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PROCEEDINGS OF THE 2001 TRINATIONAL SARDINE FORUM

An informal report of the meeting

edited by

J.R. Hunter and T. Baumgartner

ADMINISTRATIVE REPORT LJ-02-39

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Editors: J.R. Hunter
T. Baumgartner

Old Town, San Diego, California, U.S.
November 29-30, 2001

Administrative Report SWFSC-LJ-02-39

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[1] These two contributions were received as paper copies at the Forum. They are included in the printed Administrative Report, but not in the electronic copy.

2001 TRINATIONAL SARDINE FORUM: AN INFORMAL REPORT ON THE PROCEEDINGS

INTRODUCTION

The second Trinational Sardine Forum was held at the Ramada Conference Center in Old Town, San Diego, California USA from November 29-30, 2001. The objective of the meeting was to provide the opportunity for discussion of common fisheries issues in Canada, Mexico and the U.S., report progress on collaborative projects, and to sustain collaborative work on sardine that will improve the stock assessments and monitoring over the full range of sardine in the eastern Pacific in 2001 (regional biomass estimates) and other projects need continuing. Forty-seven participants representing industry, government agencies and academic institutions from Canada, Mexico, and the U.S. attended the Forum (Appendix 1). The meeting was supported by contributions from the Eastern Pacific Consortium of the Inter-American Institute for Global Change Research (EPCOR-IAI), the Southwest Fisheries Science Center (SWFSC) and Centro de Investigacion Cientifica y de Educacion Superior de Ensenada, B.C. (CICESE).

This is an informal report of the proceedings. It consists of working group reports on progress made during 2001, written before the November 2001 meeting, and the minutes from a subsequent plenary discussion on the working group topic. The working group reports are followed by minutes from plenary discussions on a variety of topics. An Appendix is provided which includes, a list of participants (Appendix I), and copies of some of the presentations listed alphabetically by first author (Appendix II). Our plan for the 2001 report turned out to be too demanding, as many participants were unable to complete writing assignments, delaying the production of the report, and creating gaps and somewhat uneven treatment of topics. However flawed the report may be, it is our only record of the meeting, and as the third Trinational is only a month away at this writing, the Chairs' decision was to submit the report as it stands without further delay or editing. The report may be cited as:

Hunter, J.R., and T. Baumgartner (editors) 2002. Proceedings of the 2001 Trinational Sardine Forum (an informal report of the meeting). Administrative Report of the Southwest Fisheries Science Center, La Jolla, LJ-02-39, 92 p.

WORKING GROUP REPORTS

WORKING GROUP 1. - Industry supported sampling of sardine

Cooperative sardine sampling with U.S. industry. A U.S. cooperative project proposed in the 2000 Forum was to determine the size and age structure, and measure the reproductive effort of the sardines that produce the extensive April spawn. However, we were not successful in sampling the spawning area using volunteer commercial purse sieners, as proposed in the Trinational Report for 2000. The distance of the spawning habitat from shore, weather conditions, and sea state were unsuitable for purse seining. We plan an alternate approach to purse seining for the April 2002 spawning season. We propose to use a nightlight-drift gill net approach, where sardine attracted by a bright shipboard light at night are collected using a small gill net. This method has been used with considerable success to collect sardine for a Daily Egg Production Method (DEPM) estimate of biomass in Australia, but is untried in the U.S. Collections using this device will be made by the fishing industry and will be coordinated by the West Coast Seafood Processors' Association.

Cooperative sardine sampling with Mexican industry: During the TSF Forum in 2000, collaboration was proposed with the Mexican industry to sample adults spawning offshore Baja California to determine size and age structure of the population there. It was originally thought that the IMECOCAL survey could be used to determine the major concentrations of sardine spawning and then this information could be relayed to the commercial purse-seine fleet from Ensenada so they could locate and capture the adults. Although cooperation was set up with the fishing captains with six vessels promised for this task, it turned out to be impractical because of the lack of on board capability on the IMECOCAL research ship (due to lack of trained personnel) to identify the eggs and the lack of good communications between the CICESE ship undertaking the survey (R.V. ULLOA) and the shore based laboratory.

Use of spotter plane: As an alternative to the ship-based location of spawning concentrations, it was decided to hire a Cessna 172 spotter plane (with CICESE funds from IMECOCAL and IAI grants) to fly daytime search patterns on 17 and 18 April, 2001, beginning both days around noon. (On 17 April, a zigzag pattern from 25 to 80 nautical miles offshore from Ensenada, starting from Sixty-mile bank and ending just south of Ensenada; on 18 April the spotter left Ensenada flying south from 10-15 nm offshore and closing into shore in the northern region of Bahia Vizcaino, then out towards Cedros Island and then back to Ensenada on an offshore track.) The spotter plane could not locate any sardine schools offshore, only onshore: both days in Bahia Todos Santos returning to Ensenada, and just off the beach around Punta Canoas (approx. 29N), where numerous schools in balls and ribbons were easy to spot from the air. Note that there were no visible sardine schools around Sixty-mile bank, which lies just south of the location along CalCOFI line 93 where large concentration of eggs were observed on 7 April during the CalCOFI-CUFES survey.

Adult sampling: Because no sardines were located by the spotter plane in the offshore waters off Baja California, the Ensenada fleet was not asked to go offshore to fish. Rather the captains were asked to provide as fresh and undamaged samples of 200 adults as possible from where they were finding fish (which was not very many places = only around Isla Coronados, just off Tijuana, and in Bahia Todos Santos, Ensenada). We obtained two samples, both from Bahia Todos Santos in

shallow water off Estero Beach. The second sample (23 April) turned out to be very fresh and consisted of 203 fish, all of which were sampled and weighed. Of the total, 102 fish were also sexed and gonads collected and weighed. Otoliths were also collected from these fish. Of the 102 fish, 58 were females (see results below under Working Group 3).

April egg production estimate of sardine biomass in U.S. waters. The NMFS and CDF&G plan to conduct a high resolution DEPM estimate of sardine biomass in April 2002. Egg abundance shall be monitored using a high resolution fixed plankton grid that will extend from the U.S. border to San Francisco. The grid will be occupied by two NOAA vessels, the *McArthur* and *Jordan*. An adaptive sample allocation design will be used: each vessel will monitor eggs continuously over the grid using a Continuous Underway Fish Egg Sampler (CUFES) and will take vertical net tows with the CalVET net whenever the egg density in CUFES is equal to or higher than 1 sardine egg per minute. The adult fish measurements needed to convert egg abundance to fish biomass (daily spawning rates, and batch fecundity) will be obtained by sampling adults using trawling and night-light gill netting on the *Jordan* and night-light gill netting on the CDFG vessel *Mako*. Industry assisted sampling of adult sardine (discussed above) will also be an important data source for estimating spawning rates and batch fecundity.

