comparing different hoop-net designs was submitted to the *Fish and Game* journal. The study showed that newer rigid-style hoop nets have increased catch efficiencies over traditional hoop nets, thereby potentially increasing the recreational catch.

Department staff also completed a report of recreational lobster fishing activity summarizing surveys conducted with recreational fishers in 2007 and submitted this to the Ocean Protection Council. In addition, Project staff received funding approval for a joint study with San Diego State on lobster movement patterns within San Diego Bay to begin in 2009. Staff biologists completed a lobster biology informational leaflet, in cooperation with California Sea Grant, which was available prior to the new lobster report card released in 2008. In conjunction with the California Lobster and Trap Fishery Association, Project staff planned a new at-sea logbook sampling program patterned after the New Zealand Voluntary Logbook program for the 2009 lobster season.

Abalone stock assessment work continued in both the northern California recreational fishery and southern California recovery region. Southern California staff completed a three-year red abalone (*Haliotis rufescens*) stock assessment at San Miguel Island in cooperation with the California Abalone Association (former com-

mercial abalone divers). Staff continued to work with the Abalone Advisory Group (AAG), an advisory group established to make recommendations on a potential San Miguel Island abalone fishery. Project staff, the AAG, and a Technical Panel of the AAG are working together to develop stock estimates and potential total allowable catch harvest scenarios to present to the Commission. Two studies were completed with red abalone from San Miguel Island to help inform this process, one examining gamete production and another looking at temperature and the onset of withering syndrome, a lethal abalone disease. A red abalone tagging study was also initiated at San Miguel Island with the former commercial abalone divers to study growth and movement patterns.

In northern California, a five-year field study assessing densities and size structure of the population at fishery index stations was completed and is being prepared for presentation to the Commission. Since 2000, abalone recruitment has been monitored within abalone recruitment modules annually while female gonad index is examined quarterly at Van Damme State Park. An abalone fishing information pamphlet was completed in collaboration with Sea Grant presenting the results of abalone research on population dynamics and importance of the existing 7 inch minimum size limit.

In 2008, a new site in Humboldt Bay was added to the Dungeness crab megalopae trapping study. This study quantifies crab recruitment in an effort to establish an index which can be used to predict the strength of the crab fishery in four years (when the megalopae grow to legal size). Dungeness megalopae trapping is also being conducted in Bodega Bay and southern Oregon in order to examine spatial as well as temporal patterns in recruitment. Department staff also worked to establish a new Dungeness Crab Task Force to discuss commercial crab management issues.

Staff resumed both fishery-dependent and independent assessments of marine bivalves along the coast. Gaper clam and razor clam fisheries in Humboldt County were assessed using both creel surveys of fishers as well as fishery-independent transect surveys. Pismo clam densities were surveyed along beaches in central and southern California to compare with previous surveys and assess current population levels.

SIO HIGHLIGHTS

Scripps Institution of Oceanography successfully completed the CalCOFI summer and fall cruises in 2008, and the winter and spring cruises in 2009. The spring 2009 cruise suffered from bad weather which prevented us from completing stations along line 77. The California Current Ecosystem-Long Term Ecological Research (CCE-LTER) group participated on all four cruises and augmented CalCOFI sampling with measurements aimed

at characterizing biogeochemical cycling and lower trophic level community structure in more detail. During the winter cruise the CCE-LTER group tested an advanced laser fluorescence system on loan from Alexander Chekalyuk for the continuous characterization of phytoplankton community structure and physiological state. The system performed extremely well, revealing small-scale structure in the community that is impossible to detect using individual stations. It is hoped that funding for the purchase of such an instrument can be obtained in the near future. The CCE-LTER group lost their laser optical plankton counter when the hydro wire broke. The marine mammal program participated on all four cruises as well, using visual observers and acoustic methods to enumerate the abundance of marine mammals on station and along the cruise tracks. The seabird program continues to be plagued by funding constraints and was only able to participate on the spring and summer cruise.

