Southwest
FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES September-October 1990

SOUTHWEST FISHERIES SCIENCE CENTER

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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

CCAMLR Meetings Held

The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) Working Group on Fish Stock Assessment, the CCAMLR Scientific Committee (SC), and the Ninth Meeting of the CCAMLR Commission met in Hobart, Tasmania, Australia between October 9 and November 2, 1990. Rennie Holt and Larry Jacobson (SWFSC) attended the Fish Stock meeting. Scientific advisers at the Scientific Committee and/or Commission meetings included Holt (Head of Scientific Delegation), John Bengtson (NMML), Beth Marks (Yale University), Polly Penhale (National Science Foundation), and Jacobson.

The entire catch of finfish was taken by the Soviet Union with the majority of it occurring in Subarea 48.3 (South Georgia Island). Total catches of fish for the 1989/90 season, in metric tons (t), in all areas were: *Champsocephalus gunnari* - 10,841; *Dissostichus eleginoides* - 9,373; *Notothenia gibberifrons* - 351; *N. rossii* - 157; *Patagonotothen brevicauda guntheri* - 145; Myctophidae spp. -23,623; for a total of all species - 47,727. The Commission agreed that regulations enacted last year concerning the reporting of haul-by-haul data and inclusion of research vessel catches as part of the total allowable catches (TACs) should be in effect during the 1990/91 season.

The total commercial krill catch during the 1989/90 season was 374,793 t. This is slightly below the 394,531 t caught in 1988/89. The Commission noted that there was a need to start to develop a management policy for determining appropriate krill fishing limits. In addition, they also endorsed the SC recommendation that once fish nursery grounds that occur in krill fishing areas had been identified, these areas should be closed to krill fishing for relevant periods.

No members undertook squid fishing in the convention area in the last year. However, in case squid fishing might be undertaken in the future, the Commission adopted instructions and data reporting procedures to be used.

The Commission noted that monitoring of krill to determine its availability to predators is directly related to the broader issue of estimating krill abundance and distribution. The Commission endorsed the SC approaches to the integration of data from the CCAMLR Ecosystem Monitoring Program (CEMP) into CCAMLR management strategies. For example, one recommendation of the SC is that analysis and evaluation of CEMP data and recommendations based upon these data should not require and should not await the determination of the precise quantitative nature of predator/prey/environmental relationships.

The Commission agreed to support the convening of a workshop to assess the current status of southern elephant seals and to compile additional information which might identify the factors causing the decline in their abundance in some regions.

The members of the International Whaling Commission (IWC) at their last meeting suggested that the objective of a joint CCAMLR and IWC workshop to study the feeding ecology of southern baleen whales, should be expanded to include all southern whales. However, the Commission agreed that limitation to baleen whales was still appropriate to CCAMLR interests and that the IWC should be so informed. A review of CCAMLR interests will be held in 1992.

Although the Commission recognized the need to reduce incidental mortality of seabirds in longline fisheries and adopted measures to provide better data concerning seabird mortality, some members felt that their national experts, who were not at the meeting, should review the technical details of the measures before a conservation measure was adopted. Therefore, a draft conservation measure was provided which will be reviewed and considered during the next Commission meetings.

The U.S. proposed a ban on the use of driftnets in the Convention Area. The Commission adopted a Resolution, which declared that, in accordance with UNGA Resolution 44/225, there will be no expansion of large-scale pelagic driftnet fishing in the Convention Area.

The Commission adopted a conservation measure to determine procedures to protect CEMP sites. Proposals to protect three sites had been drafted using provisional guidelines and were submitted during 1990 to WG-CEMP and the SC for review. It was agreed that these proposals should be redrafted and resubmitted at the next meeting for consideration in accordance with the newly adopted conservation measure.

Several members believed that a precautionary limit on krill catches should be set. Members agreed that the catch limit should be set for all areas in the Convention area. It was felt the limit should be set to prevent unregulated escalation of the fishery, not to limit the current activities of fishing members or to restrict the activities of fleets to specific areas. One possible management measure might be to establish an initial catch limit in excess of present catches and permit expansion of the fishery at a controlled rate (for example 5% a year). The USSR, Japan, and Korea held the view that they were not, in principle, opposed to a precautionary limit on krill fishing but that such a precautionary limit should have scientific justification based on assessments performed by the SC. Others felt that a central reason for the need for a precautionary limit was the acknowledged inability of the SC to give quantitative advice on biomass and potential yield of krill.

During 1990, the U.S. issued a permit for a U.S. company to harvest Antarctic crabs in Subareas 48.1, 48.2, 48.3 and 48.4. The company requested and received permission to take 1,000 t during a 90-day period. There was considerable discussion in the SC and Commission meetings concerning the proposed U.S. exploratory crab fishery. There was concern that the fishery would harvest a large part of the standing stock. It was recognized that no data existed concerning stock levels or potential yields. The Commission agreed with the principle that the development of a new fishery should not out-pace the ability of the Commission to assess the population status. Some delegations, including the U.S. supported a proposed conservation measure defining guidelines for developing fisheries, however, other members preferred to study the legal implications of the measure. The Commission will consider a conservation measure aimed at new and developing fisheries at its 1991 meeting. The U.S. agreed to provide all appropriate catch statistics to the CCAMLR at its next meeting. The captain applying for the permit has invited a scientific observer aboard his vessel and the U.S. is currently reviewing the feasibility of that option.

The Commission noted with satisfaction that the first inspection under the Inspection System was conducted by the U.S. The U.S. inspector aboard the NOAA R/V *Surveyor* boarded the Japanese krill fishing vessel *Aso Maru*. Holt, a member of the boarding party, conducted a slide presentation which discussed problems and findings of the inspection. Some progress was made towards utilization of observers to gather scientific data aboard fishing vessels.

The Commission adopted several conservation measures. Some of these were:

1. The use of trawls having a mesh size of less than 90 mm in any part of the net, is prohibited.

2. The total catch of *C. gunnari* in the 1990/91 season shall not exceed 26,000 t in Subarea 48.3 (South Georgia).

3. In Subarea 48.3 (South Geogia Island), the by-catch of *N. gibberifrons* shall not exceed 500 t and the by-catch of other species shall not exceed 300 t.

4. Directed fishing on *C. gunnari* between April 1 and November 4, 1991 is prohibited.

5. Directed fishing on several species in Subarea 48.3 is prohibited.

6. The total catch of *D. eleginoides* in Subarea 48.3 during 1990/91 season is limited to 2,500 t.

7. The taking of finfish, other than for scientific research purposes, in Subareas 48.1 (Antarctic Peninsula region) and 48.2 (South Orkneys) is prohibited in the 1990/91 season.

Finally, the U.S. IWC Commissioner represented CCAMLR at the 42nd meeting of the IWC held in the Netherlands from June 25 to July 6, 1990. In addition, Holt represented the IWC at the CCAMLR SC and Commission meetings. The CCAMLR Commission considered an application from Greenpeace International for observer status at the Commission meetings. Some members felt that because Greenpeace was a member of the Antarctic Southern Ocean Coalition (ASOC), which was now being invited to attend the Commission meetings, that Greenpeace was already adequately represented. (R. Holt, FTS 893- 5601)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

NMFS Scientist Receives Commerce Gold Medal for Ocean Research

Dr. Paul E. Smith received the U.S. Department of Commerce's Gold Medal on October 31 for his contributions to the field of marine science, including the development of innovative ocean sampling methods to more efficiently measure and describe

biological processes in the sea. Smith was cited for his long and productive 27-year career, during which he carried out pioneering work, using surveys of the early life stages of fishes (eggs and larvae) to assess and manage adult fish populations. His special contributions in survey design and analysis have helped move biological oceanography from a descriptive to the more quantitative or mathematically-based science that it is today.

Smith's work has led to improved hydrodynamic performance of sampling nets, more accurate assessment of schooled fishes using sonar, and a better understanding of the seasonal and annual fluctuations of zooplankton abundance in the California Current. These advances have led to more accurate estimates of fish stock abundance and a better understanding of recruitment.

A native of Spirit Lake, Iowa, Smith graduated from the University of Northern Iowa in 1956, and received his Ph.D. in zoology from the University of Iowa in 1962. After spending a year as a Sverdrup Post-Doctoral Fellow with Scripps Institution of Oceanography in La Jolla, California, he began work in federal marine research at the Southwest Fisheries Science Center in 1963. (J. Hunter, FTS 893-7127)

ECOLOGY AND SYSTEMATICS OF FISHES (CalCOFI)

Preliminary Results of the 1990 Groundfish Research Cruise

The annual groundfish research cruise of the Coastal Fisheries Resources Division was conducted off the coast of Oregon from January 4 to February 13, 1990 aboard the NOAA Ship *David Starr Jordan*. The principal objectives of the cruise were: 1) to define the offshore extent and pattern of distribution of sablefish eggs, 2) to relate sablefish egg distribution to oceanographic measurements made during the cruise, and 3) to determine the feasibility of estimating sablefish biomass by the egg production method. The sampling grid consisted of 52 stations extending from Cape Blanco north to the Columbia River and offshore to a maximum distance of about 180 miles. On each station a suite of plankton samplers was deployed to sample segments of the water column and a CTD cast was made to a maximum of 1500 m to measure standard oceanographic features. Plankton tows were: 1) a surface tow using a Manta net, 2) a standard CalCOFI oblique bongo net tow to 210 m, and 3) a deep bongo tow to 1500 m, bottom depth permitting.

The cruise was severely shortened by a succession of storms and ship malfunctions, therefore only one-third of the planned stations was completed. Despite this, 33 stations were occupied and a total of 94 plankton tows and 33 CTD casts were made on the portion of the original pattern between Cape Blanco and Newport, Oregon. The ichthyoplankton samples have been sorted and identified and the oceanographic data analyzed. Sablefish eggs were taken on 19 of the deep bongo tows and 5 of the shallow bongo tows. The distribution of positive deep bongo tows is shown in Figure 1, along with the occurrences of sablefish eggs on the previous year's cruise (8903JD) covering a smaller region off Newport (see Bimonthly Report of Activities for May-June, 1989). The cruise in 1989 defined the inshore limits of sablefish egg distribution at about the 300 fathom curve. The limited data from this year's cruise show that sablefish eggs are distributed throughout the offshore region. In all but three of the tows the eggs were in the early stages of development (approximately one week old), suggesting that they were produced by an offshore segment of the sablefish population and did not represent eggs advected from the continental slope. Since the bottom depth was 2,000-3,000 m in this area, this implies that sablefish may spawn at depths as great as 3,000 m, or may spawn pelagically higher in the water column.

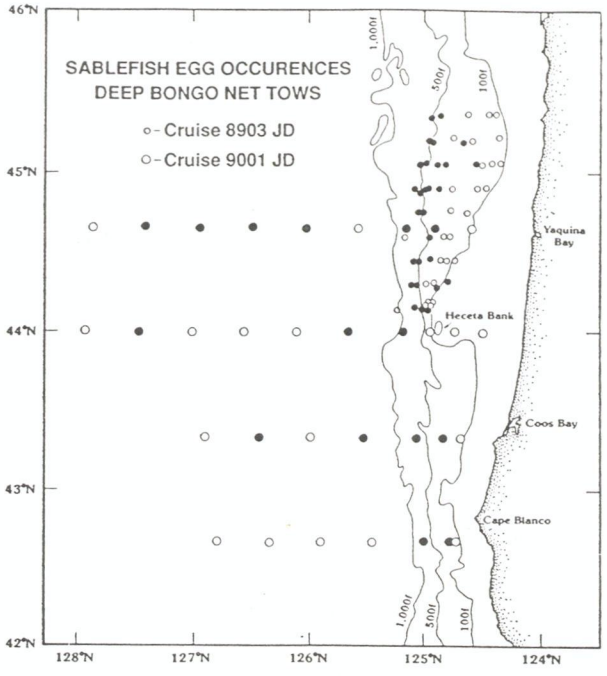


Figure 1. Occurrences of sablefish eggs in deep bongo oblique tows taken on two groundfish research cruises off Oregon. Solid circles indicate positive tows.

The pattern of baroclinic flow at mid-depth is given in Figure 2 by the dynamic height at 400 meters with respect to 1000 decibars. It does not differ markedly from the pattern of surface flow. Velocities are generally very weak: 3 to 8 cm/sec (1.5 to 3.5 n.mi./day). The waters of the northward flow in the middle of the survey area which loop to the east and southward along the continental slope have slightly higher salinities and temperatures and lower dissolved oxygen than the waters to the west. These are traditional characteristics of California undercurrent waters, the poleward flow that is usually found along the slope and which, on average, has maximum velocities in January. This survey shows that the undercurrent has diverged from the slope in a recirculation pattern that would transport mid-depth planktonic biota southward (at least south of Heceta Bank) and offshore. The flow velocities, however, are much too low to explain the offshore distribution of early-stage sablefish eggs. Additionally, no pattern coherence between the flow and egg distribution was apparent.

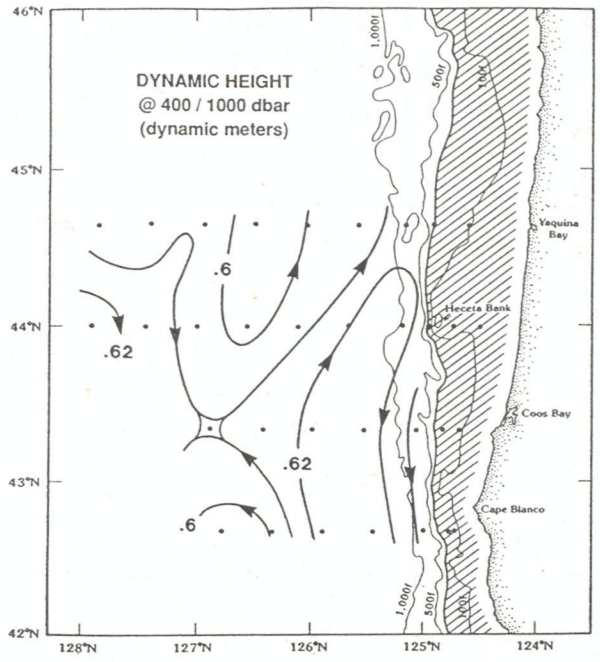


Figure 2. Dynamic height at 400 meters with respect to 1000 decibars. Shading indicates bottom depths less than 400 f.