Cooperation with IMECOCAL in the April DEPM. IMECOCAL plans to carry out their spring quarterly survey this April, as in previous years using bongo tows and CUFES. When the data from their April 2002 cruise becomes available, the Trinational team will work together to produce a joint biomass estimate for the northern stock in U.S. and Mexican waters by combining the IMECOCAL data with the DEPM survey described above. As processing of IMECOCAL plankton collections proceeds at a slower pace than CalCOFI, work on the combined data set will follow the DEPM estimate of biomass for U.S. waters.

WORKING GROUP 2 - Compilation and management of existing sardine databases.

Background: Fishery-dependent (port samples & landings) data for sardine are now collected on a routine basis by research and resource-management agencies in Mexico, the United States, and Canada. At the first Trinational Sardine Forum (TSF), Working Group 2 (WG2) was formed in an effort to organize a depository for existing sardine data that will be accessible by the cooperating organizations and updated on a regular basis by a dedicated data manager. WG2 participants, listed from south to north, include: Casimiro Quiñonez (CICIMAR, La Paz), Walterio Garcia (INP, Ensenada), Tim Baumgartner (CISESE, Ensenada), Daniel Loya (CISESE, Ensenada), Kevin Hill (CDFG, La Jolla), John Butler (NMFS, La Jolla), Jean McCrae (ODFW, Newport), Michele Robinson (WDFW, Montesano), and Angela McDiarmid (DFO, Canada). WG2 participants discussed the types of sardine data collected by their respective agencies and agreed that, for the immediate future, the priority should be to focus on consolidating port sample databases and monthly port landing summaries. Common data collected include date, port, landing weight, sample weight, and measurements taken for individual specimens (standard and fork lengths, body weight, sex, general reproductive condition, and age as estimated by otoliths. Each of the participating organizations agreed that it would be best to house these databases in a single, web-based server to be coordinated by a data manager. WG2 participants also agreed to assemble background information ('metadata') and submit it to Kevin Hill (CDFG) by 31

January, 2001, and to submit full data sets to the data manager by 31 July of each year. The data manager would be responsible for developing a web site that serves as a depository for files shared by each organization. The data manager would be responsible for gathering data files from each agency, standardizing and ensuring uniformity, and posting regular updates on the web site.

Data Description. A WG2 summary report from the 1st TSF was drafted and distributed to all participants in January 2001. Participants were reminded of the January 31 deadline for metadata submissions, and were provided an Excel template as an example of how database descriptions could be formatted (Table 1).

Database descriptions were received from DFO, WDFW, ODFW, and CDFG participants by the requested deadline. No metadata information has been received from either CRIP-INP (Garcia) or CICIMAR (Quiñonez). In February, Casimiro Quiñonez wrote to say that his biological data files for Pacific sardine from Bahía Magdalena are Excel files (1981-2001), and each record includes all information included in the example template file (Table 1). Metadata were compiled into a single Excel data file and distributed to WG2 participants.

In January 2001, Daniel Loya (CISESE) agreed to serve as the TSF webmaster and data manager. Copies of the WG2 report and Excel data file were sent to Daniel in February, 2001, and he was updated on the status of metadata or complete data bases received from each participant. Funding from NMFS ($2,000 U.S.) was deposited to the CalCOFI account in Spring, 2001. Paperwork for a grant ($3,500 Canadian) from the Government of British Columbia was received in early November 2001, but this contract has not yet been processed. To date, the CalCOFI account has not been billed for Daniel Loya's services.

Table 1. Metadata for California Department of Fish and Game's sardine port sample databases. Metadata received from ODFW, WDFW, and DFO were similar in format.

Field	Field Name	Type	Width	Dec	Description
File structure for SARDINE.LDG					
1	LD_NUM	Numeric	4		Landing number: sequential number assigned to each landing
2	LD_FGN	Numeric	5		CDFG Boat number (CONFIDENTIAL - TO BE OMITTED OR ALIASED)
3	LD_SPE	Numeric	2		Species code- from receipts, Pacific mackerel=51, Jack mackerel=55, Pacific sardine=100
4	LD_DD	Numeric	2		Day
5	LD_MM	Numeric	2		Month
6	LD_YY	Numeric	2		Year
7	LD_ALP	Numeric	6		Actual pounds landed from receipts
8	LD_BSN	Numeric	2		Boat sequence number-sequential number from 1 up to 40 for each sampled boat within a single stratum.
9	LD_HLP	Numeric	6		Hailed landings in pounds from landing observations.
10	LD_SNO	Numeric	2		Stratum number- number assigned to each stratum. Refers to month (1-12)
11	LD_STJ	Numeric	1		Number of samples of jack mackerel taken from landing.
12	LD_STP	Numeric	1		Number of samples of Pacific mackerel taken from that landing.
13	LD_STS	Numeric	1		Number of samples of Pacific sardine taken from that landing.
14	LD_BEJ	Numeric	3		Bucket sample estimate of percent by weight of jack mackerel in landing "Trace" amounts
15	LD_BEP	Numeric	3		Bucket sample estimate of percent by weight of Pacific mackerel in landing
16	LD_BES	Numeric	3		Bucket sample estimate of percent by weight of Pacific sardine in landing
17	LD_VEJ	Numeric	3		Visual estimate of percent by weight of Jack mackerel in landing
18	LD_VEP	Numeric	3		Visual estimate of percent by weight of Pacific mackerel in landing
19	LD_VES	Numeric	3		Visual estimate of percent by weight of Pacific sardine in landing
20	LD_CNY	Numeric	4		Number designating cannery, Heinz-711300, Pan Pacific-711901
File structure for SARDINE.SAM					
1	SA_KEY	Numeric	7		Landing and Sample numbers key for index
2	SA_FGN	Numeric	5		CDFG boat number (CONFIDENTIAL - TO BE OMITTED OR ALIASED)
3	SA_MM	Numeric	2		Day
4	SA_DD	Numeric	2		Month
5	SA_YY	Numeric	2		Year
6	SA_SPE	Numeric	2		Species Code
7	SA_WT	Numeric	5		Sample weight (nearest gram)
8	SA_NF	Numeric	2		Number of fish in sample
9	SA_LDG	Numeric	4		Landing number
10	SA_NUM	Numeric	3		Sample number
File structure for SARDINE.IND					
1	I_KEY	Numeric	9		Landing number, sample number, capsule number (one capsule number per fish)
2	I_L	Numeric	3		Standard Length
3	I_W	Numeric	4		Weight
4	I_SEX	Numeric	1		Sex
5	I_MT	Numeric	1		CDFG Maturity code (0-5)
6	I_YC	Numeric	2		Year class (unaged fish=0)
7	I_CC	Numeric	1		Condition code
8	I_LDG	Numeric	4		Landing number
9	I_SAM	Numeric	3		Sample number
10	I_CNO	Numeric	2		Capsule number (number of each gelatin capsule in which one pair of otoliths is stored)

Recommendations from plenary session. The issue of a common fishery data base located in Ensenada was discussed in plenary session after presentation of the 2001 progress report presented in the previous section. Key points made during this discussion are described below.