Conditions in the CalCOFI survey area in 2008 continued to be consistent with patterns observed since 1999, when the California Current entered a cool Pacific Decadal Oscillation (PDO) phase. Mixed-layer temperature anomalies suggest that La Niña conditions continued to affect the area during 2008; during 2009 conditions had returned to normal. Nitracline depth continued to be relatively shallow, about 10 m shallower than the long-term mean, and nitrate concentration continued to be higher than average. Although phytoplankton concentrations have exhibited a positive trend since 1984 in the CalCOFI survey area, concentrations in 2008 appeared close to the long-term mean. Zooplankton displacement volume followed the pattern of relatively low mean concentrations observed since about 1993; concentrations even in spring and fall have not increased notably from the low values observed through the winter.

A five-frequency (18, 38, 70, 120, and 200 kHz) Simrad EK-60 system was operated for the first time on RV *New Horizon* during the January 2009 CalCOFI cruise to examine the distribution and abundance of mid-trophic levels (krill, micronekton, and small pelagics) in relation to hydrographic features and their predators and prey.

For the past year, the California Conservancy Ocean Protection Council has funded re-sorting of historical CalCOFI samples to enumerate phyllosoma of the spiny lobster. A time series of the abundance of the early-stage larvae should provide a proxy time series for the abundance of the spawning stock extending back 60 years, which will contribute to the management of this valuable fishery as well as to understanding how the population responds to climatic forcing. The funding also enabled historical ichthyoplankton data sets from CalCOFI, the Los Angeles County Museum, and coastal power plant monitoring to be brought together in a database. The data are now being analyzed to provide base-

line data on these communities prior to establishment of marine protected areas along the California coast. CalCOFI data sets are also being made available through a publicly-available website as part of this project.

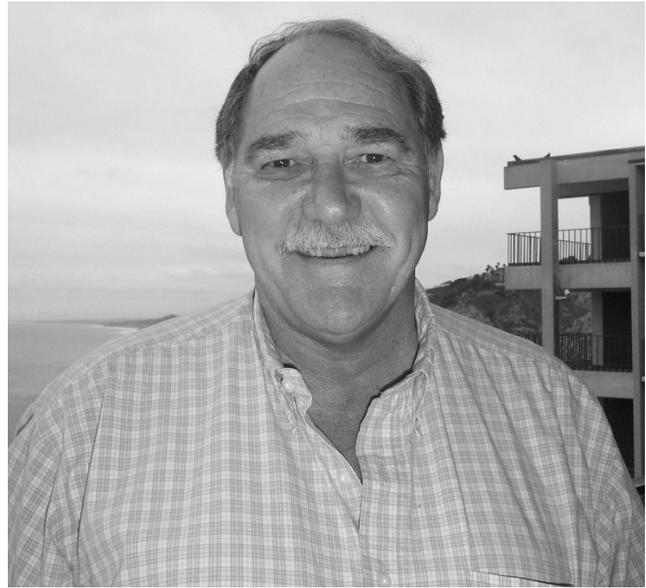
There were several research developments this past year based on the CalCOFI data. Declining oxygen concentrations in the California Current have been a source of major concern, with hypoxia on the Oregon shelf potentially having major impacts on demersal fisheries (Chan et al. 2008). Analysis of the CalCOFI oxygen time series indicates a declining trend in oxygen concentration in much of the Southern California Bight since 1984 (Bograd et al. 2008). However, a more recent analysis extending back to 1949 indicates that low oxygen concentrations were observed along the coast in the 1950s as well, raising the question as to whether the recent hypoxia may be part of a longer-term cycle (McClatchie et al. this volume). The causes of these changes in oxygen concentration remain unclear. Potential mechanisms include declining concentrations of oxygen in the California Undercurrent whose source waters are the eastern tropical Pacific Ocean and decreasing depths of isopycnals driven by large-scale wind patterns as reflected in the North Pacific Gyre Oscillation (NPGO). Increasing rates of primary productivity, that are driving such trends off Oregon, are a less likely cause in the Southern California Bight.