The two sablefish egg distribution cruises provide a basis for assessing the feasibility of estimating sablefish biomass by the egg production method. We satisfied one requirement of this method by developing a quantitative plankton tow that adequately sampled sablefish eggs to a depth of 1500 m. With the cruise in 1989 furnishing the basic fecundity and spawning parameters, the major uncertainty of the method is the offshore extent of the egg distribution. However, it is apparent that the sampling pattern for a sablefish egg production survey off Oregon and Washington would have to extend seaward at least 200 nautical miles and would require a vessel that could accomplish station operations in heavy seas.

The dedication of the ship and laboratory personnel was instrumental in carrying out the cruise objectives under difficult circumstances. The plankton sorters did their usual superb job of processing the samples, as did the team of ichthyoplankton identifiers and data processors. Co-cruise leaders David Griffith and Ron Dotson should be recognized for their outstanding performances. (G. Moser, FTS 893-7129; R. Lynn, FTS 893-7084; R. Charter, FTS 893-7157)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Antarctic Fish Stock Assessment

Larry Jacobson attended meetings of the CCAMLR Working Group on Fish Stock Assessment and Scientific Committee that were held in Hobart, Australia, October 8-24. During the meeting, Jacobson and Eduardo Balguerias, a Spanish colleague, completed a stock assessment for *Notothenia gibberifrons* (one of the Antarctic cods) around South Georgia Island. The assessment was used by CCAMLR to set a total allowable catch level for this species during the 1990/91 fishing season. (L. Jacobson, FTS 893-7117)

Economic Impacts Assessed for Proposed Limited Entry Program for Pacific Coast Groundfish

Industry Economist Sam Herrick has been working with Economist Jim Seger of the Pacific Fisheries Management Council, and Industry Economist Jim Hastie of the Alaska Fisheries Science Center on an analysis of the economic impacts associated with the proposed limited entry amendment to the Pacific coast groundfish fishery management plan. Herrick is investigating the effect of limited entry on maintaining full utilization (i.e. maintaining harvest levels as large as can be supported on biological grounds) of the groundfish resource. Given the initial distribution of limited entry permits and the

possible redistribution that might occur as fishermen buy and sell permits under the transferability feature of the proposal, it is possible that the resource as a whole could be less than fully utilized if permits become concentrated in specific geographic areas or among vessels engaged in a particular fishing strategy.

Full Geographic Utilization

Arrowtooth flounder, found primarily off Oregon and Washington, is an example of a species that has a limited geographic range. If most trawl permits under a limited entry system (particularly for larger deep-water vessels) were used in California or southern Oregon, arrowtooth flounder off Washington would be underutilized.

Another potential problem in a limited entry program stemming from underutilization is that insufficient harvesting capacity in certain areas could shift the share of landings from one port to another, affecting the distribution of economic activity along the coast. The Pacific Fishery Management Council could elect to tie permits to a specific geographic area in order to deal with this potential problem. This approach is apt to produce more problems than solutions because, although a community may experience some economic hardships if a large portion of its fleet sells fish to purchasers outside its area, the nation and consumers may lose even more over the long-run if an artificial distribution of fishing effort prevents the resource from being harvested in the most efficient manner. Additionally, fishing permits linked to specific areas would compound the problems involved in trying to secure a permit for a vessel entering the fleet and would reduce the flexibility of vessels that ordinarily fish in several areas.

Under the limited entry system currently proposed, geographic limitations on the geographic redistribution of permits would be achieved by allowing communities or states to purchase fishing permits in the marketplace. States, communities or processors who purchased permits could then lease them to fishermen with the condition that fish be landed in specified areas.

Full Species/Species Complex Utilization

If limited entry permits were to become concentrated among vessels engaged in a specific fishing strategy, certain species or species assemblages might be underutilized. This situation could occur if a component of the fleet that uses a particular fishing strategy was issued too few fishing permits. Consequently, some species or species assemblages normally harvested by boats using that fishing strategy may not be fully utilized. For example, if permits are initially issued on the basis of some specific level of past participation in the groundfish fishery (e.g. number of trips over a certain time period), smaller vessels that use a particular type of gear may have difficulty qualifying, since they average fewer trips annually than larger vessels.

The possibility of underutilization due to a limited entry program is illustrated for the groundfish trawl fleet in Table 1. At a recent meeting, the Council decided that only those vessels that had landed groundfish during July 11, 1984 through August 1, 1988, would be allowed to participate in the fishery under limited entry management. During the qualifing period, there were 29 vessels less than 40 feet in length that had recorded groundfish (other than Pacific whiting) landings. Of these, more than half had landed groundfish fewer than 18 times. On the other hand, there were 440 trawl vessels at least 40 feet in length, of which only 26% had landed groundfish fewer than 18 times. If 18 landings during the qualifying period is used as a criteria for admittance into a limited entry program for trawlers, a disproportionate number of small trawlers would fail to qualify. Furthermore, because near-shore fisheries for certain flatfish and rockfish species are predominately conducted by small trawlers, these species might not be fully utilized.

Table 1. Distribution of groundfish trawl vessels by number of landings and length class, July 11, 1984-August 1, 1988.

Vessel length class	Percent vessels with less than 18 landings	Percent vessels with at least 18 landings	Total vessels with landings
< 40 ft	55	45	29
≥ 40 ft	26	74	440

The analysis of these issues is to be completed and presented to the Pacific Fishery Management Council at its November 1990 meeting. (S. Herrick, FTS 893-7111)

The Effects of Sablefish Trip Limits

Dale Squires, industry economist, developed an economic model to evaluate the effects of trip limits on production of individual species in a multi-species fishery. He applied the model to an open-access multispecies deep-water trawl fishery that harvests sablefish, Dover sole, and thorneyheads in the Eureka area. The model uses "virtual prices" to describe the production of sablefish and other species with and without trip limits, given a fixed quantity of fishing effort under the assumption that fishermen maximize revenue.

Regulators routinely make adjustments during fishing seasons to trip limits as information about catch levels becomes available in order to ensure that annual quotas are not exhausted prematurely. Regulators are often unsure, however, about how individual boats will react to trip limits and hence, how well the modified trip limits will work. If trip limits are not effective, then the fishery may be shut down early, causing severe financial hardship or the diversion of fishing effort to other species and their possible depletion.

The model was applied to data for trawl vessels less than 75 gross registered tons which used a high-speed winch allowing them to fish in deep water. The analysis was based on data for 1984, a year without restrictive trip limits, and vessels that landed at least 1,000 pounds of sablefish. The following species or species groups were considered: Dover sole, sablefish, thornyheads, other rockfish, other flatfish, and all others.

Results indicated that changes in market prices would have a minimal effect upon the supply of all unregulated species, and hence should not confound regulation of sablefish and the groundfish fishery. Trip limits should substantially reduce harvest levels for sablefish and cause harvest levels of unregulated species or species groups to become less responsive to changes in ex-vessel prices. Lowering the sablefish trip limit level during the course of the year would reduce harvesting of other species with the exception of thornyheads. In contrast to other species, trip limits on sablefish would shift fishing effort onto thornyheads, a species already facing excessive fishing pressure. Hence, trip limits for thornyheads may become necessary to prevent their depletion. Revenues obtained from harvest of sablefish were found to be sensitive to trip limits. (D. Squires, FTS 893-7113)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

NMFS Hosts International Meetings on Mortality of Whales and Dolphins in Gillnet and Trap Fisheries

The Southwest Fisheries Science Center hosted an International Whaling Commission Conference on the mortality of cetaceans in passive fishing nets and traps, October 20-25 in La Jolla, California. In addition to NMFS, other sponsors funding the conference included the United Nations Environment Program (UNEP), World Wildlife Fund-U.S., World Wildlife Fund-Sweden, U.S. Marine Mammal Commission, the International Union for Conservation of Nature and Natural Resources, and the Government of New Zealand. A 2-day symposium was held at the Scripps Institution of Oceanography, where 32 formal scientific papers were presented by participants from a variety of international government and environmental organizations to an audience of more than 200 people. A 4-day workshop followed the symposium. Sixty-six workshop participants separated into three subgroups for the purpose of 1) identifying and reviewing fisheries that take cetaceans; 2) assessing the impacts of fishing operations on the cetacean populations; and 3) analyzing specific causes of entanglement and discussing solutions for reducing the take of these animals.

Scientists from 15 countries participated in the symposium/workshop, preparing and presenting information specifically for these meetings on marine mammal fishery interactions in their respective regions. The workshop participants agreed upon a set of conclusions and recommendations for each of the three groups.

Global Review of Fisheries

The group consensus was that throughout all regions, there is a general lack of adequate statistics on gillnet and trap usage and on marine mammal entanglement in them. It was recommended that fishery agencies and regional bodies ensure that statistically valid data on gillnet and trap effort and cetacean catches be collected and promptly analyzed and reported. Furthermore, this statistical data should be obtained through independent ob-

server programs following scientifically established designs. Other recommendations made by this group include: the collection of by-catch data on distant-water drift net fleets; the use of multidisciplinary environmental impact assessments that include the potential effects on target and non-target species for the development of new fisheries or expansion of existing fisheries; increased education of fishermen, officials, and scientists, as well as the general public concerning the problem of cetacean interactions with gillnets and traps; establishing research programs to assess the possible impact on cetaceans of lost and discarded fishing gear; and finally, to utilize license fees for fishing in developing countries' exclusive economic zones (EEZs) to fund stock assessments and fishery monitoring programs that must be carried out to ensure that incidental catches of cetaceans in particular fisheries are sustainable.

The group also concluded that the effects of totoaba gillnets on vaquita in Mexico, the effects of the longline fishery on baiji in China, and the impact of an estimated 3,500,000 gillnets in use in Chinese coastal waters require the highest priority attention.

Impacts on Species and Populations of Cetaceans

It was concluded that cetacean populations in general seem unable to sustain rates of kill of more than a small percentage of the population per year. Even kill rates as low as 2% per year may not be sustainable depending on the life history of the species and the age and sex composition of the kill. The workshop scientists recommended that the agencies responsible for the management of marine resources should manage from a conservative point of view (i.e., fisheries should not be allowed to operate at a particular level until there is evidence that the kill of cetaceans associated with that level of fishing effort is sustainable). Despite problems with the collection and analysis of data on kill rates, total fishing effort and population size, it is important that the agency responsible for managing a particular fishery collect these data on a systematic basis.

The best available information at this time indicates that several stocks of cetaceans are unable to sustain current levels of removal caused by passive net and trap fisheries. It was recommended that the killing of these stocks be reduced immediately. Mechanisms for reducing the take of these species will have to be developed by the agencies with the management authority. These stocks include: (1) vaquita in the Gulf of California; (2) baiji in the Yangtze River; (3) hump-back dolphins along the eastern coast of South Africa; (4) striped dolphins in the Mediterranean Sea; (5) harbor porpoises along the coast of central California and in the eastern and western North Atlantic; (6) bottlenose dolphins along the eastern coast of South Africa.

There are additional stocks for which we lack sufficient information as to the impact of passive net and trap fisheries, yet it appears that the current levels of removal might not be sustainable. This is particularly true where rates of kill are known to be large. Of particular concern are the following stocks: (1) dusky dolphins in the eastern South Pacific; (2) northern right whale dolphins in the central North Pacific; (3) sperm whales in the Mediterranean Sea.

Causes and Solutions

The incidental capture of cetaceans in drift and set gillnets appears to be almost universal, and it is a common occurrence in some trap fisheries as well. However, there is no universal cause or solution to the incidental capture of cetaceans in fishing gear. And although at least some cetaceans are caught wherever cetaceans and gillnets are found in the same area, the precise nature of the interaction varies by area, fishing gear type, species, culture, and any combination of these.

It was determined that small cetaceans have sensory abilities that can detect the weaving and rigging of gillnets and other passive fishing gear, but less is known of the sensory abilities of large cetaceans. Encounters with nets may occur as they forage or engage in other activities which increase the chances that they will fail to detect nets. Likewise, there are a variety of environmental, social and sensory conditions which may interfere with detection of nets, and additional study is necessary to determine the role such factors play in entrapment of cetaceans. Even if cetaceans detect nets, there is still a variety of behavioral factors that contribute to the entrapment or entanglement. At this time there is no universal modification of fishing gear which can solve all problems of incidental entrapments of cetaceans. Although some fishing gear modification and management regimes do provide potential solutions, it was recommended that in all cases, careful assessment and monitoring of the effectiveness and impact of such modifications be made.

A full report of the workshop will be completed before the end of the year and distributed to the Secretary General of the United Nations, all Commissioners, contracting Governments, members of the IWC Scientific Committee, and workshop participants. Reports submitted during the symposium will be published in a Special Issue by the International Whaling Commission. (W. Perrin, FTS 893-7096)

FISHERY DEPENDENT ASSESSMENT PROGRAM

Computer Program Assists in Environmental Data Acquisition and Analysis for ETP Dolphin Habitat Study

Prior to the beginning of the Monitoring Of Porpoise Stocks (MOPS) cruises in 1986, temperature and salinity data retrieved from the R/V *David Starr Jordan* in the eastern tropical Pacific (ETP) were recorded on strip charts, which had to be digitized onto a computer. The whole digitizing process took approximately one month to complete for one month of data collection, and accuracy was difficult to maintain.