Web-based sardine data base in Ensenada: While a web site was constructed at CICESE (Mexico) for a Trinational data source, no sardine data were ever posted on the site. A serious

barrier to posting the original port sampling data from Mexico was that INP has a policy against distribution of raw data. According to present rules, only summary data can be released by INP. For this reason, and the lack of funding to support such a database, the idea of a common site for all size and age composition data and landings for sardine was abandoned. The direct cost in the U.S. for such a facility was judged to be one 0.25 time data manager at an annual cost of $20,000 USD. No representative of any of the organizations represented at the meeting from U.S., Canada, and Mexico offered gratis management of the web site nor volunteered the funds.

Request INP Change sardine Data Policy: Walterio Garcia (INP Ensenada) supported the spirit of the Trinational by offering to request INP to change their data policy so that raw data on size and age composition of the catch could be released to the public. The northern and southern stocks of sardine mix in the Ensenada area, and in southern California, summarized length and age composition data are of little use for analyzing the dynamics of either stock.

Alternative to raw data availability on web site. It was suggested since raw data can not presently be made available by Mexico, that the size and age composition, size-at-age information, and landings could be summarized by month and put on the Trinational web site. While a useful contribution, monies to manage such a site are still a barrier to implementation.

Standardization of aging criteria: Participants agreed that a coast-wide standardization of aging criteria was essential. At present, ongoing sardine aging has been carried out by CDFG in the U.S. (Bergen and Wertz), and in Mexico by CICIMAR (Casimiro Quinonez). CDFG has been aging material from Oregon, Washington, Canada, as well as California landings, but will not be able to routinely age samples from out of the State. Canada and the states of Oregon and Washington will soon have to begin their own sardine age determination. It is critical, therefore, that all aging laboratories along the coast are using the same criteria. The Trinational strongly recommended that routine otolith exchanges should begin between the two existing age Labs (CICIMAR (Quinonez), CDFG (Bergen) and in Canada (McFarlane) and the new labs in Oregon, Washington, and Mexico as they are developed.

Trinational age determination workshop: Participants agreed that an age determination workshop could make a major contribution to the quality of future sardine stock assessments. The objectives of such a workshop would include: a summarization of all existing data on age size composition of Pacific sardine, standardized aging methods and criteria, and establishment of guidelines for cross reading of otoliths between labs. Working Group members present agreed that a joint publication, summarizing coast-wide age data would be a desirable product of the workshop.

Standardization of maturity code for sardine. The Trinational recommended that a standard maturity code for sardine be used throughout the range, thereby making it much easier to combine data from different areas and countries. Beverly Macewicz (SWFSC) volunteered to write a draft 4 stage maturity code that could be used coast wide and would provide photographs and background information to facilitate coast wide implementation.

New Age Determination Laboratory in Ensenada: CICESE (Tim Baumgartner) agreed to set up an aging laboratory in Ensenada using monies designated for the Trinational Data base allocated

by the U.S. and Canada as seed money. The intent is to propose continued support of this work from funding agencies in Mexico. This laboratory would have a research focus of separating the contributions to the Ensenada landings from the southern and northern stocks of sardine. Ensenada is believed to be a mixing area for these two stocks, with the north/south contributions to the catch probably varying seasonally and interannually with shifts in ocean climate. Determining how to separate northern and southern stocks in the fishery is of key importance internationally since the northern stock of Mexico is shared with both the U.S. and Canada, while the southern stock is shared only with the U.S. The separation also is a key element in their management since the two stocks probably differ in their fishing since they probably have different natural mortalities and population growth rates. The work will also support INPs need for routine age determination of the landed catch.

Recovering historical age data from Canadian data files: Original age structure information for landings during the previous sardine fishing era from the 1920s on up exists in paper form in Canadian archives. It would greatly assist the present interpretation of movements and dynamics if these data were available to the scientific community. Reclamation and distribution of these valuable historical data was strongly recommended by the Trinational.

WORKING GROUP 3 - Regional estimates of biomass

Background: Working group members include Martin E. Hernandez-Rivas, mrivas@ipn.mx; Sandy McFarlane, mcfarlanes@dfo-mpo.gc.ca, Robert Emmett, robert.emmett@noaa.gov; Ray Conser, rconser@ucsd.edu; Yanira Green-Ruiz, motagreen@yahoo.com.mx; Sarita De la Campa, scampa@cicese.mx; Darrell Kapp, dkapp@netos.com; Nancy C.H. Lo, Nancy.Lo@noaa.gov. The focus of the group is to compute regional estimates of sardine biomass.

CalCOFI, April cruises, 2001. Sardine eggs collected from both CalVET and CUFES and yolk-sac larvae from CalVET and Bongo during 0104 CalCOFI cruise (*R/V David Starr Jordan*, April 5-May 2) were the data source for estimating the daily egg production of sardine (Figure 1). The daily egg production of Pacific sardine (*Sardinops sagax*) off California from San Diego to Monterey was estimated to be 2.9/0.05m^2 and the spawning biomass was estimated to be 790,928 mt for an area of 321,386 km^2, from San Diego to Monterey assuming the daily specific fecundity (number of eggs/population weight (gm)/day is 23.55. The biomass of Pacific sardine in 1994 and 1996 - 2001 are 129,000; 83,000; 409,000; 310,000; 280,000; 1.06 million and 791,000 mt and therefore, the spawning biomass has been increasing since 1994 (Lo, 2001, Admin. Report LJ- 01-08).

IMECOCAL: The April cruise in 2001 was interrupted at the line extending out from Cedros Island. A total of 426 CUFES samples were collected of which 79 were positive for sardine eggs. The distribution of these positive stations are shown in Figure 2. Twenty four stations were sampled with a CalVET net and only 2 were positive for sardine eggs. No daily egg production estimate was obtained. It is not known if any samples of hydrated females were collected from commercial boats in 2001. Six purse-seiners volunteered to fish offshore in 2001. A rented spotter plane did not see any sardine fish schools offshore during the day-time flights on April 17 and 18th. Therefore, no offshore fishing took place. However, two samples of adults were obtained from Bahia Todos Santos in shallow water off Estero Beach on April 23. One sample

of 203 adults was very fresh and 102 fish were sexed with 58 females. Of the 58 females, 35 were found to be hydrated. Fish ranged from 155mm (46.3 g) to 192 mm (94 g). The age-length relationship for this sample is given in Figure 3. The distribution of lengths by age group is given in Figure 4.