CalCOFI research this year also includes the development of the NPGO index (Di Lorenzo et al. 2008). Previous climate indices, such as the PDO and ENSO indices were not well correlated with variability patterns of salinity, nutrients, chlorophyll and key fish stocks, such as Pacific sardine (*Sardinops sagax*), in the CalCOFI time series. However, the NPGO is based on regional and basin-scale variations in wind-driven upwelling and horizontal advection, which are the fundamental processes controlling salinity and nutrient concentrations, and this index appears well-correlated with these key variables. In an independent but related development, Rykaczewski and Checkley 2008 showed that offshore, wind-stress curl-driven upwelling, which is linked to the NPGO, is closely correlated with surplus production of the Pacific sardine population.

NOAA HIGHLIGHTS

CalCOFI Legend Retires

For the past 35 years Richard Charter, Supervisory Computer Specialist, has had a central role in the scientific mission of the Fisheries Resources Division at the Southwest Fisheries Science Center and has made crucial contributions to virtually all the scientific research of the Division. He excelled in data base design and management, survey cruise design and ship operations,



and in the management of the laboratory's plankton sorting laboratory.

Since 1978, Rich has been responsible for planning and monitoring the CalCOFI survey cruises, developing and implementing shipboard and laboratory equipment and computer systems, and establishing and managing the computer databases for the CalCOFI time series. Rich embodies the spirit of CalCOFI. He is always cheerful, constructive, and generous. He is philosophical, providing such advice as, "Don't put anything over the side you're not prepared to lose," and only angry at the important things, like the loss of a sea day. Rich brought CalCOFI into the computer age and his comprehensive knowledge of the databases he established was essential to the scientific advances of the program.

The CalCOFI fish-egg and larval time series has become increasingly important as a fishery-independent measure of changes in key fishery stocks and is used constantly by scientists and managers to assess stocks and set harvest guidelines. One of Rich's long-term accomplishments was making this data accessible. He was intensely involved in developing several web sites that present the data in uncomplicated ways with links to the deeper data strata. He also developed innovative graphical methods to communicate and interpret the time series, and created an open environment where the software is free for programmers to update it and each other's capabilities through frequent communication. Rich kept everyone up to date on cruise operations and key results by generating computer maps almost in real time.

In addition, Rich supervised the processing, sorting, and archiving of plankton net and trawl samples for the Fisheries Resources Division. For CalCOFI plankton samples this involves separating fish larvae and eggs from

zooplankton, identifying and enumerating key fishery species, and transferring the zooplankton samples to SIO. One of his many accomplishments has been to develop a system of data entry forms and computer programs that allow rapid and efficient archiving of data as the samples are sorted. As a result, important data needed for fisheries management decisions are made available within weeks, sometimes days, after the completion of a survey cruise. Rich shared this system with other sorting center managers and it has been adopted by numerous laboratories in the U.S. and internationally.

Rich will be sorely missed, and on behalf of the CalCOFI community, we thank him for his years of tireless effort and numerous achievements. Congratulations on a well deserved retirement.

New Addition

We would like to extend a warm welcome to Dr. Ed Weber, the newest CalCOFI data manager at SWFSC. Ed has been a postdoctoral research scientist in the Fisheries Oceanography lab for the past year. He received his Ph.D. from Colorado State University, and has previously worked for Versar, Inc., the U.S. Bureau of Reclamation, and the U.S. Fish and Wildlife Service. Ed brings considerable knowledge to the position and we look forward to working with him for many years to come.

California Current Ecosystem Surveys

In 2008 the Fisheries Resources Division of the Southwest Fisheries Science Center conducted two coast-wide California Current Ecosystem (CCE) Surveys of the U.S. West Coast. These cruises were an expansion of the basic CalCOFI approach. The first ran in April 2008 using the NOAA RVs *David Starr Jordan* and *Miller Freeman*. A second survey was conducted in July/August on the *David Starr Jordan*.

The surveys were conducted in an abnormally cold year, strongly influenced by La Niña conditions during the spring spawning season of the Pacific sardine. Spawning of sardine was only observed south of San Francisco and was concentrated south of 35°N, with strong indication of spawning extending south of the U.S.-Mexico border in waters that were not surveyed. No Pacific sardine spawning was observed in July/August except at the most southerly station. No evidence was found for spawning of Pacific sardine in northern California, Oregon, or Washington during these surveys.