PCPLUSS and the companion programs were developed by Computer Specialist Robert Holland to sample continuous and discrete data for a variety of environmental sensors during transits of a research vessel; PCRLUSS was specifically designed for the MOPS program to utilize an inexpensive personal computer (PC), but it also has potential use in any R/V oceanographic program due to its inherent expandability.

PCPLUSS is a compiled BASIC program designed to sample, average, and store multiple streams of data from a variety of sources. It is presently configured to directly access an analog-to-digital (A/D) board and convert analog data from a fluorometer to a 12-bit digital form, collect temperature and salinity data from a thermosalinograph through the communications port #1 (COM1:), and collect satellite navigation (SATNAV) latitude and longitude locations through the communications port #2 (COM2:). The input data are averaged and stored as: date, time, latitude, longitude, temperature, salinity, fluorescence voltage, fluorometer scale, mode of operation, and speed indicator. The program can be modified to handle other analog data inputs as needed.

Data are collected at 1 second intervals and are averaged over 2 minutes (default). The data file is opened only when data are to be written, thereby safeguarding data integrity from power loss or equipment malfunction. The A/D board is an 8-bit, XT style board that uses an expansion slot in a PC. The board can be attached to a multiplexer board through an external cable to allow multiple analog inputs.

The main multiplexer can be cascaded with 7 other multiplexer boards to provided a maximum of 128 current or voltage analog inputs. Turbo BASIC can operate 2 communication ports (COM1 and COM2). Thus, PCPLUSS can control 130 data inputs, although the 1 second interval may not be possible on a computer with an effective clock rate of less than 8 megahertz due to the constraints of data input/output and array management.

The following files are necessary for the operation of PCPLUSS:

CONFIGUR.EXE - Reconfigures the PCPLUSS.INF file.
PCPLUSS.BAS - The source program.
PCPLUSS.MAP - The graphics screen cruise track map.
PCPLUSS.INF - The configuration file.
PCPLUSS.EXE - The executable program.
PCPLUSSM.WP5 - This document in WordPerfect 5.1 format.

The program will locate the necessary information and the data files will be written to the pre-configured directory.

When the program is running, it is in the Standard Mode (record type = 1) of data acquisition. The date, time, temperature, salinity, fluorometer voltage, fluorometer scale, and record type indicator are constantly shown and updated. Also, the output data file name is shown (Figure 1).

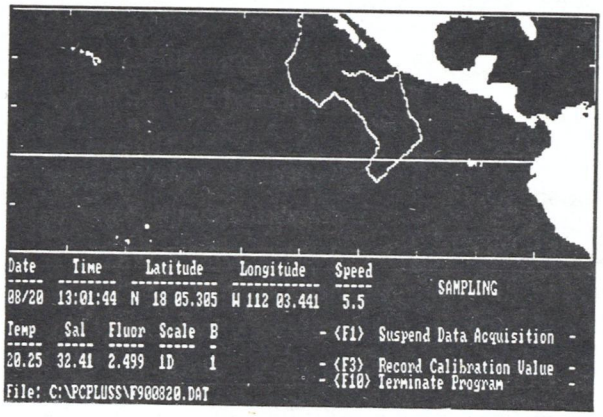
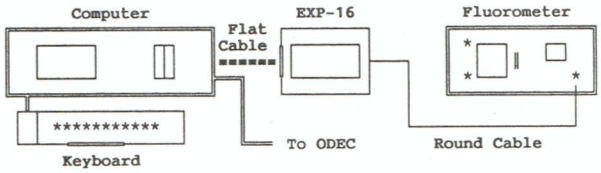


Figure 1. The normal operation of the PCPLUSS graphics screen with the cruise track map shown on the top half of the screen and the collected data shown on the bottom half of the screen. The line bisecting the map is the equator. The current map dimensions are: latitude 20°S, 30°N; longitude 170°W, 70°W.

The following is an example of how the system is used on both research vessels.



PCPLUSS has been a valuable tool in analyzing the variety of environmental data which are collected aboard the research vessels in the ETP. A report on the program and its utility has been submitted as a Technical Memorandum. An initial paper has been published which combines the environmental habitat data with cetacean sightings (Reilly 1990. Mar. Ecol. Prog. Ser. 66(1-2):1- 11). A number of subsequent analyses are in various stages, covering topics ranging from "Las Niñas" oceanographic variability to habitat relationships of cetaceans, birds and other vertebrates of the ETP. One basic objective of the habitat studies is to determine if habitat information can be used quantitatively to improve our ability to monitor trends in dolphin abundance. (S.Reilly, FTS 893-7164; R. Holland, FTS 893-7017)

HONOLULU LABORATORY

Honolulu, Hawaii

FISHERIES OCEANOGRAPHY RESEARCH PROGRAM

Effects of Ocean Currents on Inshore Fish Larvae Studied at an Isolated Oceanic Island

"Horizontal and Vertical Distributions of Larval Fishes Around an Isolated Oceanic Island in the Tropical Pacific" was recently completed and submitted for publication by fishery biologists collaborating through the University of Hawaii's Joint Institute of Marine and Atmospheric Research: George W. Boehlert of the Honolulu Laboratory; William Watson of the La Jolla Laboratory's Coastal Fisheries Resources Division; and L. Charles Sun of the National Ocean Service and formerly of the Hawaii Institute of Geophysics. The mechanism of population maintenance in the marine fauna of islands is an important question in population biology, for island species with small, pelagic larval stages. Lacking an upstream source population, these populations must rely on local recruitment to maintain their populations, despite often unidirectional ocean currents that can advect larvae away.

Their manuscript examines the effects of ocean currents on the planktonic larvae of inshore fish in a tropical island system, based on ichthyoplankton and oceanographic sampling in waters surrounding Johnston Atoll (16°44'N, 169°32'W). The isolation of Johnston Atoll makes it ideal for studying advection of inshore fish larvae; the nearest island is in the Hawaiian Archipelago, 760 km away. The flow of the North Equatorial Current at the latitude of Johnston Atoll is westward; much of the basic oceanographic information about the region is from research conducted over two decades ago by former Honolulu Laboratory Oceanographer Richard Barkley.

Discrete-depth sampling with a 1 m^2 Tucker trawl in the upper 200 m allowed a description of the horizontal and vertical patterns of larval distribution. A grid of CTD and XBT stations was occupied to estimate patterns of geostrophic currents.

Vertical resolution was based on 0-50, 50-100, and 100-200 m strata. Fish eggs were most abundant in the shallowest stratum, decreasing to about half in the 50-100 m stratum and to about 5% of the surface values at 100-200 m. Total larval densities, which were dominated by oceanic taxa, were similar in the two shallowest strata but slightly higher in the 50-100 m stratum; densities in the deepest stratum were about half those in the two shallowest strata. An analysis of inshore fish larvae revealed that most taxa were characterized by greatest abundance in the shallowest stratum, but the numerically dominant taxa (*Eviota epiphanes*, unidentified gobiids, *Pseudamiops* spp., *Parapercis* sp., and *Schindleria pietschmanni*) were most abundant in the 50-100 m stratum. The net effect was that mean densities of inshore fish larvae were highest in the 50-100 m stratum, an unusual finding in light of past studies in tropical systems.

An analysis of the geographic pattern of inshore fish larval densities in the two shallowest strata showed interesting results. In the 0-50 m stratum, larval densities were relatively uniform horizontally, but down current of the atoll, fish eggs were concentrated, and inshore fish larval densities clearly were higher (Figure 1). In the 50-100 m stratum, fish eggs were rare except in downstream waters, and larval abundance on the down current side of the island was markedly higher than either up current or farther down current. Oceanic taxa did not

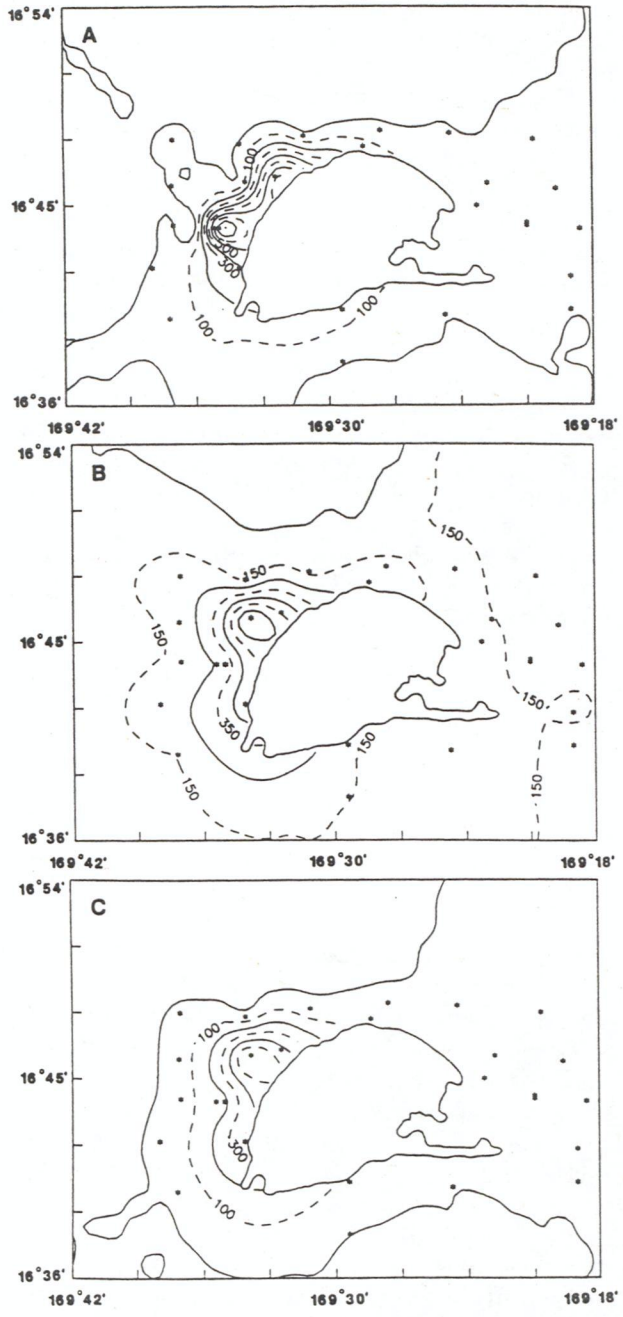


Figure 1.--Geographic patterns of densities (numbers/1000 m^3) of (A) fish eggs, (B) total fish larvae, and (C) inshore fish larvae in the 0-50 m depth stratum. The outline area without contours represents the 18 m isobath surrounding Johnston Atoll.

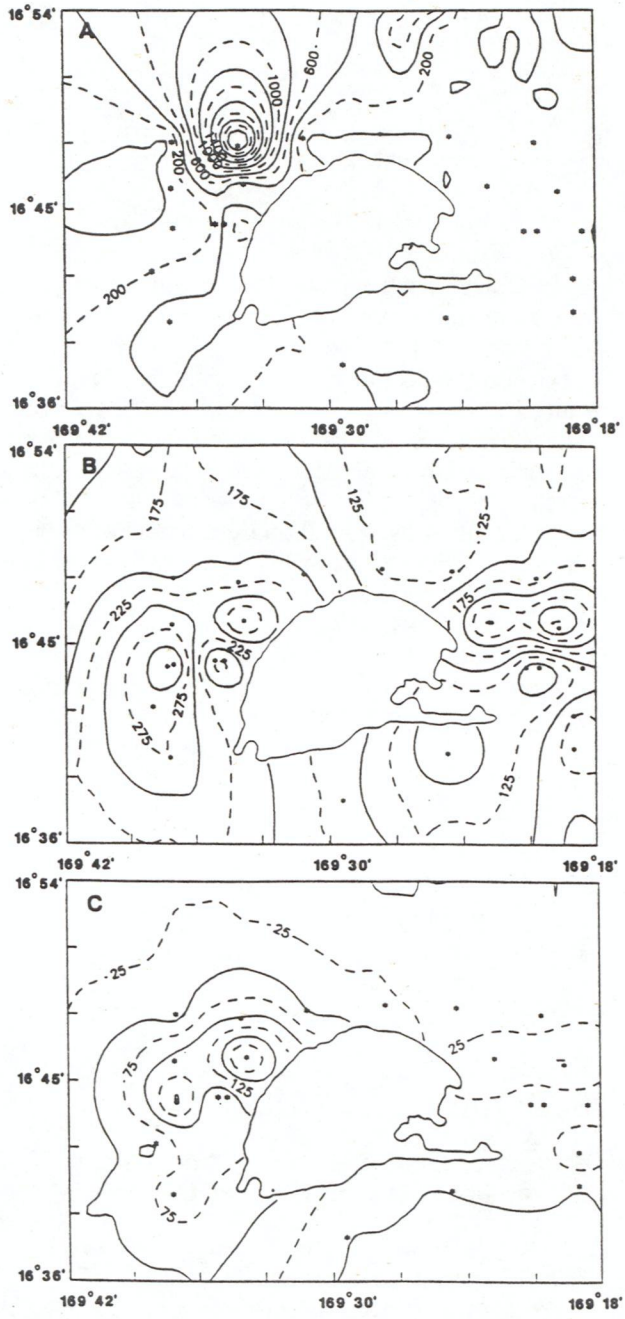


Figure 2.--Geographic patterns of densities (numbers/1000 m^3) of (A) fish eggs, (B) total fish larvae, and (C) inshore fish larvae in the 50-100 m depth stratum.

display this pattern, while marked areas of very high abundance characterized the larvae of inshore fishes (Figure 2). Estimates of geostrophic flow indicated that the region down current of the atoll (to the west) was one of return flow associated with apparent mesoscale eddies or meanderings north and west of the island. This region may serve as a retention area for the pelagic larvae of shore fishes under the oceanographic regime studied and may facilitate recruitment back to the source populations (G. Boehlert (808) 943-1221)

INSULAR RESOURCES INVESTIGATION

Spatial Distribution of Lobster Larvae Studied in the Hawaiian Islands

Jeffrey J. Polovina, Leader of the Insular Resources Investigation, reported that scientists in the Fishery Enhancement and Dynamics Task recently completed an analysis of data from a study on the spatial distribution of lobster larvae in the Hawaiian Archipelago. The study collected over 20,000 lobster larvae with a 100 m^2 rope trawl during summer and winter cruises in 1989. Tows of 1.5 hours each were conducted at 80 m during the day and at the surface at night along spokes north, south, east, and west around four banks. Along each spoke, sampling was conducted at three stations--at the 200 m isobath and at 10 and 20 nmi from the 200 m isobath.

