

Part I

REPORTS, REVIEW, AND PUBLICATIONS

REPORT OF THE CALCOFI COMMITTEE

NOAA HIGHLIGHTS

CalCOFI Cruises

The CalCOFI program completed its fifty-seventh year with four successful quarterly cruises. All four cruises were manned by personnel from NOAA Fisheries Service Southwest Fisheries Science Center (SWFSC), Scripps Institution of Oceanography (SIO), and the California Department of Fish and Game (CDFG). The fall 2006 cruise was conducted on the Scripps vessel R/V *Roger Revelle* and covered the southern lines of the CalCOFI pattern. The winter 2006 cruise was conducted on the NOAA R/V *David Starr Jordan*. The *Jordan* covered line 93 to line 60 just north of San Francisco. The spring and summer 2006 cruises were on the Scripps vessel R/V *New Horizon*, and covered the standard CalCOFI pattern. The spring CalCOFI cruise was conducted in conjunction with the first coast-wide survey (see below). The R/V *David Starr Jordan* was used to perform the northern extension of the CalCOFI pattern, while the R/V *Oscar Dyson* surveyed from Vancouver, Canada, to San Francisco.

Standard CalCOFI protocols were followed during the four quarterly cruises. Over the year a total of 374 bongo tows, 298 manta tows, 316 paironet tows, 424 CTD casts, and 40 trawls were conducted. In addition to the usual CTD casts and net tows, measurements were collected on a variety of other parameters including but not limited to primary productivity, salinity, dissolved oxygen, acoustics, and weather. Both seabird and marine mammal observers also collected data on each cruise.

Coast-wide Sardine Survey

The first coast-wide survey of the California Current pelagic ecosystem was conducted from 1 April–8 May 2006, spanning from Baja California, Mexico, to British Columbia, Canada. The survey was carried out with three U.S. vessels. The R/V *David Starr Jordan* traveled from San Diego, California, north to San Francisco, California. The R/V *Oscar Dyson* departed Seattle, Washington, and surveyed from Vancouver Island, Canada, south to San Francisco, California. In addition, the SIO vessel R/V *New Horizon* conducted the regular spring CalCOFI survey concurrently.

Scientists aboard the R/V *David Starr Jordan* and the R/V *Oscar Dyson* conducted plankton net samples of eggs, larvae, and zooplankton, and vertical profiles of temperature, salinity, oxygen, and chlorophyll. Transect observations included continuous egg pump samples, continuous multi-frequency acoustic samples of adults and possibly juvenile fish, and continuous measurements of sea surface and meteorological conditions. Trained observers on both ships surveyed for marine mammals and sea birds during daylight hours.

The data collected on Pacific sardine (*Sardinops sagax*) were used to generate an estimate of the spawning stock biomass, which resulted in an updated stock assessment. The total DEPM-based spawning biomass during April–May 2006 was estimated to be 1,304,806 mt (CV = 0.47) within an 885,523 km² spawning area from San Diego to British Columbia. Sardine eggs and adults were not found north of Coos Bay, Oregon. The standard DEPM sampling region off California (San Diego to San Francisco) had a spawning area of 336,774 km² and a spawning biomass of 1,081,612 mt (CV = 0.47). Thus, the portion of spawning biomass from San Francisco to British Columbia was approximately 223,194 mt (Hill et al., 2006).

This survey is unique in that it is the first to provide a snapshot of the physical and biological environment of the California Current ecosystem spanning the bulk of its range. The next coast-wide survey is scheduled for April 2008 with the R/V *David Starr Jordan* and the R/V *Miller Freeman*.

CalCOFI Ichthyoplankton Update

To make the CalCOFI ichthyoplankton data base more user-friendly, the Ichthyoplankton Ecology group at SWFSC has undertaken a project to update all larval fish identifications to current standards. The fish larvae have always been identified to the lowest taxon permitted by current knowledge. However, when taxonomic resolution has improved, it usually has not been possible to revisit and update earlier samples, with the result that many taxa must be aggregated back to genus, family, or ordinal level in order to perform analyses using the entire CalCOFI ichthyoplankton data set. This re-

identification effort is a multi-year project that ultimately will provide taxonomic consistency throughout the CalCOFI ichthyoplankton time series. To date, all fish larvae from all CalCOFI samples collected between January 1972 (cruise 7201) and July 2007 (cruise 0707) have been identified to current standards. Larvae collected during the 1969 CalCOFI cruises are now being re-identified.