Acoustic data provided a wealth of information on the distribution of larger plankton and fish that is relevant to assess forage for predators such as seabirds, but were of limited utility for biomass estimation of small pelagic fish. This was due to an unquantifiable contribution to “fish backscatter” from mesopelagic fish and zooplankton. The survey results highlight the need for

better acoustic target identification, which is currently being addressed with a new towed stereo camera.

Trawling results indicated that cooler surface temperatures might have affected the movement of Pacific sardine. Compared to a previous coast-wide survey in 2006, sardines were larger in the southern area in 2008, a result that is consistent with delayed or restricted northern movement of sardine. Jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber australasicus*), and Pacific sardine were absent from research trawl catches in the northern part of the survey in April 2008, but were caught south of 35°N. Pacific sardine were caught at inshore stations in the northern area in July/August. Northern anchovy (*Engraulis mordax*) were caught in both northern and southern areas in both seasons. Unfortunately, trawling was restricted south of San Francisco due to gear problems in July/August, which compromised results.

Seabird counts indicated a seasonal shift in dominant species, which is a result confirming previously published findings. Primarily piscivorous birds constituted 37% of the counts in April compared to 72% in July/August. Planktivorous seabirds such as the northward migrating red phalarope (*Phalaropus fulicarius*) dominated counts in April, followed by the common murre (*Uria aalge*) that consume both plankton and small pelagic fish. In contrast, the most abundant species in July/August were summer-resident sooty shearwaters (*Puffinus griseus*) that are more piscivorous, again followed by common murre.

A NOAA Technical Memorandum was published that summarizes the preliminary results from both surveys (McClatchie 2009).

CalCOFI Cruises

It was a busy field season for CalCOFI's 59th year and a great deal was accomplished. In addition to completing the standard quarterly surveys, back-to-back coast-wide surveys were achieved during the spring and summer months. Over the course of the 2008 calendar year a total of six individual surveys were completed using three different vessels: SIO's RV *New Horizon*, and the NOAA RVs *David Starr Jordan* and *Miller Freeman*. Throughout these surveys a total of 471 Bongo tows, 456 Pairovet tows, 442 Manta tows, 496 CTD casts, 3225 CUFES samples and approximately 3200 hours of acoustical data were collected during the field season. In addition, 140 surface trawls were conducted netting approximately 2700 kilograms of adult and juvenile Pacific sardine for the annual spawning biomass estimate. Sea surface temperature anomalies for 2008 were generally negative for the entire U.S. West Coast although the Southern California Bight did exhibit some neutral and positive anomalies during spring and summer months.

In turn, the Pacific sardine spawning distribution was limited to the offshore portion of the bight and egg densities were generally lower than past surveys.

The 2008 field season saw the welcome addition of new personnel joining the CalCOFI group at SIO as Dave Faber and Grant Susner came on board in mid-season. Their experience and expertise will benefit the entire CalCOFI program.

CalCOFI Ichthyoplankton Update

The SWFSC Ichthyoplankton Ecology group projects to update larval fish identifications to current standards from 1951 to the present, and to re-identify the fish eggs collected in the CalCOFI bongo net samples to add count data for eggs of Pacific whiting (hake, *Merluccius productus*) and jack and Pacific mackerels to the database, continued this year. We have completed egg re-identifications from 1988 to the present and currently are updating larval identifications for samples collected in 1968.

During 2008 overall larval fish abundance increased slightly compared with 2007. Northern anchovy larvae abundance increased by an order of magnitude in abundance compared with 2007, but remained well below the recent 2005 peak abundance. Pacific sardine abundance also increased, but only slightly, in 2008 compared with 2007, and like anchovy remained well below the most recent peak (in 2005) of larval abundance. Ichthyoplankton data suggest that the region of peak sardine spawning began to shift southward from central California in 2005, and in 2008 the peak spawning area was again off southern California.

Review of Rockfish

Recent genetic studies at Southwest Fisheries Science Center have revealed that the heavily exploited vermilion rockfish, *Sebastes miniatus*, is really a cryptic species pair. The splitting of this species affects stock size estimates and draws attention to the unintended consequences of depth-based management policies. Distinct differences in exploitation levels of the two species necessitated an evaluation of population structure and connectivity among regional management segments of the fishery.