Sampling resulted in the collection of larvae from five species of slipper lobster, *Scyllarides* spp., and two species of spiny lobster, *Panulirus* spp. The two species collected in greatest abundance, *P. marginatus* (Figure 3) and *S. squammosus*, are also the basis for the commercial trap fishery. The larval periods of *P. marginatus* and *S. squammosus* are believed to be about 9 and 3 months, respectively.

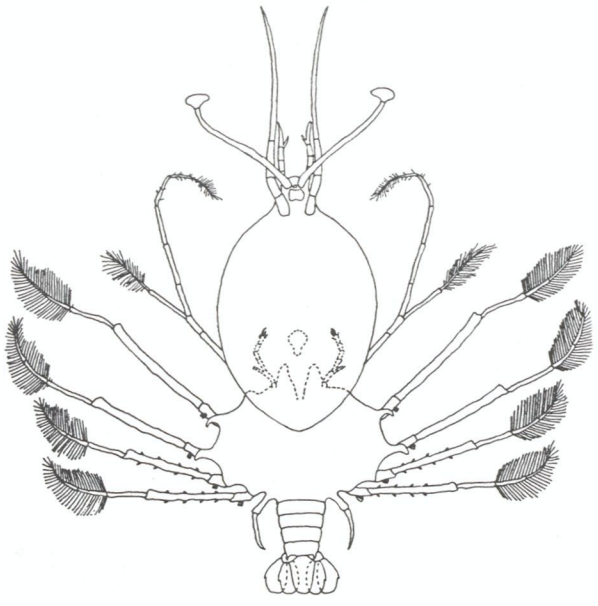


Figure 3. The ninth stage of a *Panulirus marginatus* larva.

There is a 200-fold variation in adult abundance and commercial catch levels between the four banks, yet the densities of late-stage larvae of *P. marginatus* and *S. squammosus* were very similar around each of the four banks, suggesting that benthic habitat, rather than the abundance of larvae, is a limiting factor for lobster populations at some banks. No relationship was observed between current patterns (estimated with acoustic Doppler current profiler data) and larval abundance. In summer and winter, currents were highly variable, but the mean current flow--west to east along the Hawaiian ridge at about 7 cm/s--was almost identical in both seasons.

Two larval sampling cruises are planned in 1991 to extend the spatial and temporal scales of the sampling. An advection- diffusion model will be fit to the larval data to estimate current and diffusivity parameters. These parameters will then be used in a spatial model linking the larval and benthic portions of lobster life history in order to model the spatial and temporal variations in fishery production. (J. Polovina (808) 943-1218)

FISHERY MANAGEMENT RESEARCH PROGRAM

Scientific Observers Placed Aboard Domestic Swordfish Longliners

In late September, 1990, three Honolulu Laboratory biological technicians were placed as scientific observers aboard domestic swordfish longliners operating in the waters north of the main Hawaiian Islands. This makes a total of six observer placements this year. The recent observer placements made by the Fishery Management Research Program with the voluntary cooperation of the longline fleet include: Robert A. Dollar on the *Audree Kristine*, Kevin C. Landgraf on the *Linnea C.*, and Russell Y. Ito on the *Big Al*. A nonconfidential, technical description of present swordfish fishing practices and interactions with protected species will be prepared following the completion of these fishing trips. (S. Pooley (808) 943-1216)

Bioeconomic Analysis of Lobster Fishery Completed

"A bioeconomic analysis of the Northwestern Hawaiian Islands lobster fishery" was recently completed by Raymond P. Clarke from the Southwest Region Pacific Area Office (formerly with the Honolulu Laboratory), and by two Honolulu Laboratory scientists, Operations Research Analyst Stacey Y. Yoshimoto, and Industry Economist Samuel G. Pooley. Their manuscript, which was submitted to Marine Resource Economics, develops a simple bioeconomic model of Hawaii's lobster

fishery but breaks new ground in developing an alternative stock production model of the fishery. The entire bioeconomic model may prove useful in identifying the scope for potential reductions in effort for the fishery. Lobster stocks appear to have declined in the past year, possibly due to environmentally induced changes in recruitment at some major banks. (S. Pooley (808) 943-1216)

Pooley Presents Paper on Fisheries Development Research

Samuel G. Pooley, industry economist, presented a paper on "Substantive Policy Issues in Achieving the Economic Potential of Fisheries" before the graduate Ocean Policy Seminar of the University of Hawaii. His paper identified fisheries development and management as two distinct "cultures" exhibiting their own paradigms. Problems in fisheries development were referenced to current political economic research on the role of the state (i.e. government) in economic activity, while problems in fisheries management were referenced to current approaches to adaptive management techniques and dynamic response models. Recent research emphasis in both areas has been toward better understanding of the policy-making process. The paper represents work in progress on the issues of the relationship between economic development and fisheries management. (S. Pooley (808) 943-1216)

MARINE TURTLE RESEARCH

Marine Turtle Tumor Workshop Announced

The Honolulu Laboratory is sponsoring the Marine Turtle Fibropapilloma Disease Workshop, which will be held December 4-6, 1990, at the East-West Center of the University of Hawaii in Honolulu. Fibropapilloma, a life-threatening tumor disease in marine turtles, has simultaneously reached epidemic proportions in some populations of the green sea turtle (*Chelonia mydas*) in Florida and Hawaii. The workshop will afford scientists an opportunity to discuss what is known about the tumor disease and to devise a comprehensive and cooperative research plan illucidating the cause of this disease.

Workshop participants will give presentations on a variety of topics which will include: green turtle tumor disease; epidemic development; current disease research; research on marine viruses, marine tumor growth enhancers; potential tumor disease vectors; marine pollutants and tumor susceptibility; turtle habitat changes; and the principles of epidemiological investigation. There will also be a half-day session open to other scientists as well as individuals interested in providing background information or other contributions. The papers presented at the workshop, along with the research plan developed by the workshop participants, will be prepared for publication and disseminated shortly after the workshop.

Participants in the workshop include: George H. Balazs and William G. Gilmartin, Honolulu Laboratory; Murray D. Dailey, California State University; John C. Harshbarger, National Museum of Natural History; Elliott Jacobson, University of Florida; Laurence Kolonel, Cancer Research Center of Hawaii; Sidney Simpson, University of Illinois; Alvin W. Smith, Oregon State University; and John Sundberg, The Jackson Laboratory. (G. Balazs (808) 943-1226)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

The Relationship Between Wind Forcing and Hydrography off Central California: Analysis of CTD Surveys, May-June, 1989

Physical oceanographers at PFEG have been analyzing linkages between coastal meteorology and hydrography, based on juvenile rockfish surveys conducted aboard the *David Starr Jordan* by researchers from the SWFSC Tiburon Laboratory. Some of the early results are being presented at several scientific meetings, including the Eastern Pacific Ocean Conference at Timberline Lodge, Oregon; the Fisheries Oceanography Symposium of CalCOFI at Asilomar, California; and at the upcoming American Geophysical Union fall meeting in San Francisco. One of the most interesting results of this work is the close correlation between changes in wind speed and direction, and the structure of the upper water column within the rockfish survey area (Pt. Reyes to Monterey). Furthermore, surface ocean conditions appear to be modified rapidly, within 1-2 days, by changes in wind forcing.

The temperature at a depth of 5 m for a portion of the rockfish survey region, based on CTD data from the Tiburon surveys, the Naval Postgraduate School, and UC-Santa Cruz, is shown in Figure 1 for three time periods in May-June, 1989. For the pur-

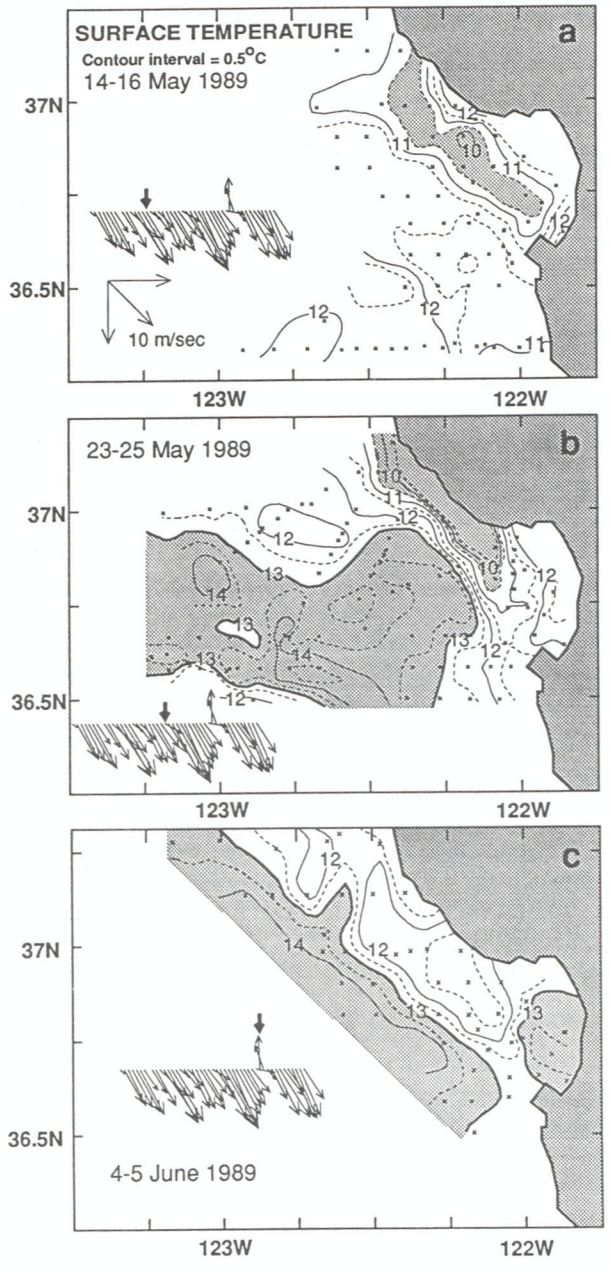


Figure 1. Sea surface temperatures for three time periods in May- June 1989, and daily average wind speed and direction (vector arrows) from NBBC meteorological buoy 46042 located at 36.8°N, 122.4°W for the period May 1 to June 15, 1989. Bold arrows above vectors denote the average wind on the first day of each cruise survey, with each vector pointing in the direction the wind was blowing.

poses of this analysis, the full survey area, such as that shown here, has been subdivided into smaller regions that were surveyed in a few days. This is because wind changes on this time scale are thought to produce profound changes in surface structure, which minimize the synopticity of the *Jordan's* 7-10 day surveys. The area mapped in Figure 1 includes an upwelling center located near Pt. Año Nuevo (~37.1°N); this upwelling source appears persistently in CTD surveys and AVHRR satellite SST images of the area.

Results from the first survey (May 14-16) display the typical surface structure of this area following several days of upwelling favorable wind (Figure 1a). A mass of relatively cool, salty water, whose source was the Año Nuevo upwelling center, extends southward across the mouth of Monterey Bay. An analysis of AVHRR imagery has shown that upwelled water was advected south from this source during periods of upwelling favorable wind, presumably in geostrophic balance with the isopycnals that slope upward toward the coast during upwelling. Upwelled water was easily differentiated in surveys and AVHRR imagery from the relatively warm and less salty water seen in the offshore portion of the entire rockfish survey region. These two water masses were separated by a front that was oriented approximately parallel with the shelf bathymetry. A third type of water was seen in the shallowest areas of this survey. Although it was warmer than the adjacent upwelled water, this coastal water features similar salinities. It was probably advected from the upwelling center into shallow shelf areas, where the surface was warmed. The 12°C isotherm closely follows the 50 m isobath. We think that much of this nearshore area was fairly sheltered from the wind, which resulted in reduced vertical mixing and a rapid accumulation of heat in the surface mixed layer. These areas may also be less susceptible to fog, which would lead to greater warming as well.

The second survey of this area, 23-25 May (Figure 1b), also took place during upwelling favorable wind conditions, but immediately followed a wind relaxation, or reduction in alongshelf wind speed. The upwelling center off Año Nuevo was again apparent; its central temperature was nearly 1°C cooler than nine days previous. However the water in the offshore region of the survey was substantially warmer and less salty, its edge was much closer to the coast, and the upwelling front was much stronger. Vertical sections off Davenport (37.0°N) showed this front moved from 90 km to just 30 km offshore between these surveys. We believe that the onshore advection of offshore water occurs almost immediately following wind relaxations or reversals. This onshore flow is probably an adjustment to the changing balance between wind stress and the tilting of isopycnals that developed during the preceding upwelling episode.

This sudden onshore flow is even more dramatic when the wind reversed to a northward, or downwelling favorable direction on June 4-5 (Figure 1c). In addition, surface temperatures near the coast had warmed by as much as 2°C since the second survey. Salinities at that time suggested that some of this warming was due to the onshore movement of warm, less saline water. However, the coastal ocean also experienced significant heating as the northward wind brought warmer air into the region. The air temperature at buoy 46042 increased by 3°C during this wind reversal.

