

Part I

REPORTS, REVIEW, AND PUBLICATIONS

REPORT OF THE CALCOFI COMMITTEE 2010

SIO HIGHLIGHTS

Four CalCOFI cruises were carried out successfully over the last 12 months. The standard CalCOFI measurements were made on all 4 cruises, with the addition of pelagic trawl samples on the Scripps cruises collected to a depth of 750 m using a Motoda-Oozeki-Hu trawl (MOHT) with 5 m² mouth opening and 1.7 mm mesh. The net samples primarily the micronekton (krill and midwater fauna), as well as larger fish larvae and juvenile fishes. The trawl sampling complements the multi-frequency acoustic sampling on the Scripps CalCOFI cruises, providing ground-truth data on species and size composition. In 2011, an MOHT opening-closing system (MOHTOCS) will be added to the summer cruise based on a Hydrobios mini multinet sampler with 5 cod ends, which will enable depth stratified sampling of acoustic targets to 1000 m depth. The acoustic and trawl sampling system was funded by a grant from the Gordon and Betty Moore Foundation. The California Current Ecosystem Long-Term Ecological Research (CCE LTER) program will provide funding for the ship-time for trawl sampling.

The CCE LTER program continues to use CalCOFI cruises to further characterize the biogeochemical cycles and populations of planktonic organisms. This year CCE purchased an advanced laser fluorometry system that uses seawater from the ship's flow-through system to characterize the phytoplankton community structure and probe the physiological health of the phytoplankton. It is hoped that this system will provide insight into spatial patterns of phytoplankton community structure and physiological state on scales smaller than the station spacing.

Since July 2009 we have been deploying drifters on CalCOFI cruises from the Institute for Computational Earth System Science (ICESS). The objective of this project is to observe and study near-shore ocean circulation off the southern California coast. The drifters record their position with GPS every 10 minutes and transmit their position data in near real-time to a web-based host computer. This sort of time and space resolution enables characteristic nearshore circulation patterns to be properly resolved. Links to tracks of drifters deployed on

recent cruises can be found on the CalCOFI Web site.

The most interesting oceanographic event during 2010/2011 was the transition from El Niño conditions to La Niña conditions. Even though these events were among the strongest equatorial events, their effects on oceanographic conditions off southern California were relatively small, in contrast to the 1998/9 event.

Starting in 2011, NOAA funding for the Scripps CalCOFI program will be carried out through the new Cooperative Institute for Marine Ecosystems and Climate (CIMEC). This entails a significant increase in the overhead rate charged for nonship and equipment items from 16.7% to 54.5%. This places considerable strain on our NOAA funders in the current fiscal climate.

The CalCOFI program submitted a proposal to the South Coast Marine Protected Areas (MPA) Baseline Monitoring Program, "An integrated monitoring and assessment program for southern California Marine Protected Areas". The proposed study would monitor fish communities, seabirds and marine mammals within and outside south coast MPAs through Continuous Underway Fish Egg Sampling (CUFES), net tows for the ichthyoplankton, acoustics, and seabird and marine mammal observations. The proposal was led by PI Tony Koslow (SIO) and co-PIs Ralf Goericke (SIO), Andrew Thompson (SWFSC), and Bill Sydeman (Farallon Institute).

The past year has seen increased interest in changing oxygen levels in the California Current and their ecological impacts. Based on analysis of the CalCOFI oxygen time series, McClatchie et al. (2010) reported that midwater oxygen concentrations were about 20% lower in the early and most recent decades of the record. Koslow et al. (in press) examined patterns in the CalCOFI ichthyoplankton time series and observed that the dominant pattern was the coherent response of a broad suite of mesopelagic and, to a lesser extent, demersal species to these changes in oxygen levels. The larval abundance for 24 species of mesopelagic fishes was lower by a factor of 2.6 in the 1950s and 1960s and since 2000. There was a highly significant correlation ($r = 0.74$) with midwater oxygen concentrations. Global climate models predict a 20%–40% decline in midwater oxy-

gen levels in the coming century due to the impacts of global warming, which will increase stratification of near-surface waters and reduce ventilation of the deep ocean. This is the first report of its potential ecological impact. These midwater fishes serve as important forage for a variety of piscivorous fishes, squids, marine mammals and seabirds.