Staff from the Fisheries Resources Division analyzed gene flow between populations and calculated larval dispersal values using 782 bp of DNA sequence data from the mitochondrial cytochrome *b* gene of 681 vermilion rockfish sampled from 16 sites between Kyuquot Sound, Canada and San Quintin, Mexico. Significant genetic heterogeneity was found among sample sites ($F_{ST} = 0.0742$, $p < 0.001$). Isolation by distance analysis produced a strong and significant correlation, suggesting that average larval dispersal distance is on the order of 10s of kilometers (Hyde and Vetter, in press).

Analysis of molecular variance showed strong and significant partitioning of genetic variance across the biogeographic boundary at Point Conception ($F_{CT} = 0.0923$, $p < 0.001$). Additional genetic barriers were found across Cape Mendocino, Punta Colnett, Santa Monica Bay, and along the coast of Washington. These genetic barriers conform to oceanographic compartments previously proposed for the California Current ecological geography province and suggest natural management units for this species at Cape Mendocino and Point Conception.

Larval Production Biomass Estimate of Bocaccio

The size of the bocaccio (*Sebastes paucispinis*) stock in the Southern California Bight was estimated based on catches of larvae in the 2002 and 2003 CalCOFI and CCA-enhanced ichthyoplankton surveys. Area-weighted total length compositions of pre-flexion larvae in each of the two years were determined from survey data and year-specific larval length-to-age transition matrices were estimated from counts of daily otolith increments. Together these results were used to estimate the daily rates of larval production and mortality during the two years, which were expanded to annual production rates with knowledge of the spawning season, estimated from the long-term (1950–2005) time series of larval abundance in all CalCOFI surveys. Total annual larval production was then translated to total spawning biomass by estimating the population weight-specific fecundity of females, derived from a length-based life table analysis of adult reproductive parameters (maturity, fecundity, and spawning frequency) and estimates of the length composition of the southern California stock of bocaccio in 2002 and 2003. The adult reproductive parameters were estimated from ovary samples collected during the 2003 spawning season in Ensenada, Mexico, whereas the length composition of the stock was estimated from a restricted, Southern California Bight stock assessment model that was based on MacCall 2005.

Results indicate that in 2002 there were 3470 mt of female spawning biomass in the Southern California Bight or, equivalently, 6953 mt of total biomass (males and females ≥ 16 cm FL). Similarly, in 2003 there were 5921 mt of female spawning biomass and 10,656 mt of total biomass (Ralston and MacFarlane, in review). Differences in these estimates are due in part to the growth and maturation of a very strong 1999 year class and in part to measurement error. The estimates, evaluated by jackknife re-sampling and application of the Delta Method, are shown to be relatively precise. The biomass estimates also agree well with the restricted southern area model.

PaCOOS—Pacific Coast Ocean Observing System

In 2008, the focus for PaCOOS was to improve data access and interoperability as well as new observations in support of the California Current (CC) ecological observing system. Data management activities centered on access of NOAA's West Coast biological and physical data in partnership with academics. With funds from the NOAA IOOS Program, the Cooperative Zooplankton Dataspace (<http://oceaninformatics.ucsd.edu/zooplankton/>) was developed and provides queryable interfaces to zooplankton and euphausiid data. In addition, three existing data portals were updated with quality assured and quality controlled data and are accessible via the PaCOOS website (www.pacoos.org) as well as through the following home servers:

1. NOAA Habitat data:
<http://tomcat.coas.oregonstate.edu/>
2. NOAA Pelagic data:
<http://oceanwatch.pfeg.noaa.gov/PaCOOS/>
3. National Marine Sanctuary physical data:
<http://portal.ncddc.noaa.gov/wco/>

Through leveraging of PaCOOS funds with CalCOFI and California Ocean Protection Council and CCE-LTER Programs at SIO, the historical CalCOFI physical and biological data are migrating to the web (<http://oceaninformatics.ucsd.edu/datazoo/>).