Larval fish overall were only about half as abundant during the 2006 CalCOFI survey as they had been in the 2005 survey. In 2005, the abundance of northern anchovy (*Engraulis mordax*) larvae increased substantially and it replaced Pacific sardine as the most abundant species collected. It was the most abundant species again in 2006, although less than one-quarter of its overall abundance in 2005. Larval Pacific sardine were about half as abundant in 2006 compared with 2005, but remained the second most abundant species collected. Ichthyoplankton data suggested the possibility that the region of peak Pacific sardine spawning began to shift southward from central California in 2005, and this was even more apparent in 2006. Preliminary results of the spring 2007 cruise suggest that again this year Pacific sardine spawning was highest off southern California.

PaCOOS

The Pacific Coast Ocean Observing System Board of Governors continues to focus on the data management of NOAA West Coast biological and physical data as well as expanding to include euphausiid data collected by academics along the California coast. With funds from the NOAA IOOS Program, three websites have been created to house NOAA-generated data. The data are either available now or will soon be available in 2007. All will be accessible through the PaCOOS website (www.pacoos.org) as well as through the following home servers:

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

More historical data will be added to these portals as they go through proper QA/QC and metadata procedures. The euphausiid data will be available at a later date through the Scripps Institution of Oceanography.

Ecological forecast development remains a top priority for PaCOOS and there were some new, modest developments in this area as well. The *Atlantis* and *Ecosim* models remain the primary focus for NOAA scientists to eventually augment existing fish and marine mammal stock assessments. Collaboration and partnerships between NOAA and academic scientists remains the primary means of developing the next generation of ecosystem forecasts with external funding.

The governance structure of PaCOOS continues to evolve. Representatives from Canada's Department of Fisheries and Oceans and from IMECOCAL, CalCOFI's sister survey program along Baja California, Mexico, were invited to join the Board of Governors. The addition of representatives from Canada and Mexico will round out representation along the entire California Current Large Marine Ecosystem.

CDFG HIGHLIGHTS

The Marine Region of the California Department of Fish and Game (CDFG) in 2006 experienced increased funding primarily from the California legislature. These funds were used to hire 44 full time staff, increasing the staff of the Region by almost 25% and restoring the Region's operating budget. The major focus of these new positions is expanding the resource assessment capabilities of the CDFG. At the same time, the Region underwent a structural reorganization aligning it with the CDFG. The new structure is based on a resource assessment project which is responsible for the CalCOFI program.

The California Ocean Protection Council continues to partner with the Marine Region and others since its inception following the passage of the California Ocean Protection Act. The Council hosted the California and the World's Ocean Conference in Long Beach, California, in September 2006. In 2006 and early 2007, the Council adopted resolutions to fund research on cooling of power plants using seawater and its impact on the pelagic organisms contained in the water, as well as addressing marine debris such as lost fishing gear. The Council is partnering with the CDFG to jointly fund \$10 million in resource assessment, data management, and program support. Along with these actions, in September 2006 the three West Coast governors signed an historic agreement on Ocean Health including the "expansion of ocean and coastal scientific information, research, and monitoring."

The Marine Region hosted the 2006 CalCOFI conference this year as it does every third year. The conference was held at Asilomar in Pacific Grove, California, in December 2006. The theme of the symposium of the conference was "Ecological Interactions Useful For Marine Ecosystem-Based Management: The Roles of Positive Species Interactions, Ecosystem Engineers and Species Diversity." In the symposium, themes such as biodiversity and the role of ecosystem engineers in structuring and providing goods and services within marine communities were explored as they relate to fisheries productivity.