PFEG scientists are continuing to study the influence of meteorological variations on the region's coastal hydrography. We are examining CTD data collected during the spring of other years to determine the persistence of the processes described here, as well as discern seasonal and interannual variations. One key hypothesis that we are testing, in collaboration with fisheries biologists at the Tiburon Laboratory, is that the timing of the spring transition, and the frequency of wind relaxation/reversal events (as seen in Figure 1c), may control the success of groundfish recruitment. (F. Schwing (408) 646-3311; D. Husby (408) 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Collection of Albacore Gonad Samples Begun

Fishery Biologist Darlene Ramon (formerly a NOAA Jr. Fellow) has begun examining albacore gonads taken in New Zealand's Exclusive Economic Zone (EEZ) by South Pacific Albacore Research (SPAR) program observers, to determine spawning periodicity. This is part of a larger program organized to examine the reproductive dynamics of North and South Pacific albacore and is a U.S. contribution to the SPAR workshop.

Sampling design and instructions for collection of albacore gonad samples from commercial vessels in the Pacific have been prepared by Program Leader Norm Bartoo. The sampling design calls for collection of mature albacore gonads from various areas throughout the year, as well as special collections by observers. Other laboratories cooperating in the collection of samples include: the Institute of Oceanography; National Taiwan University; the National Research Institute of Far Seas Fisheries, Japan; and SPAR participants in the South Pacific. (D. Ramon, FTS 893-7087; N. Bartoo, FTS 893-7073)

Theoretical Models of Longline Fishing Developed

In order to show that the relationship between catch rate and population density of passive fisheries is fundamentally different to that of active fisheries, Fishery Biologist David Au and Operations Research Analyst Carlos Salvadó at La Jolla are developing computer models of longline fishing, a passive fishery type. These models are being developed along two lines of thought:

a. Schools of fish are treated as points moving in a space, and whose foraging speed is proportional to p^a, where p is the fish population in an arbitrary neighborhood of the longline, and $0<a<1$. The direction of movement of each school is randomly selected at each time interval.

b. The diffusing population of fish p(r,t) is treated as a continuous distribution of fish of the position vector r and time t. In this case, the foraging velocity of the fish is not only proportional to a power of the local population density, but also to the gradient of a chemical signal (i.e., smell) above an arbitrary threshold emanating from the location of the longline. The chemical signal disperses by diffusion and the advective velocity of the ocean current. This model is particularly amenable to a treatment using differential equations, which have been formulated and are being solved analytically. (C. Salvadó, FTS 893-7052; D. Au, FTS 893-7071)

PELAGIC ECOSYSTEM MODEL DEVELOPMENT PROGRAM

Tag Analysis and Assessment of Fishery Interaction

One Parameter Model

In interpreting tag-recapture data for understanding migration, several investigators have calculated the probability $g(x,x_o;t,t_o)$ of finding a tag at point x, at time t, given that the tag was released at point x_o at an earlier time t_o, by use of the expression

$$g(x,x_o;t,t_o) = r(x,t)/[\#_T\, q\, e(x,t)],$$

where r(x,t) and e(x,t) are the tag recovery rate and the fishing effort at (x,t), respectively; q is the catchability coefficient and $\#_T$ is the total number of

tags released at (x_o,t_o). This is actually identical to the Greens' function (i.e., the point source solution) associated with a differential operator L which contains the dynamics of the fishery migration and population growth:

$$L\, g(x,x';t,t') = D(x-x')\, D(t-t'),$$

where D is the Dirac delta function (i.e., an infinitely peaked normalized Gaussian distribution with vanishing variance). For example, if a fishery seems to be diffusing with diffusivity K, advecting with velocity v, and with a natural mortality M, then the operator L that might describe the dynamics accurately could be

$$L = \partial/\partial t - v\partial/\partial x - K\partial^2/\partial x^2 + M.$$

Operations Research Analyst Carlos Salvadó and Fishery Biologist Pierre Kleiber make use of the empirical Greens' function in an integral equation (IE) formulation for a one parameter model. Since the inverse of the empirical Greens' function is the empirical differential operator that represents the dynamics of the fishery, its use automatically embeds fishery dynamics in the solution of the IE. The rationale is as follows:

If L is some differential operator that contains the dynamics of a population #(x,t) of tagged fish, then

$$L\,\#(x,t) = -\, r(x,t),$$

and an integral representation for the tag recovery rate can be shown as

$$r(x,t) = q\, e(x,t)[\#_T\, g(x,x_o;t,t_o) - \int_{-\infty}^{\infty} dx' \int_{t_o}^{\infty} dt' g(x,x';t,t') r(x',t')].$$

This equation, and the assumption that the history of tag recoveries does not affect significantly the probability of finding tags at a later time, lead to the empirical determination of the Greens' function given above without invoking any particular model for the fishery. Since the population p(x,t) of fish in the fishery obeys the equation

$$L\, p(x,t) = -\, c(x,t),$$

the catch rate c(x,t) can be shown to be given by

$$c(x,t) = q\, e(x,t) \int_{-\infty}^{\infty} dx' \int_{t_o}^{\infty} dt' g(x,x';t,t') \bullet [p^{(in)}(x')\, D(t'-t_o) - c(x',t')],$$

where $p^{(in)}$ is the initial population of fish. Using the observed catch and effort, we determine $p^{(in)}$ by computing

$$p^{(in)}(x)\, D(t-t_o) = L\{c(x,t)/[q\, e(x,t)]\} + c(x,t).$$

The integral equation for the catch can then be used at any level of effort, anywhere in the space and at any time, to determine how a proposed exploitation of the fishery in an area affects other economic zones.

This technique is being applied to tag recapture data from the eastern tropical Atlantic, off west Africa. (C. Salvadó, FTS 893-7052; P. Kleiber, FTS 893-7076)

Multi-Parameter Model

One approach to assessing fishery interaction is the construction of a mechanistic model incorporating fish movement, harvest, and other features of population dynamics (recruitment, growth, and natural mortality). The parameters of this model can then be estimated from tag-recapture data using a modified version of the model that deals specifically with tagged fish. The original model can then be run with hypothetical effort regimes to investigate how different fleets affect one another.

Pierre Kleiber and Carlos Salvadó at La Jolla have constructed such a model for skipjack tuna and tuna fleets in the eastern tropical Atlantic. In collaboration with Alain Fonteneau of ORSTOM and Rick Deriso of IATTC, Kleiber and Salvadó are making use of tag-recapture data from the International Skipjack Year Program that was conducted by the International Commission for the Conservation of Atlantic Tunas to test the model. The areas in which tags were released and recovered are the coastal fishing regions of western Africa.

Basically, the tag version of the model is a modification of the advection, diffusion and mortality operator, L, given in the previous section.

$$L = \partial/\partial t - V_{max} \sin(wt-a)\partial/\partial x - K\,\partial^2/\partial x^2 + M + q\, e.$$

As noted in the previous section, advection and diffusion in only one dimension--north and south, along the coast--is represented in the model. Because of low fishing effort and lack of recoveries in offshore areas, offshore-onshore movement is not represented in the model. The advective term has a time-varying, sinusoidal pattern to account for a supposed annual north-south shift or movement in

the population. The period is therefore set to one year, and the phase a set such that the maximum northward excursion occurs in northern summer and the maximum southward excursion in southern summer. Thus, the parameters estimated from the tag data are: diffusivity, K; maximum advective velocity, Vmax; natural mortality, M; and catchability, q.

The above are cast into a finite difference equation system which predicts monthly recoveries in five different fishing zones based on a release of tagged fish in a given zone and month, and the field of fishing effort data by zone and month. The parameter space is searched to maximize the multinomial likelihood of predicted recoveries, given the observed recoveries. The results from several releases in different zones and months can be combined into one fitting. The experience with this formulation so far is that the fitting system converges readily.

The picture that is emerging is that advective movement is small relative to diffusion in the skipjack tuna stock in the eastern tropical Atlantic. Estimated maximum advective velocity is 20 to 40 nautical miles per month, whereas the diffusivity estimate is approximately 50,000 square nautical miles per month, corresponding to an average displacement in one month of 250 nautical miles. Natural mortality is high, at 5 to 10% per month, but a significant part of this percentage is suspected to be due to offshore diffusion, which cannot be accounted for separately from mortality in the model. At the prevailing average effort levels, the estimated catchability implies an average fishing mortality of less than 1% per month, which corresponds well with the findings of low exploitation rate in previous analyses of International Skipjack Year Program data.

The next step will be to formulate the model for predicting catch rates of any fish rather than recovery of only tagged fish. When this is done, the model will be available to test the interaction of different fleets operating either in the same zone, or in different zones. (P. Kleiber, FTS 893-7076; C. Salvadó FTS 893-7052)

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Sampling of Tunas Under the South Pacific Tuna Treaty

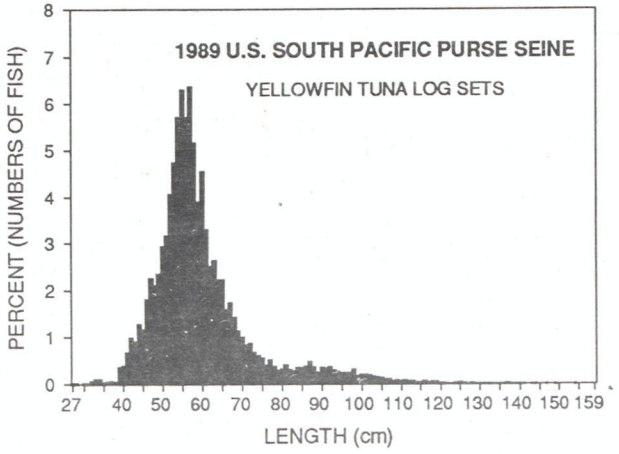
U.S. purse seiners have fished under the South Pacific Regional Tuna Treaty since June, 1988. Landings were 137,400 metric tons (t) in 1988 (January 1, 1988 to December 31, 1988), 145,100 t in 1989, and 72,000 t through July of 1990. Landings are predominately skipjack tuna, ranging from 60 to 80%, with the remainder being yellowfin and bigeye tuna. So far this year, the percentage of skipjack has been at the lower end of this range, as good yellowfin tuna catches are being made.

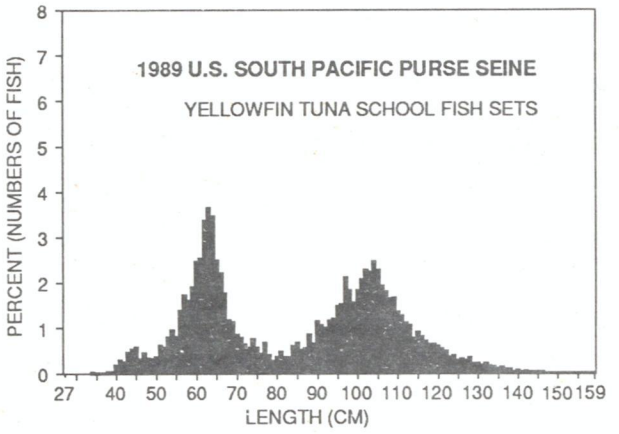
Catches were measured for size composition as they were unloaded to canneries in American Samoa. The approximate number of fish sampled in each year was as follows:

Year	Species	Number of fish
1988	yellowfin	11,700
	skipjack	11,500
	bigeye	4,600
1989	yellowfin	29,500
	skipjack	25,300
	bigeye	12,300
1990	yellowfin	11,400
(Jan - July	skipjack	9,800
only)	bigeye	5,300

In general, fish in school fish sets tended to be larger than those caught in log sets (Figure 1). The majority of the yellowfin tuna were between 40 and 77 cm long, bigeye tuna between 40 and 65 cm long, and skipjack between 46 and 66 cm long. More small fish are being caught thus far in 1990 than in 1988 or 1989. Modes of fish sizes appear to increase by approximately 2 cm between quarters 1, 2, and 3 (Figure 2). Smallest fish are found in quarter 4. This may indicate recruitment to the fishery in quarter 4 of each year.

Yellowfin and bigeye tunas are not separated, but landed mixed as yellowfin tuna at U.S. canneries, as the price paid for both species is the same. Species composition samples were taken from these mixed landings, showing bigeye tuna making up about 6 to 9% of the landing, and yellowfin tuna making up the remainder. (A. Coan, FTS 893-7079)





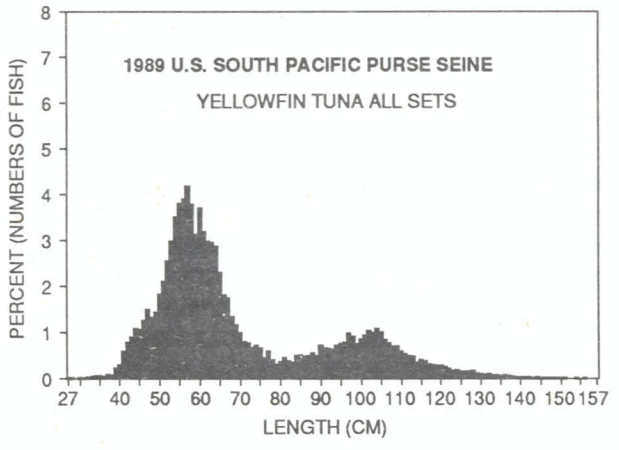


Figure 1. 1989 yellowfin tuna size composition by type of set. (above).