CDFG HIGHLIGHTS

Marine Regulatory Changes

In 2010, the Commission undertook ten rule-making actions that addressed marine and anadromous species' aquaculture. In 2010, Fish and Game unveiled its new Automated License Data System (ALDS) for sport fishing and commercial licensing and fees. The new system will create an accurate customer database, reduce the risk of fraud, improve DFG's ability to manage resources, as well as meet state and federal mandates for tracking customer data. The Commission adopted changes to the herring, rock crab, and groundfish commercial fisheries and sport fishing regulations related to salmon, lobster hoop nets, and groundfish. Permits and procedures for aquaculture-restricted species were revised and updated as were sport fishing and commercial licensing requirements.

Marine Life Protection Act

The FG Commission adopted a network of 36 Marine Protected Areas (MPAs) encompassing approximately 187 square miles in the south coast region, defined as state waters between Point Conception (Santa Barbara County) and the California border with Mexico under the Marine Life Protection Act (MLPA). The MLPA requires California to reexamine and redesign its system of MPAs with the goals to, increase their effectiveness in protecting the state's marine life and habitats, marine ecosystems, and marine natural heritage. In addition, emergency action was taken to establish a portion of the Stewarts Point State Marine Reserve in Sonoma County along the north central coast as a State Marine Conservation to allow for the recreational take from shore of specified marine aquatic plants, finfish and marine invertebrates including red abalone with specified gear types. This emergency action was taken to avoid serious harm to the health, safety and general welfare of the Kashia Band of Pomo Indians of the Stewarts Point Rancheria.

Aquaculture and Bay Management

The Aquaculture and Bay Management Project completed the California Pacific Herring Commercial Fishing Regulations Supplemental Environmental Document (SED) for the 2010–11 season. The SED included

herring spawning biomass estimates, as well as spawning population, and commercial catch assessments. The SED evaluated DFG's recommendation to reopen the commercial herring season with a quota equal to 5% of the 2009–10 spawning biomass estimate. The spawning population increased from the historic low in 2008–09, primarily due to favorable estuarine and oceanic conditions. The spawning biomass estimate for the 2009–10 season is 38,409 tons, which is below the historic average (1978–79 to present) of 49,428 tons. However, this is a significant increase over the 2008–09 season estimate of 4,833 tons, which demonstrates the potential for stock recovery with conservative management of the fishery.

Staff worked collaboratively with the newly formed San Francisco Bay Herring Research Association. The Association was formed by the fishing industry with funds set aside from the Cosco-Busan oil spill settlement dedicated for Pacific herring research.

Invertebrate Fisheries Management

Project staff have been working to develop a stock assessment model for lobster in California. A surplus production model with size/age structure information was evaluated for its use in stock assessment. The NOAA fishery toolbox version of this model, ASPIC, failed with the datasets available. Currently, a model based on Beverton and Holt Invariant methods, used to evaluate the Baja fishery, is being evaluated for its use in estimating California stocks. Furthermore, staff worked with Ocean Protection Council funds to digitize 20 years of commercial logbook information as well as the newly introduced recreational lobster report card data. Project biologists completed a joint study with San Diego State University examining lobster movement patterns in San Diego Bay. The size of the lobster population in the bay was estimated at 94,000 to 108,000 lobsters. Tagging suggests that 75% of the lobsters reside near the bay mouth and 25% residing within the submerged rocky structures and seagrass beds along North Island and Shelter Island. There were no patterns of movement toward the mouth or away from the interior of the bay.

The abalone project continued stock assessment work in northern and southern California. The southern Pink/Green Abalone Translocation/Aggregation Study began in 2008 with funding from NOAA Protected Resources. Study sites were established at San Clemente and Santa Catalina Islands in 2009 and 2010, and monitoring is ongoing. Abalone were tagged with both a PIT tag and external-numbered tag so that each abalone could be individually identified. Green abalone were translocated at both Santa Catalina and San Clemente Islands at two sites on each island with two additional sites as controls. The white abalone restoration project funded by

a NOAA Section 6 Protected Species grant began this year. This three year collaborative project will focus on developing and implementing restoration tools for the critically endangered white abalone working with the captive breeding program at the Bodega Marine Lab, University of California, Davis.