California State Legislature and White Sturgeon

In response to preliminary information suggesting a decline in the white sturgeon population in the San

Francisco Bay-Delta, the California Fish and Game Commission established several new sportfishing regulations for this species in 2006. In addition to fishing pressure, white sturgeon are known to be at risk from habitat loss and degradation, and are also subject to poaching and illegal commercialization. The allowable slot size was reduced from 46 to 72 inches to a smaller slot size of 46 to 66 inches, and an annual limit of three fish per angler per year was instituted. Additionally, a report card program was established which requires that every angler targeting or possessing white sturgeon record catch and other fishery information. In an effort to improve enforcement of the new annual bag limit, the report card comes affixed with three tags which are to be attached to any legally taken and retained white sturgeon.

Marine Protected Areas

On 13 April 2007, in a landmark decision, the California Fish and Game Commission adopted regulations to create a new suite of marine protected areas (MPAs) designed for the Central Coast of California, the second region considered for the State. This move effectively launches the state's Marine Life Protection Act (MLPA) Program, which is designed to conserve marine resources for their long-term sustainability while enhancing outdoor recreation and ocean research opportunities along the coast.

The Fish and Game Commission voted unanimously in favor of its preferred alternative: 29 MPAs representing approximately 204 square miles (or approximately 18 percent) of state waters with 85 square miles designated as no-take state marine reserves along the Central Coast, which ranges from Pigeon Point in San Mateo County south to Point Conception in Santa Barbara County.

The newly established Central Coast MPAs represent the culmination of a two-year public process with nearly 60 public meetings held for stakeholders and scientists, as well as the oversight of the MLPA Blue Ribbon Task Force, convened by Secretary for Resources Mike Chrisman.

The California Department of Fish and Game, the lead agency charged with managing the state's marine resources, will be responsible for implementing the MLPA program, including all enforcement and research and monitoring activities. The Central Coast MPA regulations will go into effect this summer after the appropriate filings with the Office of Administrative Law and Secretary of State.

Ocean Salmon Project

In 2006, the ocean salmon fisheries were severely constrained primarily by ocean abundance of Klamath River Fall Chinook salmon from Point Sur, California, to the

California-Oregon border. The Salmon Fishery Management Plan requires that ocean fisheries be regulated to allow a minimum of 35,000 natural adult spawners to return to the Klamath Basin; however, even without any fisheries in 2006, the Klamath Ocean Harvest Model predicted that this goal couldn't be attained. As a result, NMFS took emergency action in March to allow ocean fishing and advised the Pacific Fisheries Management Council to regulate the commercial and recreational fisheries so that no less than 21,000 Klamath River Fall Chinook natural adults returned to spawn. Ocean landings were centered on the San Francisco port area (61% of all estimated landings). An estimated 158,300 Chinook were landed in all ocean fisheries during 2006.

Fishery-Independent ROV Assessment Project

For the fourth consecutive year, the California Department of Fish and Game and the Marine Applied Research and Exploration (MARE) program, in partnership with the the Channel Islands National Marine Sanctuary, The Nature Conservancy, and Kingfisher Foundation, used a remotely operated vehicle (ROV) to survey fish populations in the Channel Islands National Marine Sanctuary. The objective of our ongoing research is to monitor changes in finfish density within areas of predominantly rocky habitat that are beyond the depth limit of scuba-based sampling. Our work will provide data for the evaluation of the Channel Islands Marine Protected Areas Monitoring Plan and will make available archival video for future research and monitoring.

During the 2006 survey, we measured substrate and finfish abundance within 10 priority sampling sites in the northern Channel Islands. Five of the sites are located within Marine Protected Areas (MPAs) near San Miguel, Santa Rosa, Santa Cruz, and the Anacapa Islands, and the other five reference sites are outside and adjacent to our MPA sites. In general, our permanent sampling sites are rectangles 500 meters wide spanning a depth range from 20 to 70 meters. Each year we plan to survey randomly selected 500 meter track lines to create finfish density transects over predominantly rocky habitat at each of the 10 sites.

In August and September of 2006 we worked aboard the CDFG's patrol vessel *Swordfish* to quantitatively sample seven sites, completing 65% of the total planned survey. In September and October of 2006, our work continued aboard the Sanctuary's R/V *Shearwater*, completing the season's remaining quantitative survey and two additional experiments aimed at developing a method for calculating habitat relief and sizing fish from video.