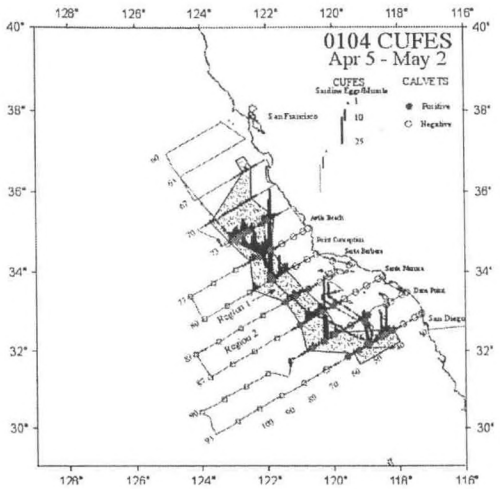

Figure 1. Sardine yolk-sac larvae from CalVET (circle and triangle) and from Bongo (circle and Square in 0104 CalCOFI survey from April 5 – May 2, 2001. Solid symbols are positive and open symbols are zero catch.

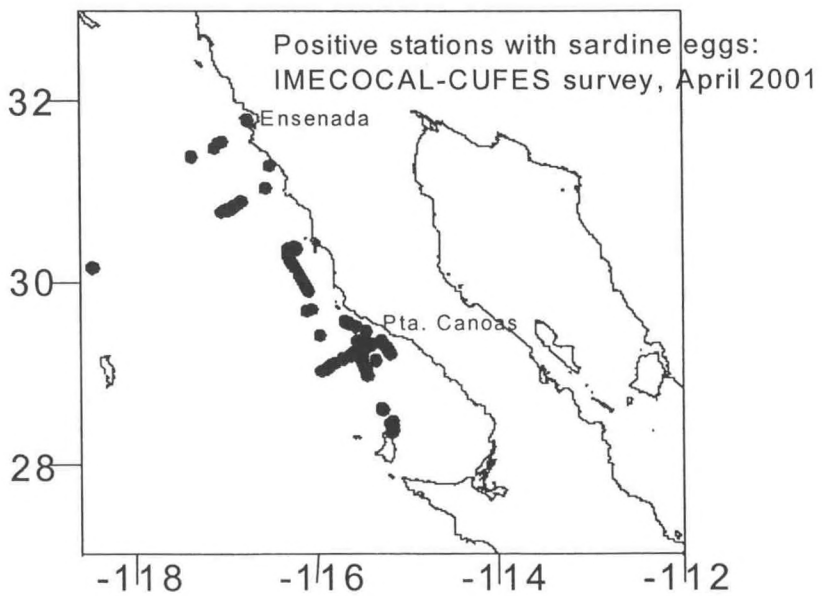

FIGURE 2

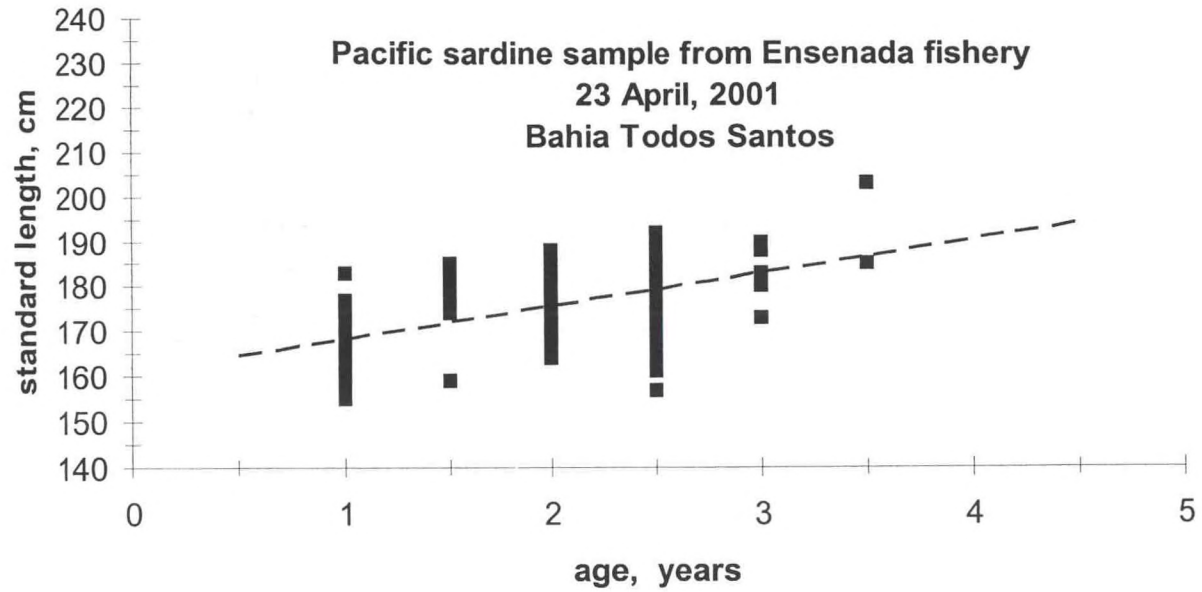

FIGURE 3

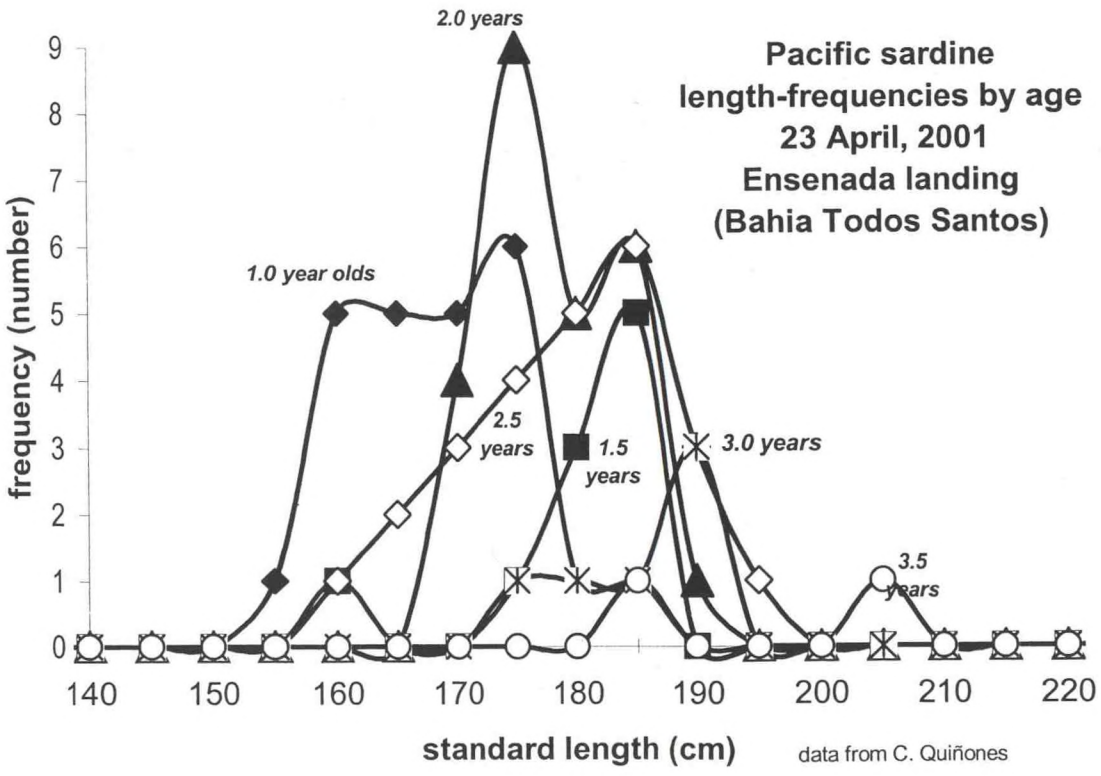

FIGURE 4

Egg and larval data collected in 1997-1999 IMECOCAL were analyzed (Figure 5). The eggs were found in October 1998 from Punta Colonett to Punta Canoas. In January, 1999 the eggs were found in an oceanic station off Punta Baja, and in August eggs were abundant in Bahia Sebastián Vizcaino and Punta Santo Domingo, B.C.S. Larvae were found from Punta Colonett to Punta Santo Domingo, B.C.S. in most expeditions, but they were most abundant in August 1999 and most scarce in October 1997. The biomass indices based on larval density during the peak spawning period within a year were 2652, 58,968; and 94,096 mt.

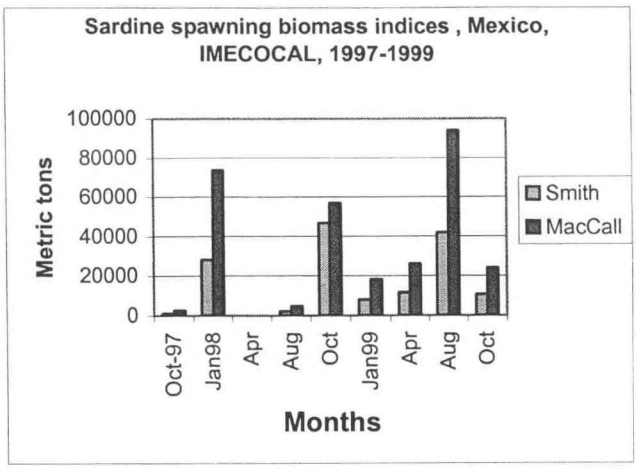

Figure 5. Spawning biomass index from each cruise of IMECOCAL, 1997-1999

NWFSC Egg production and adult reproductive parameters off Oregon and Washington. The objective of this work was to estimate the spawning biomass of Pacific sardine off Oregon from 1994-1998 and reproductive parameters of adult sardine in 2001. Up to this time reproductive rates of sardines off Oregon and Washington have not been measured and reproductive rates of sardine from California are used to calculate sardine biomass off Oregon and Washington using the Daily Egg Production Method (DEPM).

Data from four ichthyoplankton surveys conducted from 1994 and 1996-1998 were examined. Data from 1995 were not analyzed because the cruise did not cover the whole spawning area. Due to the low numbers of positive tows for sardine eggs of 1997-1998 and the unusual stage distribution of eggs in 1996, it was impossible to estimate the daily egg production and mortality rates for 1996-1998 simultaneously. Instead, assuming egg mortality rate is the same as the estimate obtained in the 1994 survey: 0.12/day and the specific daily fecundity is similar to that in California: 23.55 egg/gm, the mean egg density for 1994, and 1996-1998, 1.12, 1.24, 0.076 and 0.168/0.05m^2 were used to estimate the daily egg production. The estimates of spawning biomass were 26, 445, 43,763, 3326 and 2530 mt, for 1996-1998. The survey areas were 69,303, 115,594, 104,475 and 48,640 km^2. Obviously, the egg production declined during 1994-1998 off Oregon.

No offshore survey was conducted to capture adults in June because locations and timing of the spawning were unknown. Effort was concentrated on near shore trawling surveys. However, Darrell Kapp was able obtain gravid females which were frozen for later analysis. Sardines were