A status report on the northern California red abalone recreational fishery was completed and submitted to the Fish and Game Commission. The main finding was the average density of red abalone at eight index sites was near the Abalone Recovery and Management Plan trigger which would require a reduction in the Total Allowable Catch (TAC) from the current level approximately 280,000 red abalone per year. Abalone staff completed surveys at Stornetta Ranch an area that had been a “defacto” reserve as access was restricted due to private property but was opened to the public in 2005. In 2010, the site was once again closed to abalone fishing as part of the MLPA process and there was a modest increase in abalone density at the site.

Dungeness crab megalopae trapping continued in Bodega Bay and Humboldt Bay. This monitoring of recruitment will be used to develop a predictive population abundance index for the fishery, complementing a similar index in Oregon. In 2010, Humboldt Bay clam creel survey results were published which used bootstrap methods, to compare with historic surveys. The 2008 survey revealed an important shift in the species composition of clams in the fishery, a decrease in fishing effort, and unique methods of take within Humboldt Bay, compared to the historical survey period of 1975–1989.

Ocean Salmon

In 2010, California ocean salmon fisheries were open for the first time in two years due to an increase in the abundance of Sacramento River Fall Chinook (SRFC). Despite the opening, fisheries were still constrained to satisfy both the National Marine Fisheries Service and the Pacific Fishery Management Council’s guidance to target the upper end of the SRFC’s conservation objective of 122,000–180,000 hatchery and natural adults to return to spawn the following fall. Commercial ocean salmon fisheries were opened for the first time since 2007 for a 70 day season. Estimated total commercial landings were 15,100 Chinook salmon (103 mt). Average nominal ex-vessel price was \$12.00/kg (\$5.50/lb), with an ex-vessel value of \$1.2 million. The recreational fishing season increased significantly for a season total of 500 days across four major port areas. In 2009, only a 10-day sport fishery was allowed in northern California. An estimated 14,700 Chinook were landed in 2010, compared to 700 salmon landed in 2009. Approximately 48,800 anglers fished for salmon in 2010 compared to 5,400 salmon anglers in 2009.

Groundfish

New recreational and commercial groundfish regulations were developed for 2011–2012 and approved by the Pacific Fishery Management Council (Council) in June 2010. However, following revisions by the National Marine Fisheries Service (NMFS) and delays in the federal rulemaking process, the new regulations did not go into effect until June 9, 2011 in state waters. Key recreational regulation changes include: simplified gear restrictions, renamed management areas, and liberalized lingcod seasons and size limits, cabezon bag limits, California scorpionfish depth restrictions, and central California season and depth restrictions.

Commercial management strategy highlights for 2010 included preparing environmental documents for the Trawl Rationalization Program, federal commercial regulations, and federal Groundfish Fishery Management Plan amendments. In addition, staff provided updated sections for the regulatory package that increased the statewide cabezon total allowable catch for both the commercial and recreational sectors as indicated by the Council and NMFS, based upon the results of the 2009 cabezon stock assessment. Groundfish staff also collaborated with NMFS to complete a historical catch reconstruction of recreational and commercial landings information, and completed a set of California sheephead research maps for California and Mexico to summarize existing research and to help identify information gaps. Completion of both tasks will contribute information to future stock assessments.

For the 2010 recreational outreach program, groundfish project staff disseminated regulation information to anglers and the public at 12 ports from Crescent City to Morro Bay. Statewide, staff distributed approximately 5,000 rockfish identification flyers and barotrauma information flyers to anglers, license vendors, tackle shops, CDFG wardens and CDFG offices. Lastly, staff helped hire, train, equip, schedule and supervise new California Recreational Fisheries Survey staff in preparation for the new Department program implementation in 2011.