In addition, we continue to locate lost fishing gear that the CDFG, the Sanctuary, and marine debris removal groups have been working to remove. One such piece of gear located last year was a large 4,000 pound

purse seine net which was later removed off the eastern end of Santa Rosa Island from a depth of 23 to 30 meters.

For more information on ROV sampling protocols and research cruises, see (www.dfg.ca.gov/mrd) and the MARE web site (www.maregroup.org).

Kelp Surveys

During 2006 the CDFG completed the fifth annual coast-wide survey of California's kelp beds. The results of ongoing aerial assessments are available to GIS users on the Department's web at: http://ftp.dfg.ca.gov/Public/R7_MR/Natural_Resources/Kelp/

California Recreational Fisheries Survey

The California Recreational Fisheries Survey (CRFS) began in January 2004 to provide catch and effort estimates for marine recreational finfish fisheries. The development and implementation of CRFS has been a collaborative effort of the California Department of Fish and Game and the Pacific States Marine Fisheries Commission (PSMFC) with funding from state and federal sources.

The CRFS produced monthly estimates for 2006 and field samplers conducted more than 100,000 angler interviews and examined over 200,000 fish. The CRFS data were used to manage California's marine fisheries. Because catch and effort are reported by six geographical districts, managers were able to track catches in each district and to provide increased fishing opportunities in some areas while protecting overfished stocks.

In 2006, the CDFG began conducting studies to validate the catch and effort estimates and to verify the assumptions made in designing the sampling program. In addition, the CDFG began a review of the CRFS in 2006 to ensure that CRFS data and estimates address management needs and conform to the best available science. The review is examining each part of the CRFS program: sample design, survey methods, statistical methods, estimation procedures, computer programs, data and documentation needs, and outreach. For more information, go the CDFG's Marine Region website: <http://www.dfg.ca.gov/mrd/crfs.html>

Aquaculture and Bay Management

The Aquaculture and Bay Management Project completed the California Pacific Herring Commercial Fishing Regulations Supplemental Environmental Document (SED) for the 2006–07 season. The SED included the herring spawning biomass estimates for San Francisco, Tomales, and Humboldt Bays for the 2005–06 season, spawning population and commercial catch assessment, and the results of sub-aquatic vegetation surveys in key herring spawning areas for Humboldt and San Francisco

Bays. The spawning biomass estimate for San Francisco Bay of 145,054 tons (including catch) for the 2005–06 season is the largest recorded estimate in the history of the roe herring fishery.

Invertebrate Fisheries

In 2006, the Marine Region reprioritized the invertebrate species groups within the Marine Life Management Act Master Plan. Spiny lobster (*Panulirus interruptus*), subtidal snails including *Kelletia* and *Megastrea*, and marine bivalves including gaper, pismo, and razor clams, were listed as top priorities for future research and assessment efforts. In conjunction with this, the Invertebrate Program has initiated the hiring of a plankton sorter to work within the CalCOFI program to sort for lobster larvae (phyllosoma and puerulus stages).

The Dungeness crab (*Cancer magister*) industry, with assistance from the Invertebrate Management Project, began exploring the possibility of a trap limit program, following the lead of Oregon and Washington. A number of meetings were held up and down the coast in an effort to create a series of alternative plans. However, northern and central California crabbers have competing interests with regard to a trap limit program and those differences have yet to be reconciled. Also, during 2006, legislation was passed and signed into law that extends the authority of a California Dungeness crab permit out to 200 miles (into the EEZ) off California.

Abalone

In 2006, the implementation of the Abalone Recovery and Management Plan (ARMP) began after its adoption by the Fish and Game Commission in late 2005. The Commission adopted the ARMP, opting to select an alternative to begin development of a potential limited fishery for red abalone at San Miguel Island. The Department embarked on the limited fishery consideration process by collaborating with interested constituents. The collaborative process included a joint "Snap-shot Survey" of the red abalone resource at the island. A total of 187 survey stations with 371 transects were completed during the five-day cruise. In addition, an abalone advisory group (AAG) and a Technical Panel were formed. The AAG is a constituent representative body charged with providing recommendations to the Department and the Commission on the potential fishery.