captured during a variety of fish surveys off Oregon and Washington: BPA Columbia River plume study: from northern Washington to Newport in May, June, and September; a NWFSC salmon predator and baitfish survey off the Columbia River; a night surface trawl surveys are taken off the Columbia River every 10 days from late April through July; and a Lower Columbia River purse seine survey occurring every 2 weeks from April through September. Results of these surveys indicate that there are many small (~100 mm FL) sardines around the Columbia River. This differs significantly from 1999 and 2000, where very few of this size were captured. Most of the sardines in the Columbia River estuary were of the smaller class size. Overall catches (abundance and distribution) of sardines have declined off Oregon/Washington since 1998. Other species - especially smelt, have increased significantly. Otoliths and stomachs from a subsample of the sardines captured in the Columbia River estuary were saved and to be analyzed this winter. Bob Emmett is preparing a report to describe length/frequency distributions and catch information.

Industry Support of sardine sampling in the NW Pacific: Darrell Kapp indicated that there are 4-6 spotter planes for the sardine fishery. Kapp planned to ask his spotter pilot to search for sardine schools for the offshore survey in July 2001. Since no offshore survey was conducted, the spotter pilot's assistance was not needed. Fishing took place between June-October. Most fish showed up off the Columbia River. Two daily estimates from pilots ranged from 3-5000 tons. Fish fat content varied from low fat content in June to good fat content (>18%) in September. This was similar to results from three fish surveys, unlike prior seasons (1999, 2000), large amount of small fish (27 – 44 grams in August catch) were in the fishing area from south of the Columbia River to north of Grays Harbor (probably all up and down the coast). Large schools of small fish made it difficult to set the nets because fish gilled in the nets. Seal bombing was the only efficient method to identify the size of fish. Baja California: no contact and no report.

Canadian Trawl surveys. The objectives of this work is to provide information on the distribution of the presence and absence of sardine, biological parameters, and feeding behavior and to estimate a minimum biomass of Pacific sardine off Vancouver Island from the July cruise each year since 1996. Research cruises were conducted and sardine samples were collected from November 2000 to October 2001. Research cruises were carried out aboard the R/V W.E. *Ricker*, except for one cruise, June 29 to July 5, when a fishing vessel *Caledonia* was employed. During all research cruises, fish were captured using a model 250/350/14 mid water rope trawl (Cantrawl Pacific Ltd., Richmond, British Columbia). Fish were measured for fork lengths which were recorded to the nearest millimeter.