Data access and data interoperability underlie ecological forecasts and assessments in the California Current. Both the continued closure of the California salmon fishery in 2008 and the discussions at the Pacific Fisheries Management Council (PFMC) on the influence of ocean conditions on salmon survival demonstrate a growing need for PaCOOS and others to develop these assessment products.

Collaboration and partnerships within NOAA and between NOAA and academic scientists remains the primary means of developing ocean surveys. The effort by NOAA/NWFSC and Oregon State University at Newport Oregon is the longest-running ocean survey program in the northern California Current, established in 1996. A second effort was established in 2008 off Trinidad Head as a collaboration between NOAA/SWFSC and Humboldt State University. A third ocean survey line began in the fall of 2008, off Bodega Bay. This new line is operated by the Bodega Marine Lab of the University of California, Davis with funds from the Sonoma County Water Agency. Each of these two new lines is patterned after the Newport Line hydrographic and plankton survey. An ecological forecast is also under development between the SWFSC and SIO with funds from the

NOAA IOOS Program. This project utilizes existing SIO climate model outputs (temperature, salinity with depth, sea surface height, and currents) to project West Coast sardine larvae distribution and habitat to improve the NMFS coastal pelagic sardine stock assessment required by the PFMC. A similar web-based effort has been developed by Bill Peterson (NOAA/NWFSC) that successfully forecasts salmon returns. See <http://www.nwfsc.noaa.gov> and click on "Ocean Index Tools."

The 2009 plans for PaCOOS include continuing coordination on proposal development with NOAA RAs emphasizing data management, ecological forecasting and assessment, and increasing ocean observing data when opportunities arise. In addition, an ecosystem status report is under development for the coastal pelagic species Stock Assessment and Fisheries Evaluation document.

Other Surveys Conducted in the California Current

Lines 60 and 67 Monterey Bay Aquarium Research Institute (MBARI), National Park Service (NPS), and University of California, Santa Cruz (UCSC) scientists continue to occupy Line 67 off Monterey and Line 60 off San Francisco with NOAA funding. A consistent suite of samples has been collected quarterly along Line 67 since 1997, and nearshore since 1989. In recent years, this shipboard work has been augmented by mooring, AUV and glider programs. The focus has been on: (1) seasonal/interannual/decadal temporal variations; and (2) Monterey Bay/upwelling system/California Current spatial variations. The data document California Current and Upwelling System dynamics over several ENSO cycles as well as a decadal to multi-decadal shift.

In 2008, MBARI and UCSC personnel collected nutrient, phytoplankton, and zooplankton samples during winter and spring cruises aboard RV *David Starr Jordan* (0801 and 0804). MBARI, NPS, and UCSC personnel conducted summer and fall cruises aboard the University-National Oceanographic Laboratory System RV *Point Sur* (S308 and S408). These data have been processed and quality-controlled, and are available both in the MBARI Biological Oceanography database and online. With the continued La Niña-like conditions of 2007, 2008 experienced unusually strong upwelling-favorable winds and in consequence, nearshore (≤ 30 nmi) surface waters were cold and salty and high in macronutrients and phytoplankton production and biomass. The effects of these conditions on fish, birds, and mammals have in some cases been surprising (seabird starvation, etc.). As analysis and publication proceed, the 2008 work will enable data-based exploration of: (1) the forecast shift from La Niña to El Niño later this year; (2) the putative decadal shift to cool conditions after 1998; and (3) secular climate change.

Trinidad Head Line

NOAA recently established an ocean observing effort (PaCOOS) in cooperation with Humboldt State University where data are collected at roughly monthly intervals along the Trinidad Head Line, which consists of six stations along a transect extending approximately 27 nm due west from Trinidad Head. Data reported here are based on temperature, salinity, and chlorophyll-*a* profiles from CTD casts to a maximum depth of 150 m at each station. Time series of these data have now reached a state where limited analysis of variability in the coastal ocean off northern California over time is possible (calculation of anomalies from a climatological mean is not currently viable) as well as comparisons to observations elsewhere along the coast.