SIO HIGHLIGHTS

Dr. Tony Koslow joined the CalCOFI Committee this year, after taking up a position in January 2007 as Research Professor and Director of CalCOFI at SIO. Tony's links with CalCOFI and the California Current extend back to the late 1970s, when he was a graduate student at SIO, working on the feeding of northern an-

chovy schools and its influence on the zooplankton. His principal mentors were Mike Mullin, John Isaacs, Paul Smith, John Hunter, and Joe Reid. After graduating, Tony Koslow served as fishery oceanographer in the Oceanography Department at Dalhousie University in Halifax, where his research focused on large-scale climatic influences on recruitment to cod and haddock stocks in the northwest Atlantic. In 1989, Tony joined Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Marine and Atmospheric Research, where he led projects on deepwater fisheries, seamount ecology and conservation, and the biological oceanography off Western Australia.

Elizabeth Venrick stepped down from the CalCOFI Committee, after passing the baton to Tony Koslow. She has represented SIO on the Committee since 2001, when she stepped into the breach left by Mike Mullin's tragic and unforeseen death. She guided SIO's CalCOFI program through the exceptionally difficult period of California's budget crisis, when State support for CalCOFI was slashed. Remarkably, the program was maintained without loss of a single cruise.

SCCOOS

Funding from the Southern California Coastal Observing System (SCCOOS) continued to fund work at nine nearshore stations that are occupied on CalCOFI cruises. The larval fish community at these stations, which are located along the 20 m isobath, is distinct from that observed at the standard coastal CalCOFI stations somewhat further offshore. In the future, samples at these stations may prove useful in providing baseline data on these communities prior to the establishment of nearshore marine protected areas (MPAs), as well as in monitoring their future impact.

For the first time in more than 25 years, spiny lobster phyllosoma will be routinely removed from CalCOFI samples, and historical CalCOFI samples will be sorted for them at selected stations. There are indications that spiny lobster recruitment to southern California fishing grounds is strongly influenced by ENSO, but this has never been documented. There are also no fishery-independent data on historical trends in the abundance of spiny lobster off California.

The spiny lobster population spawns from around Point Conception to southern Baja California from July through October. The phyllosoma larvae remain within the plankton for approximately eight months, the late

stages being found primarily between April and June. The phyllosoma then metamorphose into the puerulus stage, which swims inshore, settles out of the plankton, and develops into a juvenile lobster. Our knowledge of the development and early life history of the spiny lobster is based largely on studies carried out by Martin Johnson, during the first seven years of the CalCOFI program (1949–55).

The abundance of early stage phyllosoma will be used to develop an index of the abundance of spiny lobster in their nearshore spawning habitat, and the abundance of late stage phyllosoma will be examined for their utility as an index of recruitment. These time series can be used to assess changes to the spiny lobster population off southern California since the early 1950s, as well as to examine the influence of climate variability and the fishery on recruitment. Collaboration with colleagues in Baja California is foreseen, in an effort to understand the dynamics of this species over the extent of its range. Progress on this project has been accelerated by the discovery in the Scripps Library Archives of unpublished phyllosoma data from Martin Johnson, based on CalCOFI cruises between 1974 and 1981.

CCE-LTER Program

The California Current Ecosystem Long Term Ecological Research (CCE-LTER) program has augmented sampling on CalCOFI cruises since the fall of 2004. The objective of this work is to characterize in greater detail lower trophic level communities and processes, along with the dynamics of the carbon system. In the spring of 2007 the CCE-LTER program conducted its second process cruise off Point Conception, following the pattern of the previous year's cruise. It was initially hoped that the cruise would sample the California Current (CC) during an El Niño, but the weak equatorial El Niño did not materialize in the CC. However, the primary objective, to study processes in the CC, was met successfully.

All CalCOFI Atlases up to Atlas 35 (2002), except Atlas 33, are now available as pdf files that can be downloaded from the CalCOFI website. See: <http://www.calcofi.org/newhome/publications/Atlases/atlases.htm>

REFERENCES

- Hill, K. T., N. C. H. Lo, B. J. Macewicz, and R. Felix-Uraga. 2006. Assessment of the Pacific sardine (*Sardinops sagax caerulea*) population for U.S. management in 2007. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-396. 102 pp.