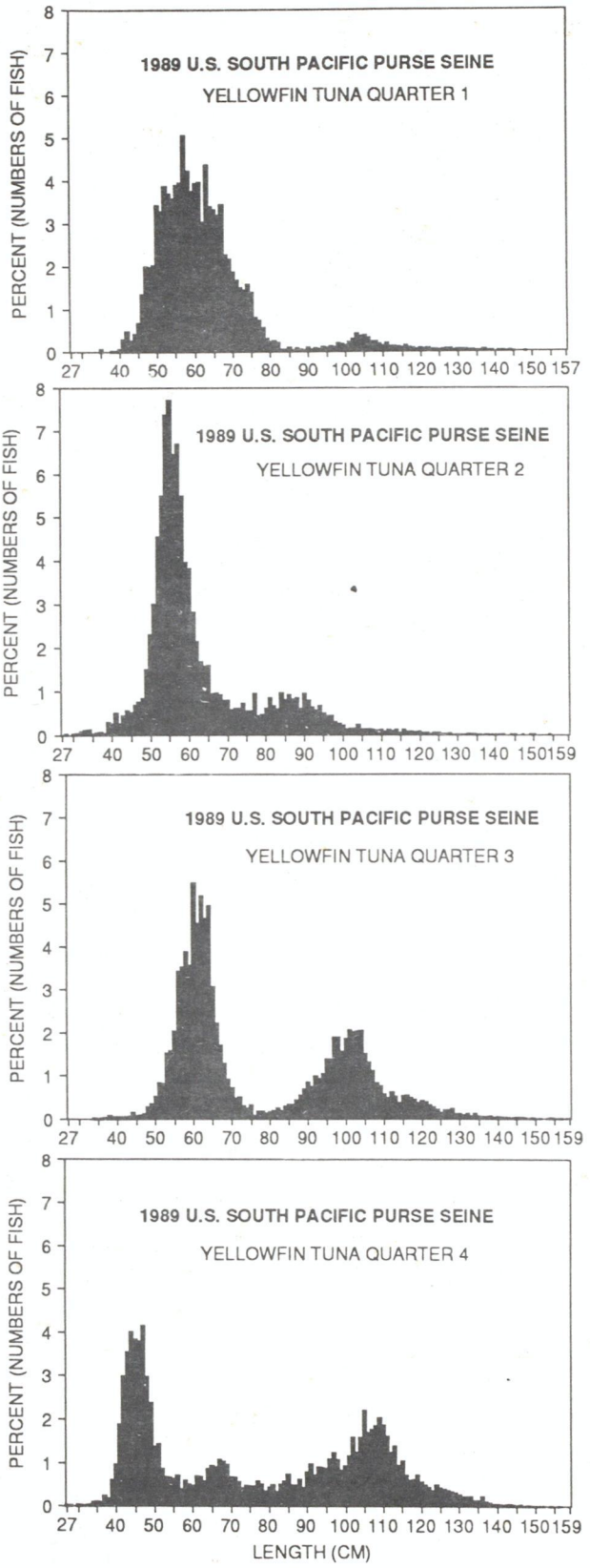


Figure 2. 1989 yellowfin tuna size composition by quarter of the year. (at right).

Seychelles Purse Seine Data Updated

Biological Technicians Gary Rensink and Cheryl Brown completed the update of the first and second quarter Seychelles Fishing Authority data for tuna purse seiners fishing in the western Indian Ocean. Data are summarized in LOTUS spreadsheets, and cover the period 1983 to the present.

The number of vessels participating in this fishery reached a historical record high of 55 in February, 1990 (20 French, 21 Spanish, 2 Mauritian, 8 Soviet, and 4 Japanese flag vessels). The previous record was 50 vessels in November, 1989.

Catch rates continued to be low (Figure 3). The first two quarters of 1990 produced an average of 11 metric tons (t) per day's fishing, which is far below the 22 t per day's fishing recorded for the first half of 1989.

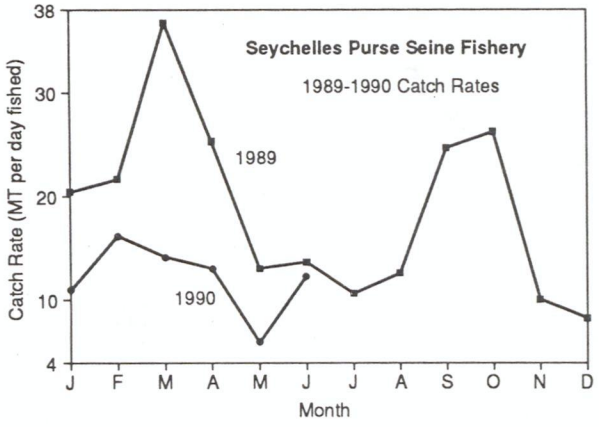


Figure 3. Monthly catch rates (metric tons/fishing day) for purse seiners fishing in the western Indian Ocean in 1989 and 1990.

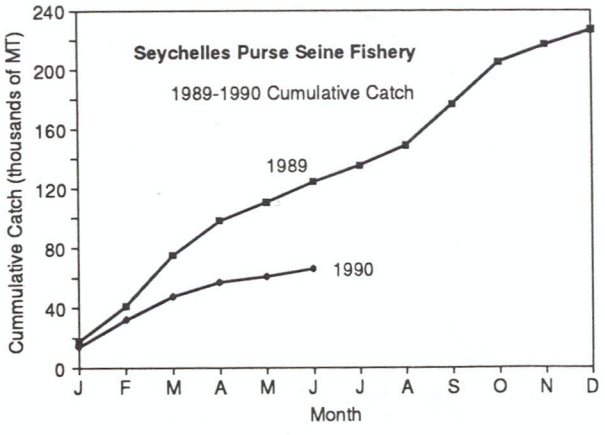


Figure 4. Cumulative catches (metric tons) of yellowfin and skipjack tunas from purse seiners fishing in the western Indian Ocean in 1989 and 1990.

Cumulative catches through June 1990 were 65,800 t, a decrease of 47% as compared to the same period in 1989 (Figure 4). Yellowfin and skipjack tuna were equally represented in the catch during the first two quarters of 1990. (G. Rensink, FTS 893-7192)

TIBURON LABORATORY

Tiburon, California

A New Compensatory Mechanism in Exploited Populations

Contrary to the widespread fisheries assumption that the natural mortality rate is invariant with age, natural mortality may increase with age for many species and stocks. One well-known effect of harvesting is to reduce the average age of individuals in a population. In the presence of accelerated natural mortality rates, harvesting will therefore cause a decrease in the average natural mortality rate of the population due to the loss of oldest fish, which had the highest natural mortality rates. A lower natural mortality rate is equivalent to higher per capita productivity, so this mechanism provides weak compensation for the harvest.

Simulations indicate that 10 to 20% reductions in natural mortality rate may be likely. Figure 1 shows the decrease in realized mortality rates for the case where a demographic increase in M, at age, is 0.005 yr^{-1} and unfished population average M is 0.1 yr^{-1}.

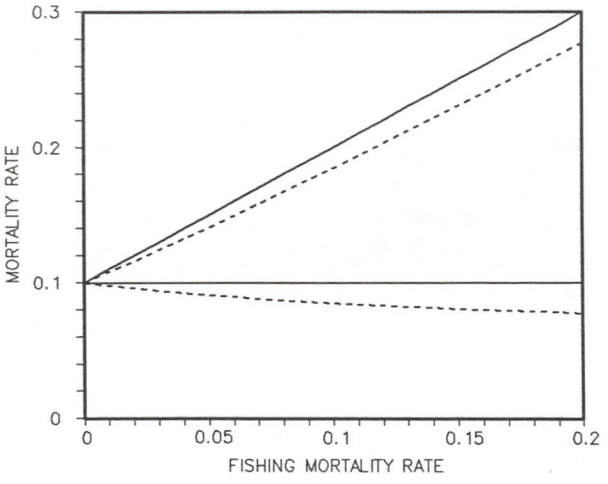


Figure 1. Compensatory response in total (upper pair) and natural (lower pair) mortality rate for a simulated population.

In the figure the solid line is the result if unfished population average M is unchanged, and the dotted line is the compensatory response. The reduction in average natural mortality rate is smaller than the fishing mortality rate which causes it, indicating that this mechanism by itself is unlikely to provide for an equilibrium harvest. Nonetheless, this is a compensatory mechanism which appears to have been generally overlooked previously, perhaps due to the entrenched assumption of constant natural mortality rate in the fisheries literature. (A. MacCall, FTS 556-0565)

Tiburon Laboratory Biologist Evaluates Industry Salmon Proposal

A hypothetical fishing industry proposal for Klamath River chinook salmon has been evaluated by Robert Kope. The proposal to increase the ocean harvest involves marking all hatchery produced chinook salmon in the Klamath basin. Tagged Klamath hatchery fish would then be released when caught by the ocean commercial and sport fisheries. In contrast, the river fisheries would target on hatchery fish and would release all unmarked, "natural run" fish. This would allow for an increase in the harvest rate in the ocean from the recent targets of between 0.325 to 0.4, up to 0.67; it would also increase landings in the commercial troll fishery. The river fisheries would then be required to adopt non-lethal fishing methods in order to target on hatchery fish. This assumes, however, no increase in mortality due to tagging, which may be considerable.

This proposal was evaluated using a spatial model of the ocean fisheries and major salmon stocks contributing to the ocean fisheries in California and Oregon. The model was calibrated by adjusting individual stock abundances and ocean distribution patterns to recreate the historic patterns of ocean landings for 1986 through 1989. The proposed management scheme was then applied to the calibrated model for each year, and also to hypothetical years of high, medium and low abundance using the ocean distributions and historic patterns of fishing effort from the two most extreme years in ocean distribution and fishing effort (1986 and 1989).

Compared with historic seasons, the proposed management scheme typically resulted in an increase in commercial landings of approximately 10%. It also doubled non-catch fishing mortality (shaker mortality) and reduced ocean sport landings, ocean population at the end of the season, and spawning escapements to the Central Valley and north coast stocks by approximately 10%. The impact on the river fisheries was to increase the variability in landings, ranging from a 20% increase in 1986 to a 50% decrease in 1989. The hypothetical cases of high, medium and low abundance were run because the four historic years with sufficient data were all years of above average abundance. Results from the high abundance cases were similar to the results from the historic years. The main difference in cases of simulated medium abundance was that river fisheries were disproportionately reduced. In the low abundance cases, meeting escapement goals under the proposed management scheme required elimination of all river fisheries, and in the case with 1986 patterns of effort and distribution, all landings, including those in the commercial troll fishery, were reduced. The reduction in all fisheries in low abundance years was required to offset the increase in shaker mortality while meeting escapement goals.

In summary, there were many problems with this proposal, notably the unanswered question of delayed marking mortality and problems with survival of fish thrown back after recapture by fishermen. Several other aspects also remain to be evaluated, including the cost of marking all hatchery fish and the development of non-lethal methods such as weirs. (R. Kope, FTS 556-0565)

GROUNDFISH COMMUNITIES INVESTIGATION

Fewest Juvenile Blue and Yellowtail Rockfishes Counted Since 1983

The numbers of first-year juvenile rockfishes counted by Fishery Biologist Dan Howard off the Sonoma and Mendocino coasts during August and September were lower than during any other year since 1983 (Tables 1 and 2). The Groundfish Communities Investigation has used occurrences during these months to measure recruitment in the three species regularly present as first-year juveniles in the nearshore environment: the blue rockfish (*Sebastes mystinus*), the yellowtail rockfish (*S. flavidus*), and the black rockfish (*S. melanops*). August and September are used because, during some years, the yellowtail continues to recruit in pulses through the summer. Only the blue and yellowtail rockfish are involved in this year's sharp decline, however. There was much less of a decline in numbers of juvenile black rockfish; in fact, juveniles of that species, which usually are far less numerous than juveniles of the other two, were the most abundant of the three this year off Sonoma.

Table 1. Mean number (standard error in parenthesis) of first year juveniles counted/minute off the Mendocino coast during August and September. n=number of one minute assessments.

Species	1983 n=36	1984 n=57	1985 n=50	1986 n=103	1987 n=112	1988 n=62	1989 n=181	1990 n=99
S. flavidus	0.00	6.58	115.60	6.01	102.66	59.47	1.29	1.93
	(0.00)	(2.29)	(21.26)	(1.50)	(11.08)	(10.23)	(0.35)	(0.90)
S. mystinus	0.27	1.49	70.56	7.83	181.04	75.89	6.08	0.76
	(0.09)	(0.30)	(15.32)	(1.88)	(26.19)	(10.18)	(0.94)	(0.17)
S. melanops	0.41	0.31	4.34	9.52	7.58	5.94	3.14	0.84
	(0.14)	(0.08)	(1.54)	(2.08)	(1.24)	(1.35)	(0.59)	(0.29)
Total	0.68	8.38	190.50	23.35	291.67	141.29	10.49	3.53
	(0.19)	(2.33)	(29.82)	(3.91)	(33.99)	(16.88)	(1.44)	(1.05)

Table 2. Mean number (standard error in parenthesis) of first year juveniles counted/minute off the Sonoma coast during August and September. n=number of one minute assessments.

Species	1984 n=57	1985 n=50	1986 n=103	1987 n=112	1988 n=62	1989 n=186	1990 n=100
S. flavidus	4.39	135.17	6.73	89.39	39.92	1.54	0.12
	(1.48)	(26.00)	(2.29)	(18.42)	(7.94)	(0.42)	(0.05)
S. mystinus	4.89	117.63	15.27	328.05	175.06	7.19	0.66
	(1.29)	(19.50)	(3.81)	(52.15)	(16.76)	(0.93)	(0.12)
S. melanops	1.63	4.40	3.00	4.48	6.40	1.66	1.03
	(0.52)	(1.17)	(1.31)	(1.70)	(1.95)	(0.39)	(0.42)
Total	10.91	257.20	24.97	442.48	221.38	10.39	1.81
	(2.12)	(35.38)	(5.17)	(66.72)	(22.55)	(1.34)	(0.48)

(E. Hobson, FTS 556-0568)

Directed Fishery for Lingcod Found to Lack Association with Other Groundfish Species

One of the major problems in management of lingcod (*Ophiodon elongatus*) comes from the multi-species nature of the groundfish fishery; specifically, this includes the extent to which the effort is directed at lingcod, rather than the catch being simply a by-product of efforts directed at other species. In an earlier bimonthly report (November-December 1989), Peter Adams and Kelly Silberberg used the PacFIN research data base to show that 80% of the total lingcod catch is landed in less than 30% of the number of trips landing lingcod. They presented these figures as evidence that the lingcod fishery is based on directed effort, but the importance of this issue called for additional support for this position.