Recreational Fisheries

The California Recreational Fisheries Survey (CRFS) began in January 2004 to provide catch and effort estimates for marine recreational finfish fisheries. The CRFS generates monthly estimates of total recreational catch for four modes of fishing (beach/bank and shore, piers and jetties, commercial passenger fishing vessels, and private vessels launched from public launch ramps) for six geographic districts along California’s 1,100 miles of coast. The data are used by state and federal regulators to craft regulations to protect fish stocks and provide recreational fishing opportunities. This is a multipart sur-

vey which uses field sampling and telephone surveys. In 2010, approximately 45 samplers worked to gather the field data. The CRFS samplers interviewed more than 73,000 anglers at over 500 sites, and examined more than 146,000 fish. The licensed angler telephone survey completed almost 26,000 interviews. For more information, go the CDFG's Marine Region Website: <http://www.dfg.ca.gov/marine/crfs.asp>.

Fishery-Independent SCUBA Assessment

In southern California, project staff published their analysis of historic Department barred sand bass tag and recapture data collected in the 1960s and 1990s. Staff also collaborated with researchers at California State University, Long Beach on a study that utilized active acoustic telemetry to quantify the fine-scale movement patterns of barred sand bass, *Paralabrax nebulifer*, within the spawning aggregations on Huntington Beach Flats.

In central California, project staff have completed three years of study using traps, hook and line, and mark-recapture methods to determine relative abundance, size, and movements of several nearshore groundfishes in Carmel Bay. Data were collected at several sites, including the newly created Carmel Pinnacles State Marine Reserve. In total, 5,632 fish were tagged and ~3% were recaptured or visually resighted during scuba surveys. Gopher rockfish (*Sebastes carnatus*), black-and-yellow rockfish (*S. chrysomelas*), kelp greenling (*Hexagrammos decagrammus*) and cabezon (*Scorpaenichthys marmoratus*) were the most abundant species caught by traps. Blue rockfish (*Sebastes mystinus*), gopher rockfish, olive rockfish (*Sebastes serranoides*) and kelp rockfish (*Sebastes atrovirens*) were the most abundant species caught using hook and line gear. Age, growth, and maturity information were collected for kelp greenling from 2008 to 2010. Maturity data collected indicates that kelp greenling spawn from September to January. Preliminary estimates of size at 50% maturity are 275 mm TL for females and 215 mm TL for males. For more information see <http://www.dfg.ca.gov/marine/scuba/index.asp>.

NOAA HIGHLIGHTS

2010 CalCOFI Field Season

The field season of 2010 will be noted and remembered for two significant milestones. On August 3, 2010 we officially said goodbye to the NOAA ship *David Starr Jordan* as she was decommissioned during ceremonies conducted at the NOAA Fisheries facility on Lake Washington in Seattle. The *David Starr Jordan* was built by the Christy Corporation in Sturgeon Bay, Wisconsin, and launched in 1964 for the U.S. Bureau of Commercial Fisheries, which later became part of NOAA as the National Marine Fisheries Service. Since her commis-

sioning in 1966 in San Diego, over 1.3 million nautical miles have passed under the *Jordan's* keel during almost 9,000 days at sea. Many of those miles were earned during CalCOFI surveys.

Shortly after we witnessed the *Jordan's* decommissioning, the newest member of the NOAA fleet, the *Bell M. Shimada*, was commissioned on August 25, 2010 in Puget Sound, Washington. The *Shimada* is the fourth ship of the FSV (Fisheries Survey Vessel) class built in Moss Point, Mississippi, by V.T. Halter. The 208 foot vessel represents the latest in state-of-the-art technology with a suite of scientific acoustic sensors mounted on an acoustically quiet platform. The *Shimada* will serve West Coast scientists to support NOAA's mission to protect, restore and manage living marine, coastal and ocean resources. The *Bell M. Shimada* is scheduled to conduct the spring CalCOFI survey beginning in March of 2011.

The beginning of the field season for CalCOFI's 61st year saw the remnants of a moderate equatorial El Niño which persisted into May of 2010. Positive equatorial SST anomalies became negative by June as a weak La Niña system established itself and persisted through the remainder of 2010. Local anomalies within the CCLME remained neutral to negative throughout the year. The 2010 field season saw the successful completion of the standard quarterly CalCOFI surveys and the Pacific sardine (*Sardinops sagax*) biomass survey using a total of three different research vessels but also was noted for additional activities towards the latter part of the year.