On October 11, 2001, a research cruise being conducted off the west coast of Vancouver Island reported large catches of sardines in various inlets (up to 2 – 4 t per tow in the inlets), but no sardines have been captured further offshore. Biomass estimates were calculated for the July cruise, according to the method described in McFarlane and Beamish (2001). The west coast of Vancouver Island was partitioned into 6 major "regions", and total volume was determined to allow biomass estimates to be calculated regionally and coast – wide (Figure 6). The volume swept during each set was determined by multiplying the area of the midwater trawl net used during the fishing operations by the distance traveled during fishing. Biomass was estimated to be 43,845 Mt with 95% C.I. being 33,839 to 62,336 Mt for the west coast of Vancouver Island.

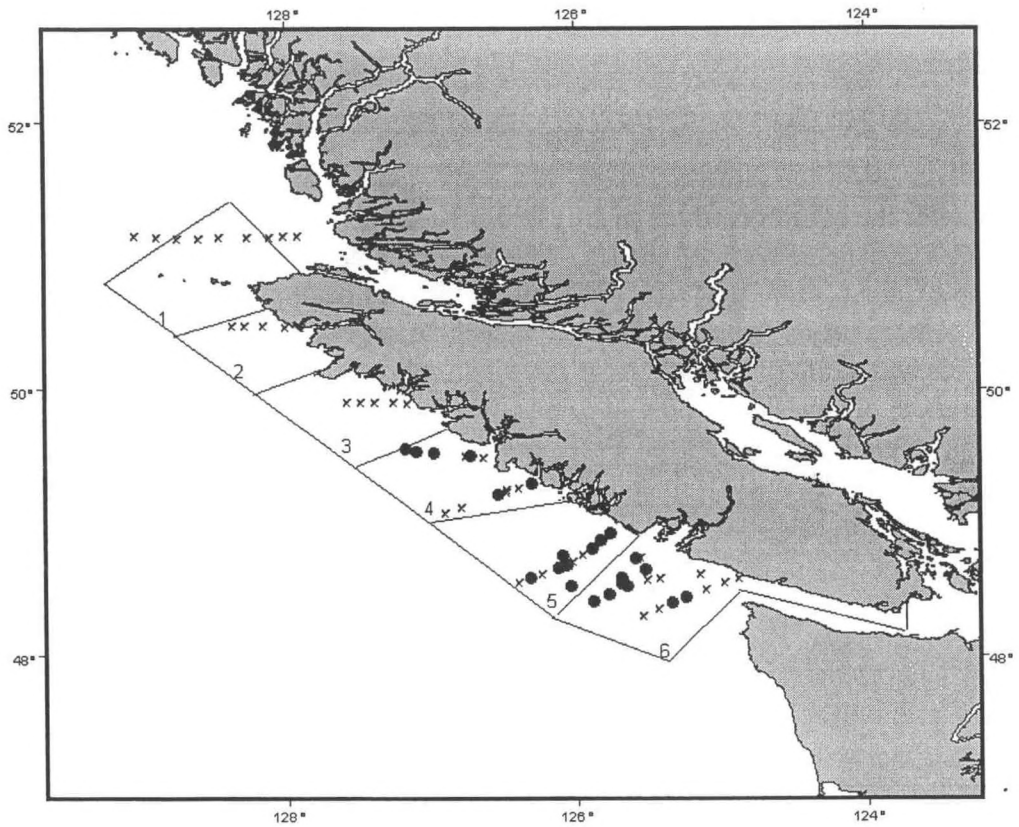

Figure 6. Canadian trawl survey from July 24 – August 21, 2001. Solid dots were positive for anchovy.

Egg and Larval Surveys in South Baja California and the Gulf of California. The objectives of this work is to estimate spawning biomass of Pacific sardine in south Baja California, Mexico and in the Gulf of California and to investigate the migration of Pacific sardine between the Gulf and west of Baja California. The approach was to examine historical data of Pacific sardine in the Gulf of California prior to 1993. No estimate of spawning biomass was obtained due to poor quality of adult samples. An ichthyoplankton survey in the Gulf of California starts in December 2001.

Minutes from plenary discussion session on regional biomass estimation. After the above working group progress reports were presented, a plenary discussion on the regional biomass estimates was held. Minutes from that discussion are recorded below.

Canadian trawl surveys in U.S. waters: The Trinational strongly encourages the Canadian Government to carry out trawl surveys in U.S. waters using the *Ricker*, to provide a biomass estimate of sardine for the northern California Current, British Columbia, Oregon and Washington coasts, as well as size and age structure information. The U.S. government (NMFS) does not have the funds or the vessel to monitor sardine in the northern California Current. The ideal approach would be two cruises, one in the winter and one in the summer to evaluate the effect of migration on the concentration of sardine in northern waters. A Canadian DFO survey was conducted off Oregon and Washington in the summer of 1997. If the same area were surveyed again, an estimate of the increase in sardines at the northern end of their range could be assessed. If only one survey could be conducted, the extension of this time series over a period of high sardine population growth would be the greatest value.

Joint U.S.-MEXICO analysis of 2001 April 2001 plankton surveys. Both CalCOFI and IMECOCAL carried out surveys using CUFES and other plankton tows for sardine eggs in April 2001. A large number of positive egg tows were detected by CUFES (unlike the condition in April 2000) in Mexican waters. This means by combining the CalCOFI and the CUFES data it will be possible to estimate the spawning biomass of the northern stock of sardines over a much larger area than has been possible since 1994. A combined U.S./Mexico estimate of spawning biomass for April 2000 was identified by the group as a top priority objective for 2002.

Joint Mexico-U.S. analysis of winter and summer spawning. Substantial spawning of sardine occur in the waters of Baja California in the summer through the winter. The April-May peak of spawning in U.S. waters and Northern Baja is believed to be produced by the northern sardine stock, while spawning during the rest of the year in Baja California and Southern California may be produced by the southern stock. From the standpoint of stock assessment, a joint estimate of biomass for the southern stock would be a very useful complement to the April estimate for the presumed northern group. An essential ingredient of this work would be to develop criteria for attributing spawning areas to a particular stock. The size at age, and vertebral number of the spawners would be needed to validate such criteria. This is a complex project, which will depend primarily on data collected in Mexican waters with ancillary data from CalCOFI and CDFG. At this point the project should be viewed as a research recommendation that might be undertaken by Mexican scientists some time in the future.

Adding fishery independent information to Trinational data base. Although useful, this is not practical at the present time since the Trinational data base project was delayed indefinitely, or at least until INP (Mexico) lifts restrictions on the distribution of raw fishery dependent data.