This additional support has come from a more detailed analysis of the relation of lingcod to other species in catches that included lingcod (based on landings each year in each designated area of International North Pacific Fisheries Commission). To determine the degree of association of lingcod with the rockfish fishery, the question of whether catches with high numbers of lingcod were consistently related to higher (or lower) numbers of some other species was examined by calculating regressions of these other species on lingcod, run on two sets of data. The first set included all of the trips that landed lingcod, and the second was a subset of the first, which included just those trips that landed the most lingcod (40% of the total catch) and thus could be assumed to represent the most directed elements of the fishery.

The results of this analysis are illuminating. The regressions based on the first data-set (i.e., all trips) indicate that landings of lingcod are associated with the rockfish fishery. But the regressions based on

the second data set (i.e., trips that landed the most lingcod) show no associations with other species.

That the larger lingcod catches, those targeting on this species, apparently are unrelated to other species means that management of lingcod can proceed without severe effects on other groundfishes. (P. Adams, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATION

Interannual Variation and Overlap in the Diets of Pelagic Juvenile Rockfish

The diets of five species of pelagic juvenile rockfishes (widow, yellowtail, chilipepper, shortbelly, and bocaccio) were compared among samples collected during 1984-87 as part of the annual Tiburon Laboratory May/June Juvenile Rockfish Recruitment Surveys. All five species co-occur off central California. Although rockfishes of the genus *Sebastes* are an important component of the west coast groundfish fishery, little is known of their early life history. The study of food utilization patterns and overlap is useful in understanding survival mechanisms during the pelagic juvenile lifestage. The purpose of this study was to identify the food habits of the five species, and to determine the extent of dietary overlap and the importance of interannual variations in patterns of prey utilization.

A combined total of 1,088 juvenile rockfish stomachs was examined from mid-water trawl samples obtained in the four survey years (Table 3). Prey were examined by frequency of occurrence (FO), percent by number (PN), a ranking index (the product FO and PN), and an index of dietary overlap:

$$C_{ih} = 1.0 - 0.5 \left(\sum_{j=1}^{N} p_{ij} - p_{hj} \right)$$

where pij and phj are the proportions of prey j=1...N found in the diets of species i and h, respectively. Multivariate analysis of variance (MANOVA) was used to examine the effects of station latitude (north or south of 37°20'N) and bottom depth (greater or less than 100 m) on the diets of chilipepper, shortbelly, and widow rockfish. Sufficient data on all three species were only available in 1987, although adequate samples of shortbelly rockfish were obtained in all years. Latitude, bottom depth, and their interaction were incorporated as independent variables; the dependent variables were the transformed numerical proportions in the diet of the three prey types with the highest frequency of occurrence in the year considered. The effect of predator size (fish larger or smaller than the annual median lengths) on diet was also examined in this manner.

Table 3. Number of juvenile rockfish stomachs examined from juvenile rockfish surveys, 1984-87.

Year	Survey dates	Species	Number of stomachs	SL (MM) range
1984	8-24 June	Widow rockfish	15	40-63
		Yellowtail rockfish	40	36-56
		Chilipepper	20	38-55
		Shortbelly rockfish	120	30-65
		Bocaccio	50	21-77
1985	5-30 June	Widow rockfish	75	43-63
		Yellowtail rockfish	30	39-48
		Shortbelly rockfish	85	49-75
1986	3-25 June	Yellowtail rockfish	10	35-47
		Shortbelly rockfish	168	15-47
		Bocaccio	25	18-40
1987	23 May-21 June	Widow rockfish	105	48-80
		Yellowtail rockfish	17	39-52
		Chilipepper	125	41-76
		Shortbelly rockfish	150	17-78
		Bocaccio	53	22-86
Total stomachs examined			1,088	

The five species of juvenile rockfish examined in this study consumed pelagic zooplankton almost exclusively. Frequency of occurrence, numerical proportion, and the ranking index show that in any given year, a few prey types made up the major portion of the diet; these were the various lifestages of calanoid copepods and euphausiids. The diets of pelagic juvenile rockfishes off the central California coast are typical of other species possessing a pelagic juvenile lifestage. A noteworthy finding of this study is that Sebastes spp. juveniles periodically forage heavily on euphausiid eggs, a very important dietary item in 1985 and 1987, when they averaged over 37% of prey items consumed by the five species. Yet eggs were absent in 1984 and were but a minor constituent in 1986. Another finding of interest was the consumption of fish larvae by bocaccio juveniles; between 15-20% of all bocaccio sampled in 1984 and 1987 contained larval fish. It is possible that the absence of this prey type in 1986 may be due to the lack of any specimens larger than 40 mm SL (Table 3).

In general, intraspecific overlap values obtained from interannual pairings were much less than overlap values calculated between different species sampled in the same year (Figure 2). Thus, interannual variation in a species' diet is generally greater than that between species sampled in the same year. This suggests that annual changes in diet, which can be substantial, reflect annual alterations in the composition, availability, and abundance of the zooplankton resource base upon which these juvenile rockfish prey.

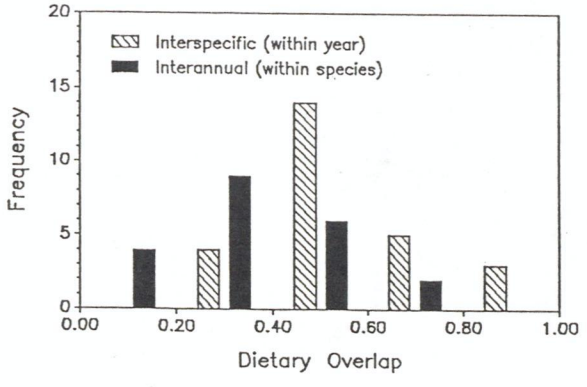


Figure 2. Frequency of dietary overlap indices among all interspecific rockfish pairs within each year compared with the frequency of overlap indices calculated for each rockfish species paired with itself in separate years.

MANOVA model effects were variable, depending on the particular combination of species and year examined. In 1987, highly significant (P) diet variations occurred with depth for shortbelly and widow rockfish, whereas for chilipepper results were of borderline significance (Table 4). In that year chilipepper consumed more *Calanus* sp. copepods in shallow water, while juvenile copepods and juvenile euphausiids were present in higher proportions at bottom depths 100 m. Likewise, all three prey types of widow rockfish (*Calanus* sp., euphausiid eggs, and euphausiid juveniles) were consumed in greater proportion in deep water, especially euphausiid eggs. For shortbelly rockfish, consumption of *Calanus* sp. copepods was depressed at shallow southerly stations. Euphausiid eggs were consumed in greater quantities at deep stations, both north and south, while larval euphausiids were lower in fish from northern deep stations. These findings suggest that spatial variability in the environment can influence, to some extent, the diets of pelagic juvenile rockfish in a species-specific manner.

Results for the full time-series of shortbelly rockfish data (1984-87) showed a lack of consistency over time. Although depth was a highly significant factor influencing diet composition in 1986 and 1987, it was unimportant in 1984 and of borderline significance in 1985.

These interspecific (within year) and interannual (within species) comparisons also demonstrate a lack of stability in the specifics of how spatial dietary effects are expressed. It is likely that the complex nearshore pattern of circulation that characterizes the study area defines the spatial distribution of the zooplankton animals upon which these rockfish feed.

The same data were also explored with MANOVA to assess the effect of fish size on diet composition. Of the six cases examined (Table 5), two produced significant results. Large shortbelly rockfish in 1986 tended to eat a higher proportion of *Calanus* sp. copepods, whereas small fish had a higher fraction of juvenile euphausiids and juvenile copepods in their diet. However, in 1985 large shortbelly rockfish consumed fewer *Calanus* sp. copepods and greater quantities of euphausiid eggs than did small fish. This may be explained by the fact that 34 of the 42 fish classified as small came from deep stations and previous results showed reduced consumption of euphausiid eggs and copepod juveniles at deep stations.

Table 4. Results of MANOVA of depth, latitude, and depth by latitude effects on three principal prey types. Significance levels: b=borderline, *=P<0.05, **=P<0.01. [Cal=*Calanus* sp.; CoJv=copepod juveniles; EJv=euphausiid juveniles; EuEg=euphausiid eggs; ELv=euphausiid larvae; UnCo=unidentified copepods; Fur=furcilia].

Species	Year	Prey type			MANOVA model effects					
					Depth		Latitude		Depth*latitude	
		I	II	III	Wilks'λ	P	Wilks'λ	P	Wilks'λ	P
Chilipepper	87	Cal	CoJv	EJv	0.9019	0.0580[b]	0.9186	0.1044	0.9715	0.5525
Widow	87	Cal	EuEg	EJv	0.6638	0.0001**	0.9536	0.2813	0.9805	0.6632
Shortbelly	87	Cal	EuEg	ELv	0.7649	0.0001**	0.9805	0.5059	0.9243	0.0252*
Shortbelly	86	Cal	CoJv	EJv	0.8917	0.0005**	0.7522	0.0001**	0.9404	0.0234*
Shortbelly	85	Cal	EuEg	CoJv	0.8934	0.0472*	0.9293	0.1600	0.9185	0.1121
Shortbelly	84	Cal	UnCo	Fur	0.9647	0.3110	0.9213	0.0429*	0.9095	0.0240*

Table 5. Results of MANOVA of fish size on three principal prey types. Significance levels: *=P<0.05. [Cal=*Calanus* sp.; CoJv=copepod juveniles; EJv=euphausiid juveniles; EuEg=euphausiid eggs; ELv=euphausiid larvae; UnCo=unidentified copepods; Fur=furcilia].

Species	Year	Prey type			Fish size	
		I	II	III	Wilks' λ	P
Chilipepper	87	Cal	CoJv	EJv	0.9927	0.9088
Widow	87	Cal	EuEg	EJv	0.9678	0.4407
Shortbelly	87	Cal	EuEg	ELv	0.9634	0.2132
Shortbelly	86	Cal	CoJv	EJv	0.9362	0.0161*
Shortbelly	85	Cal	EuEg	CoJv	0.8801	0.0261*
Shortbelly	84	Cal	UnCo	Fur	0.9928	0.8654

(C. Reilly, FTS 556-0565)

INFORMATION TECHNOLOGY SERVICES

Overview of Administrative Information Management System

Since the late 1970's, the managers of the Southwest Regional area have recognized a need for an integrated system of administrative functions. In mid-1989, a committee of members from the Southwest Region (SWR) and the Southwest Fisheries Science Center (SWFSC) met to define the objectives of an Administrative Information Management System (AIMS). By group consensus, the stated objectives of AIMS were set, in order to meet the desired needs of the Southwest Regional staff in managing administrative information in an efficient, cost-effective, and timely manner.

Systems Analyst Dorothy Roll and Programmer Analyst Rob Bistodeau were assigned the task of developing a master plan for AIMS. To provide a system to meet user needs, they selected the questionnaire method and follow-up interview process to survey both the mandatory needs and the desires of users. In mid-February, the survey questionnaire was distributed to managers and task leaders at the SWR and SWFSC sites. After reviewing all responses to the survey, the analysts began follow-up interviews in July with potential users.

Analysis of the responses to the survey and the interviews revealed common and unique needs of users. Although the users were from different sites, they shared common requirements in the types of information categories they used, including labor costs, personnel statistics, commitments, CYOP/MBO, and accountable property.

Based on the analysis of these requirements, a conceptual design of an integrated system was structured and presented in the AIMS Design Overview Report. In the report, the identified information categories were described in brief and discussed in reference to users requirements. A high level framework of the system design was presented in the data flow diagram, which displayed the data path from input to output for the identified information categories.

The Design Overview Report was distributed to potential users in early October so that analysts could get feedback and ensure a common understanding of the users requirements. Because AIMS is a dynamic data base system consisting of information modules, new modules can be added during later phases, identified modules can be eliminated, and the implementation schedule changed to meet new requirements imposed by other operating environments. (D. Roll, FTS 893-7057)

PUBLICATIONS

Published

Choy, B. K., G. H. Balazs, and M. Dailey. 1989. A new therapy for marine turtles parasitized by the piscicolid leech, *Ozobranchus branchiatus*. Herp. Rev. 20(4):89-90.

Dizon, Andrew E. and Jane E. Rosenberg. 1990. We don't care, Professor Einstein, the instructions to the authors specifically said double-spaced, pp. 65-74. *In*: J. R. Hunter (ed.), Writing for Fishery Journals. Am. Fish. Soc., 102 pp.

You can ensure that your relations with a scientific editor will be adversarial by following three basic rules. (1) Submit a manuscript that is inappropriate for the journal. (2) Prepare the manuscript in a style that deviates--but not consistently--from accepted standards of form, syntax, and spelling, and submit barely legible photocopies. (3) When critical reviews are received, treat them as an affront to your professional image and respond accordingly. On the other hand, relatively little effort by you will contribute much toward establishing and maintaining cordial relations with the scientific editor. Being objective about your manuscript and choosing the appropriate outlet, preparing your submission copy carefully, and dealing constructively with the review-revision cycle will more than pay back the time invested. This should be obvious, but an amazing number of authors fail to pay such attention, and thereby prejudice the acceptance of their manuscripts.