Over the course of the 2010 calendar year a total of four individual surveys were completed using three different vessels: SIO's R/V *New Horizon*, the NOAA ship *Miller Freeman*, and the chartered fishing vessel F/V *Frosti*. Throughout these combined surveys a total of 407 Bongo tows, 349 Pairovet tows, 271 Manta tows, 421 CTD casts, 43 Oozeki trawls and 1,898 CUFES samples were collected during the field season. Also collected during the season were approximately 2,900 hours of acoustic measurements, 1,200 hours of marine mammal and bird observations and 52 satellite-tracked current drifters were deployed. In addition, 98 surface trawls were conducted netting approximately 270 kilograms of adult and juvenile Pacific sardine for the annual spawning biomass estimate.

Sandwiched in between the summer and fall surveys, members of the CalCOFI seagoing group and SWFSC scientists were given the opportunity to put the recently commissioned NOAA ship *Bell M. Shimada* through her paces. Over two five-day periods the ship conducted an abbreviated CalCOFI survey within the Southern California Bight and performed high resolution sampling of a glider identified mesoscale front over the Santa Rosa Ridge. Between these two short surveys, researchers were able to identify strengths and weaknesses

of the new platform and present suggestions which will hopefully benefit users and operators before the ship goes into full operation next year.

California Current Ecosystem Surveys

During spring 2010, the Fisheries Resources Division of the Southwest Fisheries Science Center conducted a survey of the California Current Ecosystem (CCE) off the U.S. West Coast, from the Mexican to Canadian borders. The cruise was an expansion of the standard CalCOFI sampling and was conducted during April and May using the NOAA ship *Miller Freeman* and the contract vessel F/V *Frosti*.

The survey was conducted in an anomalously warm year, when the spring spawning Pacific sardine (*Sardinops sagax*) were subjected to El Niño conditions. Prior to the survey, during March 2010, sea-surface temperatures, averaged along the entire West Coast, were 0.5 to 1 degree Celsius (0.9 to 1.8 Fahrenheit) warmer than normal, and at points off southern California were as much as 1.6 degrees Celsius (2.9 degrees Fahrenheit) higher than normal. The most unusually high temperatures were mapped around Santa Catalina and San Clemente islands. Spawn of sardine was only observed north of the Channel Islands and was concentrated off the central California coast. No evidence of sardine spawn was found off northern California, Oregon, or Washington during the survey.

Acoustic data provided a wealth of information on the distributions of euphausiids and fish, particularly Pacific sardine and jack and Pacific mackerel. This information is relevant to stock assessments and ecosystem investigations, for example seabird-prey interactions. Consistent with the aforementioned observations of sardine spawn, sardine were acoustically mapped south of San Francisco and north of the Channel Islands. Again, consistent with their seasonal migration pattern, no sardine were sampled north of California with the acoustic-trawl method.

Mammal and seabird observations were conducted only from the NOAA ship *Miller Freeman*, between San Diego and San Francisco. A notable feature of the marine mammal sightings was a school of approximately 850 Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) and about 650 northern right whale dolphins (*Lissodelphis borealis*). Observations of this megapod of mixed dolphin species spanned over six miles, nearshore, south of Monterey. By far, the most numerous seabird species encountered by the *Miller Freeman* was red-necked phalarope, accounting for more than 75% of the total. On 12 April, an estimated 10,000 birds of this species were encountered in less than one hour, spanning about 10 nm, just north of the Channel Islands. Cassin's auklets and humpback whales were also observed feeding in

the area. A NOAA Technical Memorandum is planned to summarize the preliminary results from the spring 2010 CCE survey.

CalCOFI Ichthyoplankton Update

During the past year the SWFSC Ichthyoplankton Ecology continued to retroactively update to current standards larval fish identifications from 1951 to the present. Identification of Pacific whiting (hake) and jack and Pacific mackerels collected in the CalCOFI bongo net samples are now complete from 1986 to the present for the eggs and 1966 to the present for the larvae.