All cruises were conducted aboard Humboldt State University's RV *Coral Sea* except for the March 2008 cruise which was conducted aboard the NOAA RV *Miller Freeman*. All sampling since November 2007, with the exception of cruises in March 2008 and 12 April 2009, has been conducted at night. Only three stations (TH02, TH03, and TH04) were sampled on 12 April 2009. The March 2008 cruise stands out with respect to the conditions just prior to and during sampling (25–50 knot southerly winds) that would have precluded operations aboard the *Coral Sea*.

The time series of observations along the Trinidad Head Line exhibits clear seasonal patterns, including the consequences of upwelling during spring and summer and warming and freshening of nearshore waters during the winter. Lenses of relatively fresh water, presumably associated with riverine plumes, are commonly encountered near the coast during mid-winter cruises, which underscores the role of freshwater input to nearshore hydrography during winter off northern California.

Spring 2008 was marked by relatively cold, salty water at depth on the shelf—the coldest and saltiest yet observed over the limited course of the time series—coupled with a broad cross-shelf extent of cool conditions in the upper water column. Cross-shelf patterns must be interpreted with some caution because offshore stations frequently encounter hydrographic structure extending southward from the coast between Cape Blanco, Oregon, and Point St. George, California, during periods of active upwelling.

Temporal and spatial patterns of chlorophyll-*a* concentrations reflect expected responses of the ecosystem to enrichment via upwelling. Not only were observed chlorophyll-*a* concentrations generally higher in 2008 than in 2007, areas of elevated chlorophyll-*a* concentration developed earlier and exhibited greater cross-shelf extent in 2008.

Shark Surveys The SWFSC's shark research group is responsible for collecting data to support the man-

agement of blue (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*) and common thresher sharks (*Alopias vulpinus*), all of which are common in the Southern California Bight and taken in regional fisheries, primarily as juveniles. Common thresher and mako sharks have the greatest commercial value and are also targeted by sport fishers. Although the blue shark has little market importance in the United States, it is a leading bycatch species in a number of U.S. fisheries and is targeted in Mexico. One of the primary methods used by NOAA Fisheries to collect data on the three species is fisheries-independent surveys. These surveys provide catch data that allow us to track trends in abundance. Use of fisheries data alone for estimating population status is complicated by changes in regulations, fishing methods, and areas over time. The surveys also provide the opportunity to deploy conventional and electronic tags, obtain biological samples and conduct studies on age and growth.

In June and July of 2008, the SWFSC conducted its fifteenth juvenile shark survey since 1994. Working aboard the FV *Ventura II*, a total of 6007 hooks at 29 sampling stations in seven main areas in the Southern California Bight were fished. Survey catch totaled 40 makos, 233 blue sharks, one common thresher, five pelagic rays (*Pteroplatytrygon violacea*) and one bat ray (*Myliobatis californica*). Nearly all of the sharks caught were injected with OTC for age and growth studies, tagged with conventional tags, and released. In addition, satellite tags were deployed on four blue sharks and nine shortfin makos. The cruise was conducted in two legs with 85% of the shortfin mako sharks caught during the second leg when higher water temperatures were encountered. The overall survey catch rate was 0.184 per 100 hook-hours for shortfin mako and 1.090 per 100 hook-hours for blue sharks. The nominal CPUE for blue sharks was somewhat higher than in 2007; however, there is a declining trend in nominal CPUE for both species over the time series of the survey.

In September of 2008, the SWFSC team worked with the F/V *Outer Banks* to sample common thresher sharks in the California Bight from Point Conception to the Mexican border. Forty-eight longline sets were made in relatively shallow near-shore waters. Over the 18-day cruise, catch totaled 300 common thresher sharks, two spiny dogfish (*Squalus acanthias*), 28 soupfin sharks (*Galeorhinus galeus*), two leopard sharks (*Triakis semifasciata*), and five brown smoothhound (*Mustelus henlei*). Nearly all of the common thresher sharks were injected with OTC for age and growth studies, tagged with conventional tags, and released. In addition, pop-off satellite tags were deployed on three common thresher sharks.