Inventory of Fishery Independent information on sardine since 1992. To assist future assessments of sardine, Working Group 3 agreed to develop an inventory of fishery independent indices, or direct measures of abundance, for the Pacific Sardine. These shall include time series of ichthyoplankton, acoustic surveys and trawling surveys that have taken place since 1992. The inventory must indicate the years covered, area sampled or represented by the survey, the extent

the data have been worked up (species identification, age determination, counts, weights, etc.) and contact information on how the data may be obtained as well as other descriptive information.

Editors note. The useful data sets for stock assessment of sardine, are well documented in southern California because of annual assessments (all useful southern California data appear and are cited in the U.S. annual assessment document). Thus, the chief value of the inventory would be to identify unutilized data sets for Canadian, Northwest and Mexican waters where there has not been an assessment since the recovery. To that end, a possible objective of the working group (instead of producing an inventory) could be to produce two short, multi-authored papers for CalCOFI Reports in which all the useful data could be identified and used in the publication. Provisional titles for the papers could be: The status of the sardine in Canadian and Northwest waters since 1992; or similarly, a paper entitled the dynamics and present status of the southern stock of Pacific sardine.

WORKING GROUP 4 - Stock structure and Latitudinal origins

Minutes from plenary discussion of stock structure.

Data requirements for two stock management. The group agreed, in principle, with Paul Smith's views outlined in his talk, i.e. that the weight of current evidence supports the existence of northern and southern spawning habitats of sardine, and that such information should be used for management. The basis for this judgment is past age-growth, meristics, and immunological work. However, to be effective for management purposes, sardine measurements that routinely identify the origin of landed fish would be needed because landings in southern California and Mexico are believed to be mixtures. Smith suggested that it might be possible to build a management strategy sensitive to stock origin by monitoring vertebral counts and mean water temperatures. There are no financial or technical resources to do this at the present time. No quick method is available that could be used to identify a northern or southern stock origin. Thus, the best approach to further this end is to encourage long-range research projects on stock structure, monitoring and stock sensitive management. The group identified the following research projects with the hope of encouraging researchers to seek funds to pursue these lines of research.

Research topics on stock structure recommended by the Trinational. The following research topics were recommended:

Determine the genetic diversity of the Pacific sardine stock using specimens from the extreme range and modern molecular methods.

Identify physiological traits that separate northern from southern stocks. Possible approaches include studying the characteristics of eggs, including lower thermal limit for hatching and various enzyme systems.

Monitor summer spawning of sardine in southern California (CalCOFI) and off Baja California Mexico (IMECOCAL) and determine the northern limit of spawning.

Identify traits that will serve as inexpensive proxies for northern or southern stock origins.

Conduct a comparative life table analysis of putative north and south sardine stocks using existing life table information, and generating new life table information as needed. Use the life table approach to measure the relative effects of fishing on the two stocks.

PLENARY DISCUSSION OF FISHERY ISSUES

A variety of fishery issues were discussed by industry representatives and fishery scientists in plenary session. Much of the discussion dealt with U.S. fishery management policies, matters far beyond the scope of the Trinational. Topics included the U.S. Limited Entry Plan, consequences of a declining Scripps pier water temperature which might sharply lower the U.S. harvest in 2002, allocation of unused sardine quota to other countries, and the north south allocation formula in the U.S. Fishery Management Plan. While we do not have constructive minutes on all of these subjects, we cover a few of them as well as provide the minutes on other less controversial topics that were discussed.

U.S. Limited Entry Plan: The present U.S. limited entry plan for the sardine, and its relation to other CPS limited entry programs in the U.S. FMP, was discussed at length. Issues regarding limited entry are beyond the scope of the Trinational and the FMP should be read for the details. However, to set the record straight, we summarize briefly the main and the more controversial features of the plan and specify the process that would be required to change any features of the U.S. plan.

Limited entry permits for Pacific sardine, Pacific mackerel, jack mackerel, and northern anchovy were issued to the current owner of the vessel that landed at least 100 metric tons (mt) of these species from January 1, 1993 through November 5, 1997. Many vessels had a history of fishing coastal pelagics, but the owners made the decision at some point to enter other fisheries. A common criticism of the limited entry program is that fishermen who have a historical background in harvesting coastal pelagic species, some of it extensive, were not considered for limited entry permits. This has been the most common criticism, apart from criticisms of limited entry programs in general.

Initially, permits were transferable for one year, followed by a period of non-transferability to allow for some attrition in the fleet. The current situation of non-transferable permits creates economic problems for owners of vessels; however, an amendment to the plan is being developed to allow transferability with certain controls.

Coastal pelagic species fishermen rely on a variety of species, including squid. The squid fishery is managed by the California Department of Fish and Game, which is preparing a management plan. The current incompatibility between limited entry permits in the two fisheries results in problems for those fishermen who own permits for both fisheries.

Allocation of U.S. sardine quota to other countries: Jim Morgan discussed the issue of allocation of unused U.S. sardine quota to other countries; his full report is included in

Appendix II. Morgan's report indicates U.S. approval gaining for sardine fishing by foreign flag vessels requiring a country to country agreement, and any allocations to foreign vessels considers the individual nation's compliance with U.S. law, and its contributions to the U.S. fishing industry and cooperative research. Allocation of sardine to foreign harvesters is unlikely under the current biomass levels because the harvest strategy in the plan is just being met even though there is a significant amount of the domestic harvest guideline that has not been harvested. This has resulted because the harvest formula has not fully accounted for removals beyond U.S. jurisdiction. Total removals exceed planned removals.

Domoic acid advisory affecting Monterey sardine fishing: toxin affecting sardine products. Domoic acid toxin was first detected in Canada when dozens of people died and hundreds more were made ill from eating shellfish in the mid-80's. It was detected first in finfish when anchovy tested positive for domoic acid where pelicans were acting strangely in Monterey Bay in about 1990. It has since been detected in anchovy in the Southern California Bight, as a cause of death in sea lions, and most recently in Monterey Bay sardines which are now quarantined for human consumption based on an October advisory from the El Dorado County California Environmental Management Department. Domoic acid toxin is now monitored with the paralytic toxin in shellfish along the west coast of North America (CDHS/PS/Division of Food, Drug & Radiation Safety/Food & Drug Laboratory Branch, north).