Henderson, John R. and Michael R. Finnegan. 1990. Population monitoring of the Hawaiian monk seal, *Monachus schauinslandi*, and captive maintenance project at Kure Atoll, 1988. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-150, 10 p.

Holland, K., R. Brill, and R. K. C. Chang. 1990. Horizontal and vertical movements of Pacific blue marlin captured and released using sportfishing gear. Fish. Bull., U.S. 88:397-402.

Jackson, Alan R. 1990. Summary of the 1988 U.S. tuna/porpoise observer data. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-149, 32 p.

Johanos, Thea C., Brenda L. Becker, Mary A. Brown, Barry K. Choy, Lisa M. Huruki, Russell E. Brainard, and Robin L. Westlake. 1990. The Hawaiian monk seal on Laysan Island, 1988. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-151, 17 p.

Kope, Robert G. and Louis W. Botsford. 1990. Determination of factors affecting recruitment of chinook salmon *Oncorhynchus tshawytscha* in central California. Fish. Bull., U.S. 88:257-269.

We computed correlations between various population estimates for central California chinook salmon *Oncorhynchus tshawytscha* and both freshwater and marine environmental variables using methods that account for intraseries correlation in a more accurate and conservative way than those used previously. These indicated a negative influence of ENSO (El Niño-Southern Oscillation) conditions in the year during which most of these fish are caught or leave the ocean to spawn. Although freshwater environmental influences have been previously proposed on the basis of correlation analysis, and have been demonstrated using direct survival estimates based on marked fish, they were not detectable using correlation techniques that accurately account for intraseries correlation. There was also weak evidence for an influence of conditions associated with a negative upwelling index at the time chinook salmon enter the ocean. However, because these conditions are associated with high river flows in addition to oceanographic effects, these correlations may merely result from the influence of freshwater flows. To further describe oceanographic influences we computed the principal components of upwelling index, sea level height, and sea surface temperature. The first principle component, which reflected the effects of ENSO conditions in the equatorial Pacific during the previous winter, was significantly correlated with chinook salmon abundance in their final year, and marginally correlated with abundance during the first ocean summer. This work demonstrates new techniques for reducing spurious correlations and the practical difficulties involved in sorting out the multivariate influences on populations subject to remote forcing through oceanographic and meteorological conditions.

Lynn, Ronald J. and James J. Simpson. 1990. The flow of the undercurrent over the continental borderland off southern California. J. Geophys. Res. 95(C8):12,995-13,008.

Complex bathymetric features offshore of southern California have a pronounced effect upon the flow of the California Undercurrent. Geostrophic dynamics and water mass characteristics are used to reveal the various paths of flow and spread of undercurrent waters for a July 1985 survey. Undercurrent waters are identified by relatively high spiciness and low dissolved oxygen at densities between t=26.4 and 26.9 (200 to 400 m). A jetlike core of flow follows the continental slope within the California Bight and exits the bight through a gap in the Santa Rosa-Cortes Ridge. Mixtures that include undercurrent waters exit the bight through other gaps in the bathymetric ridge and about the southern end of the ridge. As evidenced by patterns in the fields of geostrophic currents and water mass characteristics, baroclinic instabilities develop about the ridge which result in the diversion of undercurrent waters offshore beneath the California Current and into the offshore mesoscale eddy field. The offshore subsurface diversion of undercurrent waters and their inclusion in the offshore mesoscale eddy field are also found in the long-term mean distributions for July.

Perrin, William F. 1990. Subspecies of *Stenella longirostris* (Mammalia: Cetacea: Delphinidae). Proc. Biol. Soc. Wash. 103(2):453-463.

Three subspecies of *Stenella longirostris* are named, described and compared: *S. l. longirostris* from the world's tropical oceans, *S. l. orientalis* from tropical oceanic and coastal waters of the eastern Pacific, and *S. l. centroamericana* from Pacific coastal waters of Central America.

Polovina, Jeffrey J. and Richard S. Shomura (eds.). 1990. United States Agency for International Development and National Marine Fisheries Service Workshop on Tropical Fish Stock Assessment, May 26, 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-148, 143 p.

Polovina, J. J., R. A. Benco, A. H. Carlot, E. Cillaurren, P. Dalzell, N. Howard, D. Kobayashi, T. F. Latu, P. Lokani, G. Nath, H. Pitiale, A. Sesewa, R. Shomura, T. Sua, G. Tiroba, and S. Tulua. 1990. Introduction and summary of methods and results from the Tropical Stock Assessment Workshop. *In*: J. J. Polovina and R. S. Shomura (eds.), United States Agency for International Development and National Marine Fisheries Service Workshop on Tropical Fish Stock Assessment, 5-26 July 1989, Honolulu, Hawaii, p. 1-6.

Reilly, Stephen B. 1990. Seasonal changes in distribution and habitat differences among dolphins in the eastern tropical Pacific. Mar. Ecol. Prog. Ser. 66:1-11.

Large-scale patterns of dolphin distribution and oceanography were studied from research-vessel surveys conducted in the pelagic eastern tropical Pacific during June to November 1982, 1986 and 1987. Substantial changes were observed in relation to previously reported winter distributions for spotted and/or spinner dolphin schools (Stenella attenuata and/or S. longirostris) and for striped dolphin schools (S. coeruleoalba). These dolphin species were sighted in abundance west of 120°W along 10°N coincident with seasonal shoaling of a thermocline ridge. No seasonal distribution changes were observed for common dolphin schools (Delphinus delphis); as in the winter, they occupied upwelling-modified waters of the region. Highest-density areas for the 3 school types were clearly separated spatially, and the thermocline depths and sigma-t's of sighting localities were statistically different between spotted/spinner dolphin schools and common dolphin schools. Striped dolphin schools could not be discriminated from the other 2 types based on these habitat variables, indicating other factors or processes contribute to the observed spatial separation of the 3 distributions.

Somerton, D. A. 1990. Baitfish stock assessment using the egg production method: an application on the Hawaiian anchovy or nehu (Encrasicholina purpurea). In: S. J. M. Blaber, and J. W. Copland (eds.), Tuna baitfish in the Indo-Pacific region: Proceedings of a Workshop, Honiara, Solomon Islands, 11-13 December 1989, p. 152-158. Inkata Press PTY LTD Publ., Victoria, Australia.

The biomass of nehu (Encrasicholina purpurea) in Pearl Harbor was estimated weekly, over a two year period, using a new stock assessment procedure known as the Egg Production Method (EPM). Although the EPM was originally developed for assessing relatively long-lived, temperate anchovies (Northern Anchovy and Anchovetta), it has proven to be a low-cost, effective way of assessing the abundance of nehu, a short-lived, tropical stolephorid anchovy. The effectiveness of the EPM in largely the result of its being based on the life history stage that is the least aggregated and easiest to sample, that is, the egg stage. Because of this, the biomass estimates obtained using the EPM are less influenced by environmental fluctuations than estimates obtained using commercial catch statistics. Over the study period, nehu spawning stock biomass varied between 0.5 and 5.0 tonnes and was clearly associated with the variation in the rate of nehu bait catch for the pole-and-line tuna fishery. Stock variation also was associated with seasonal variation in reproductive output, primarily changes in the weight-specific fecundity and spawning frequency and in the survival rate from the egg stage through the first feeding larvae.

Ueber, Edward, and Alec D. MacCall. The collapse of California's sardine fishery. p. 17-23 In: Michael H. Glantz and Lucy E. Feingold (eds.), Climate variability, climate change and fisheries. National Center for Atmospheric Research, Boulder, CO.

The California sardine fishery began in the last decades of the 1800's, peaked in the 1930's, and began to collapse after World War II. It is a classic case of the rise and fall of a fishery dependent on a pelagic species, of overcapitalization of an industry, and of too many fishing boats using new technologies to harvest a fragile, if not dwindling, resource. Its collapse spawned the rapid development of similar fisheries in Peru, Chile and South Africa, each of which then underwent essentially the same kind of growth and decline as the California sardine fishery. This fishery can be used as an analogy of potential changes that might accompany the regional implications of a global warming of the atmosphere and could provide lessons for adaptive responses to changes in abundance of a pelagic industrial fishery.

Westlake, R. L., and W. G. Gilmartin. 1990. Hawaiian monk seal pupping locations in the Northwestern Hawaiian Islands. Pac. Sci. 44:366-383.

Most births of the endangered Hawaiian monk seal, *Monachus schauinslandi*, occur in specific beach areas in the Northwestern Hawaiian Islands. Data collected in 1981-1988 on the locations of monk seal births and of the first sightings of neonatal pups were summarized to identify preferred birth and nursery habitats. These areas are relatively short lengths of beach at the breeding islands and have some common characteristics, of which the primary feature is very shallow water adjacent to the shoreline. This feature limits access by large sharks to the water used by mother-pup pairs during the day and this should enhance pup survival.

Winchell, J. M. 1990. Field manual for phocid necropsies (specifically *Monachus schauinslandi*), U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-146, 55 p.

Approved by Science and Research Director, SWR

Au, David. Avifaunas of differently schooling tuna. For consideration for publication in Condor.

Bakun, A., A.D. MacCall and R.H. Parrish. Impacts of climate change on fisheries. For consideration for publication in EOS, Transactions of the American Geophysical Union.

Barlow, Jay. The utility of demographic models in marine models in marine mammal management. For consideration for publication as a Report of the International Whaling Commission.

Boehlert, George W. Early life history research. For publication in the American Fisheries Society Early Life History Section Newsletter.

Boehlert, George W., William Watson, and Charles Sun. Horizontal and vertical distribution of larval fishes around an isolated oceanic island in the tropical Pacific. For consideration for publication in Deep-Sea Research.

Brill, Richard W., Peter G. Bushnell, and David R. Jones. Effects of open and closed system temperature changes on acid-base status of isolated blood from yellowfin tuna (*Thunnus albacares*). For consideration for publication in the Canadian Journal of Zoology.

Clarke, Raymond P., Stacey S. Yoshimoto and Samuel G. Pooley. A bioeconomic analysis of the Northwestern Hawaiian Islands lobster fishery. For consideration for publication in Marine Resource Economics.

Coleman, D. E., H. S. Nishimura, J. Beattie, M. Woods, and D. Losey. 1990. The role of CD-ROM in library automation: applications of the NOAA Library and Information Service Division's "Intelligent Catalog" CD-ROM database. Proceedings of the International Association of Marine Science Libraries and Information Center, 1990.

Hohn, Aleta, Ruth B. Miller, Kelly Peltier and Susan Chivers. Composition of the incidental kill of small cetaceans in the US purse-seine fishery for tuna in the eastern tropical Pacific during 1989. For consideration for publication in the Report of the International Whaling Commission.

Kope, Robert. Current analytic concerns with harvest rate management. For publication in the Proceedings of the 1990 Northeast Pacific Chinook and Coho Salmon Symposium, Humboldt State University, Arcata, CA.

Laidig, Thomas E., Stephen Ralston and James R. Bence. Dynamics of growth in the early life history of shortbelly rockfish, *Sebastes jordani*. For consideration for publication in Fishery Bulletin, U.S.

Perrin, William F. and Carrie E. Wilson. Striped dolphin *Stenella coeruleoalba* (Meyen, 1833). For publication as chapter in Handbook of Marine Mammals.

Smith, M. Kimberly. Regional differences in morphology and growth of the deep slope snapper *Etelis carbunculus* and its otoliths. For consideration for publication in the Canadian Journal of Fish and Aquatic Sciences.

Smith, M. Kimberly and Eric Kostlan. Estimates of age and growth of ehu (*Etelis carbunculus*) in four regions of the Pacific from the density of daily increments in otoliths. For consideration for publication in Fishery Bulletin, U.S.

Somerton, David A. and Donald R. Kobayashi. Bias in the Wetherall estimates of Z/K and Là due to population disequilibria. For consideration for publication in Fishbyte (ICLARM).

Woodbury, David, and Stephen Ralston. Interannual variation in growth rates and back-calculated birthdate distributions of pelagic juvenile rockfishes (*Sebastes* spp.) off the central California coast. For consideration for publication in Fishery Bulletin, U.S.

Wyllie Echeverria, Tina, William H. Lenarz and Carol A. Reilly. Survey of the abundance and distribution of pelagic young-of-the-year rockfishes, *Sebastes*, off central California. For consideration for publication as NOAA Technical Memorandum.

Administrative Reports

Abramson, Norman J. 1990. A test of using wind velocity data with a product estimator to improve the efficiency of sport salmon landings estimation. SWFSC Admin. Rep., Tiburon, T-90-04, 8 p.

Gilmartin, W. G. 1990. Hawaiian monk seal work plan, fiscal years 1991-93. SWFSC Admin. Rep., Honolulu, H-90-14, 43 p.

Myrick, Albert C., Jr., Jerry Taylor, Charles W. Oliver, Edward R. Cassano, Lawrence L. Robertson, and Anthony P. Majors. 1990. Results of underwater tests of double-base smokeless-powder pipe bombs on targets to determine physical hazards to swimming dolphins. SWFSC Admin. Rep., La Jolla, LJ-90-26, 16 p.

Parker, Keith R., and Alec D. MacCall. 1990. An interactive port sampling model for California groundfish. SWFSC Admin. Rep., Tiburon, T-90-03, 32 p.

Pooley, S. G., and K. E. Kawamoto. 1990. Economic analysis of bottomfish vessels operating in the Northwestern Hawaiian Islands, 1984-88. SWFSC Admin. Rep., Honolulu, H-90-13, 21 p.

Reilly, Carol A., and James R. Bence. 1990. Documentation and management of data from trawl surveys of pelagic young-of-the-year rockfishes. SWFSC Admin. Rep., Tiburon, T-90-06, 68 p.

Woods, Maureen H. 1990. Publications of the Southwest Fisheries Science Center, Tiburon Laboratory. SWFSC Admin. Rep., Tiburon, T-90-05, 55 p.

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