We have identified market squid paralarvae from CalCOFI bongo samples dating back to 1997 and from neuston samples dating back to 1981. All cephalopod paralarvae have been identified in all samples and included in the database since 2008. Additional cephalopod paralarvae species were identified sporadically from CalCOFI samples from 1997 to 2007. The presence or absence of jumbo squid paralarvae has been of particular interest in recent years; ommastrephid paralarvae are rare in CalCOFI collections, and none have been collected since summer of 2008.

We collaborated with Ron Burton and his students at SIO on the development of a high-throughput system for molecular identification of ichthyoplankton in the California Current Ecosystem. The ultimate aim of this project is to provide accurate, near real-time identifications of fish eggs, which often are difficult or impossible to identify to species using traditional morphological characters. When fully developed, this method will be able us to identify with accuracy the spawning locations of several taxa of that are valuable to sport or commercial fisheries such as Pacific hake, Pacific mackerel, white seabass and California barracuda.

We analyzed the larval fish assemblage from the winter CalCOFI cruises in 2002–2004. These cruises coincided with detailed sampling within the Cowcod Conservation Area (CCA), a marine reserves embedded within the core CalCOFI sample frame. We evaluated simultaneously assemblage dynamics from the relatively large (CalCOFI) and small (CCA) spatial scales. We found that the larval fish assemblage changed significantly during a transition from La Nina (2002) to El Niño conditions (2003–2004) at the smaller scale, but was relatively stable through time at the larger scale. A manuscript describing these results is being prepared.

PaCOOS—Pacific Coast Ocean Observing System

In 2010 the focus for PaCOOS was to continue to serve biological data via the Internet as well as increase survey coverage in support of the California Current (CC) ecological observing system. Data access and data

interoperability underlie ecological forecasts and integrated ecosystem assessments in the California Current. Collaboration and partnerships within NOAA and between NOAA and academic scientists remains the primary means of developing these forecasts and assessments.

Data management activities in 2010 centered on merging and access to the historical CalCOFI biological and physical data housed at the Southwest Fisheries Science Center and the Scripps Institution of Oceanography, respectively. Currently, PaCOOS is developing a map with a series of overlays of ongoing ocean surveys carried out in the California Current Large Marine Ecosystem. The surveys include government, academic and other research nonprofit organizations from Mexico to Canada. The final activity to highlight is the quarterly reporting of climate and ecosystem science and management activities in the California Current that started in 2008. The quarterlies can also be accessed on the PaCOOS Web site.

The 2011 plans for PaCOOS include continued coordination with the Regional Associations on joint proposal development with an emphasis on data management, ecological forecasting and assessment, and increasing ocean observing data when opportunities arise.

Other Surveys Conducted in the California Current

Lines 60 and 67. MBARI, NPS, and UCSC scientists continue to occupy Line 67 off Monterey and Line 60 off San Francisco with NOAA and MBARI funding. A consistent suite of samples has now been collected quarterly along Line 67 since 1997, and near-shore 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 multidecadal shift.

In 2010 we were able to occupy Line 67 five times. The first two cruises (winter and spring) were in association with southern CalCOFI. The first cruise was on the F/V *New Horizon* in February (S110) and the second on the NOAA ship *Miller Freeman* in April (S210). MBARI and UCSC personnel collected nutrient, phytoplankton and zooplankton samples during a summer cruise aboard the NOAA ship *McArthur II* in July (S310) with support from the Monterey Bay National Marine Sanctuary. A fall cruise out to 67–135 (400 km from shore) was made aboard the MBARI vessel *Western Flyer* in September (S410). Finally, a cruise was made aboard the Point Sur in November (S510). Data from the three cruises have been processed and quality-controlled, and

are available both in the MBARI Biological Oceanography database and online. 2010 was a near-normal year, although with warmer than average start due to the effects of the 2009–10 El Niño. MBARI moorings documented warmer than average and fresher conditions during the first 4 months of the year. Lower than average surface chlorophyll and higher than average deep chlorophyll accompanied the warmer and fresher conditions. The last 8 months of the year were average or slightly cooler and saltier than average. As analysis and publication proceed, the 2010 work will enable data-based exploration of: 1) the 2009–10 El Niño; 2) the putative decadal shift to cool conditions after 1998; and 3) secular climate change.