LUTH cruise Since 2006, NMFS has been studying swordfish in the Southern California Bight to examine migratory patterns, foraging ecology, and local

stock structure. In 2008, researchers in the Fisheries Resources Division (FRD) teamed up with the Protected Resources Division (PRD) and the Southwest Region to launch a new initiative, Swordfish and Leatherback Utilization of Temperate Habitat (SLUTH). The overarching objective of SLUTH is to integrate studies of swordfish and leatherback sea turtles to inform management and conservation efforts. The endangered leatherback is taken incidentally in swordfish fisheries, and concerns about leatherback populations are currently shaping the management of swordfish along the U.S. West Coast.

A research goal of SLUTH is to characterize and quantify the habitat overlap of swordfish and leatherback sea turtles in vertical and geographic space. To this end, FRD and PRD staff collaborated to conduct a pilot project in conjunction with the PRD Leatherback Use of Temperate Habitat (LUTH) survey. The survey was conducted off central California aboard the NOAA RV *David Starr Jordan* in August and September 2008. The objectives of this first cruise focused on the feasibility of using one platform to conduct research on both species. If possible, this would allow the same temporal and spatial data collection and strengthen conclusions about habitat overlap. During the cruise, rather than sample along a grid pattern, sampling was dynamic and executed to capture the characteristics of oceanographic features thought to be important for defining leatherback or swordfish habitat. Sampling methods included using CTDs, net tows, acoustics, and aerial surveys. Fishing via longline was used to determine patterns of occurrence of swordfish. During the cruise, four longline sets were conducted in three different areas. Four swordfish were captured on two sets, both of which occurred on the warm side of a frontal system, and two animals were taken for sampling. In addition to the swordfish, 65 blue sharks and three mako sharks were caught and released. Efforts provided important insight into swordfish distributions and an important proof of concept for this type of multidisciplinary research approach.

West Coast Midwater Trawl Survey The ninth annual West Coast midwater trawl survey was conducted during the peak of the upwelling season from 20 May–25 June 2009. This coast-wide survey represents a major geographical expansion of the traditional SWFSC

Fisheries Ecology Division's pelagic juvenile rockfish survey, which was fielded in the central California region between Carmel and Bodega Bay. The survey now spans the entire U.S. West Coast and in 2009 extended from San Diego, California (lat. 32°42'N), to Cape Alava, Washington (lat. 48°06'N). In previous years the expanded survey was conducted using two vessels, usually the NOAA RV *David Starr Jordan* and the FV *Excalibur*. The latter vessel hails from Newport, Oregon, and operates under a cooperative research contract between the NWFSC and the Pacific Whiting Conservation Cooperative. This year, however, because the *David Starr Jordan* was tied up due to budgetary constraints, the NOAA RV *Miller Freeman* was deployed instead. The use of a new ship in this fishery-independent survey required inter-vessel calibration, which was achieved by 20 joint, paired tows of the two ships that occurred at the same time and place over a five-day period between Monterey Bay and Fort Ross. Both vessels use identical trawl gear, i.e., a 12 m × 12 m modified Cobb midwater trawl equipped with a 3/8" cod-end liner, with a standard trawl consisting of a 15-min tow at a head-rope depth of 30 m.

Sampling is focused on young-of-the-year (YOY) groundfish, including especially rockfishes (*Sebastes* spp.), Pacific whiting, lingcod (*Ophiodon elongatus*), rex sole (*Glyptocephalus zachirus*), and sanddabs (*Citharichthys* spp.). In addition, a wide variety of other epipelagic micro-nekton are captured and enumerated, including krill (*Euphausia pacifica* and *Thysanoessa spinifera*), market squid (*Loligo opalescens*), lanternfishes (*Diaphus theta*, *Tarletonbeania crenularis*, *Stenobrachius leucopsarus*, *Lampanyctus* spp.), northern anchovy, and Pacific sardine.

The catch rate of YOY rockfish continued to increase this year, after hitting a record low of 0.61 rockfish/haul in 2005. Since that time, catch rates have approximately doubled each year, with a catch rate of 19.60 rockfish/haul recorded this year. Catches of other YOY groundfish were also up, as were catches of krill.

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