Trinidad Head Line. NOAA's National Marine Fisheries Service, Southwest Fisheries Science Center and Humboldt State University continue collaborative ocean observing efforts off northern California. 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. Standard sampling protocols include CTD casts to a maximum depth of 150 m, collection of zooplankton samples by oblique bongo tows (505 μm to formalin and 335 μm mesh to EtOH) from a maximum depth of 100 m and vertical 0.5 m ring net tows from a maximum depth of 100 m (200 μm mesh to formalin). These observations are being augmented by CTD data and ring net samples collected at the first five stations during research cruises lead by Dr. Jeff Abell (HSU, Oceanography) to quantify ocean acidity and other hydrographic and chemical parameters under a grant funded through the Ocean Protection Council. All cruises in 2010 and into 2011 were conducted aboard Humboldt State University's R/V *Coral Sea*. On NMFS-HSU PaCOOS cruises, sampling of offshore stations occurs after dark, but sampling over the shelf is conducted during daylight hours. Sampling on OPC cruises is typically conducted during daylight hours.

Here we report hydrographic and chemical data for Station TH02 (41°3.50'N, 124°16.00'W). These data show the dissipation of coastal effects of the 2009–2010 El Niño as strong upwelling resumed in the late spring and summer of 2010. Modest warming occurred in late summer and fall 2010, but was not nearly as pervasive as during the previous year's. Observations into 2011 indicate the effects of variable upwelling and downwelling during winter and early spring.

Shark Surveys

The SWFSC's shark research group is responsible for collecting data to support the management of blue (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*) and common thresher sharks (*Alopias vulpinus*), all of which are

common in off the U.S. West Coast 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.

Juvenile Mako and Blue Shark Survey. In 2010, the SWFSC conducted its seventeenth juvenile shark survey for mako and blue sharks since 1994. The annual abundance survey was completed between July 14 and August 12, 2010. Working aboard F/V *Ventura II*, a team of scientists and volunteers fished a total of 5,956 hooks during 29 daytime sets inside seven focal areas within the Southern California Bight. Survey catch totaled 13 shortfin makos, 25 blue sharks, 18 pelagic rays (*Pteroplatytrygon violacea*), 10 opah (*Lampris guttatus*), and 1 mola (*Mola mola*). The preliminary data indicate that the nominal survey catch rate was 0.057 per 100 hook-hours for shortfin mako and 0.105 per 100 hook-hours for blue sharks. The nominal CPUE for both blue and shortfin mako sharks were the lowest in survey history. There is a declining trend in nominal CPUE for both species over the time series of the survey.

Additional research projects were also conducted during the cruise. An experiment begun in 2009 was continued to examine the potential for using a composite of rare earth metals to reduce shark bycatch. The metals were secured close to the baited hooks and catch rates on treatment and control hooks were compared. Thirteen sets were completed for the experiment during the 2010 cruise to add to the 25 sets conducted in 2009. Preliminary results indicate that the rare earth metals did not affect the catch rate of shortfin mako or blue sharks as they were caught on the experimental hooks and control hooks in almost equal numbers. These results differ from those found on some coastal shark species where the deterrents proved effective at lowering catch rates. The data are being further examined based on size, sex, and other potential factors before drawing final conclusions.

Other objectives of the cruise were to deploy satellite and conventional tags, and to collect biological samples from sharks and swordfish. A total of 242 conventional tags were deployed on 50 shortfin mako sharks and 192

blue sharks. A total of 310 DNA samples were collected including samples from 53 shortfin mako and 244 blue sharks. In a cooperative effort with TOPP (Tagging of Pacific Pelagics), 10 electronic tags were deployed on sharks to examine the habitat-use patterns in the California Current system. Four shortfin mako sharks ranging from 147 to 203 cm fork length were released with a radio position transmitting tag (SPOT). Six blue sharks ranging from 175 to 221 cm fork length were also released with SPOT tags. Satellite tagging of mako and blue sharks has been ongoing since 2002 and reveals site fidelity of both species to the Southern California Bight waters in the summer months with excursions throughout the entire temperate Eastern Pacific Ocean during other seasons.

Neonate Common Thresher Shark Survey. The common thresher shark pre-recruit index and nursery ground survey was initiated in 2003 to develop a fisheries-independent index of pre-recruit abundance and has been conducted in each year since. Common thresher sharks are the most valuable sharks taken in commercial fisheries off California and are also frequently caught by recreational fishermen. In September 2010, the SWFSC team worked aboard the F/V *Outer Banks*. Forty-eight long-line sets were made in relatively shallow, nearshore waters and a total of 4,800 hooks were fished during the 18-day cruise. Shark catch included 295 common thresher, 5 smoothhound (*Mustelus*), 2 spiny dogfish (*Squalus acanthias*), and 1 leopard (*Triakis semifasciata*) shark. Two hundred and sixty-eight sharks were tagged with conventional tags and 280 DNA samples were collected.

The preliminary survey data indicate that the average nominal catch rate by set was 3.75 per 100 hook-hours for common thresher sharks. This is the highest catch rate since the inception of the survey. The distribution of common threshers is very patchy and areas of high abundance are not consistent across years. In all years, a large percentage of the catch has been neonates, which were found in all areas surveyed. In addition to providing important information on abundance and distributions, the thresher shark pre-recruit survey enhances other ongoing research at SWFSC, including age and growth, feeding, and habitat utilization studies.

West Coast Midwater Trawl Survey. The twenty-ninth annual West Coast midwater trawl survey was conducted during the peak of the upwelling season from May 2 through May 26, 2011. The survey targets pelagic juvenile rockfish for fisheries oceanography studies and for developing indices of year class strength for stock assessments, although in recent years the focus of the survey has expanded to encompass an ecosystem survey focusing on the productivity and distribution of the forage assemblage (particularly krill).

Although in recent years the survey has typically

been conducted on larger research vessels over a 6 week period, and spanned the region from Cape Mendocino to the U.S./Mexico border, budget constraints led to a cancellation of the anticipated cruise on the newly christened NOAA ship *Bell M. Shimada*, and a very abbreviated (over time and space) survey was conducted onboard the chartered fishing vessel F/V *Excalibur*. As a result, research activities did not include daytime oceanographic or seabird/marine mammal surveys (for the first time since 1985), nor was it possible to collect multi-beam acoustic data, and the duration and spatial extent of the survey was truncated considerably. High winds during much of the survey and an abundance of jellyfish in many areas also constrained the survey. Consequently, a reduced number of trawls (66) and CTD casts (70) were conducted in 2011. By contrast, from 2003–2010 the average number of tows per year was 144, with an average of 251 CTD casts. Future surveys are anticipated to take place on the NOAA ship *Bell M. Shimada*, which should result in a return to greater spatial and temporal resolution and data availability. A companion survey north of Cape Mendocino also took place in 2011, consistent with a collaborative survey run by the NWFSC and the Pacific Whiting Conservation Cooperative surveys conducted from 2001–2009. Efforts to standardize

and pool the results of these surveys for the development of coastwide indices of abundance are ongoing.

Sampling is focused on young-of-the-year (YOY) groundfish, particularly rockfishes (*Sebastes* spp.), Pacific whiting (*Merluccius productus*), lingcod (*Ophiodon elongatus*), rex sole (*Glyptocephalus zachirus*), and sanddabs (*Citharichthys* spp.). Data are used in stock assessments for several of these species. In addition, a wide variety of other epipelagic micronekton 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 (*Engraulis mordax*), and Pacific sardine (*Sardinops sagax*). The entire assemblage is analyzed to develop indicators of ecosystem state and productivity, which relates the productivity of higher trophic level species that forage on much or all of this assemblage. As with the 2009 and 2010 data, results from 2011 continue to represent a return to cool, high productivity conditions similar to the 1999 to 2003 period for many groups, with the highest catches since this period being observed for juvenile rockfish, sanddabs and market squid in particular. Additional information on these data and efforts are reported in the State of the California Current report in this volume.