Balanced National Policy needed for the use of coastal pelagic species for aquaculture. Hunter advised the group that since publication of the paper by Naylor et al. (Nature, Volume 405, June 2000) there has been an increasing concern by environmental groups that increased use of fish meal and frozen fish in aquaculture is causing overfishing of small pelagic fishes. One of the reasons cited is that the usage of CPS for aquaculture feed is increasing. For example, the use of fish meal in aquaculture was negligible in the early 80's, but currently aquaculture uses 33% of the world fish meal supply and it is projected to increase to 56% by 2010. Some conservation groups are advocating reduced consumption of aquaculture products, and trade barriers. Of course, not all CPS species are over fished, and reducing the use of fish-based foods in aquaculture may not reduce the fishing effort for CPS, nor may trade barriers and food bans be an effective way of dealing with this issue. Clearly, a need exists for national and international policy based on bioeconomic analysis of this problem.

FUTURE OF THE TRINATONAL

The goals of the Trinational Sardine Forum are to serve the sardine fishing communities by providing a forum for information exchange and by improving, through collaboration, the new monitoring and assessment of Pacific sardine. The Trinational Sardine Forum is not mandated by any agency, national policy, legislation, or international agreements, nor is it driven by tradition. Thus, at the end of each Forum we discussed in plenary session if the benefits warrant continuation, how the Forum could be improved, and when and where we should meet again. The group agreed that the positive benefits generated thus far warrant meeting again in 2002 following a format similar to 2001 with the following additions or modifications:

Location and host: Orlando Amoroso (Southern California Commercial Fishing Association) offered to host the next meeting in San Pedro, California if a suitable site can be found; his offer was accepted.

Date: The first week of December was selected as the date for the 2002 Forum. Holding a meeting of the Forum in conjunction with other related fall meetings (CalCOFI Conference, and annual presentation of the U.S. sardine stock assessment to the Coastal Pelagics Fishery Management Plan Industry Advisory Group) was discussed and dismissed. Either meeting would require shifting the Forum to earlier in the fall, which would cause problems in attendance for some key participants.

Meeting duration and format: The major elements in the Forum agenda in the last two years were: 1) Presentation of landings and related information from each reporting area (Canada, Washington, Oregon, California, Ensenada, Mexico and the Gulf of California (Mexico); 2) reports of Working group accomplishments, 3) breakout sessions of working groups, 4) plenary reports from working group sessions, 5) discussion of the sardine fishing by an industry panel, and 6) planning and organization of future meetings. The consensus was that none of these blocks should be eliminated. However, the entire format was completed in 2000 in 2.5 days, but in 2001 we allowed 2 days and ran out of time. Therefore, we eliminated the breakout groups. Thus, a 2.5 day format was recommended for 2002. It may also be preferable for the working groups to meet early in the meeting, and subsequently prepare a single report that includes both a summary of last year's work and future plans.

Industry panel: The group recommended several improvements to the industry panel: a processor and a fisherman from each region should be on the discussion panel; the panel should have an agenda with discussion topics specified; the panel meeting should be scheduled at a time that would facilitate attendance by industry people, who would not be inclined to attend the full meeting. .

Presentation of scientific details and tailoring a presentation to industry needs: A way needs to be found for separating presentations giving detailed scientific methods and results, or lengthy scientific debate from the rest of the proceedings so that interested industry persons can participate in the Forum without being immersed in such scientific detail. In addition, the suggestion was made that time should be allotted for a summarization of the most important scientific results and issues in a format tailored to the more general audience. While these modifications of the Forum are clearly worthwhile, it was uncertain as to the extent that they could be accomplished given time constraints and multiple objectives of the meeting. The chairs agreed to work with Trinational members to improve the Forum in this regard.

Sardine markets: The focus of nearly all Trinational presentations in the last two years have been on sardine biology in relation to fisheries monitoring and management with little discussion of markets. A presentation on sardine markets by someone involved in this aspect of the business would be a most welcome addition to the Forum. Such a presentation would serve to broaden the knowledge of the group and therefore be highly beneficial.

Spanish - English simultaneous translation: In previous years we have managed to find the $5000 required for simultaneous translation, but were not able to obtain the funds this year. Translation greatly benefits the frank exchange of views between Mexican, U.S. and Canadian scientists, industry, and fishermen; and better communication fosters closer collaboration.

APPENDICES

APPENDIX I.

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APPENDIX II. CONTRIBUTED ELECTRONIC PAPERS

Stock Assessment of Pacific Sardine with Management Recommendations for 2002 Executive Summary

by

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Dedication

This paper is dedicated to the late Dr. Garth Murphy, who passed away during 2001. Dr. Murphy was a world-renowned population biologist and a genuine pioneer in the study of Pacific sardine. Without his diligent, conscientious, and truly innovative efforts, this work would not have been possible.

Introduction

The following summary presents pertinent results and harvest recommendations from a stock assessment conducted on Pacific sardine (*Sardinops sagax*). It is an update to the stock assessment carried out last year (Conser et al. 2001), and is intended for use by the Pacific Fishery Management Council (PFMC) when developing management goals for the upcoming fishing season for sardine beginning January 2002.

The assessment results presented here are applicable to the sardine population off the North America Pacific coast from Baja California, Mexico to British Columbia, Canada. The majority of the fishery-independent and fishery-dependent data were collected off northern Mexico and southern California only (Area 1 or *Inside* Area); however, as was done in past assessments, assumptions regarding sample coverage (e.g., representativeness of survey trends to areas outside Area 1) and sardine biology (e.g., recruit emigration out of Area 1) were used to make scientific inferences about the entire population, e.g., to provide fishery managers coastwide estimates of stock biomass, mortality rates, and harvest guidelines.

Methods

An age-structured stock assessment model (CANSAR-TAM, **C**atch-at-age **AN**alysis for **SAR**dine - **T**wo **A**rea **M**odel, see Hill et al. (1999) was applied to fishery-dependent and fishery-independent data to derive estimates of population abundance and age-specific fishing mortality rates. In 1998, the original CANSAR model (Deriso et al. 1996) was modified to account for the expansion of the population northward to waters off the Pacific northwest (see above). The models are based on a 'forward-simulation' approach (see Megrey (1989) for a description of the general modeling approach), whereby parameters (e.g., population sizes, recruitments, fishing mortality rates, gear selectivities, and catchability coefficients) are estimated after log transformation using the method of nonlinear least squares. The terms in the objective function (to be minimized) included the sum of squared differences in ($\log_e$) observed and ($\log_e$) predicted estimates from the catch-at-age and various sources of auxiliary data used for 'tuning' the model, e.g., indices of abundance from survey (fishery-independent) data. Bootstrap procedures were used to calculate variance and bias (95% confidence intervals) of sardine biomass and recruitment estimates generated from the assessment model. The CANSAR-TAM model was based on two fisheries (California, U.S. and Ensenada, Mexico) and semesters within a year were used as time steps, with ages being incremented between semesters on July 1 and spawning that was assumed to occur on April 1 (middle of the first semester).

Fishery-dependent data from the California and Ensenada fisheries (1983 to first semester 2001) were used to develop the following time series: (1) catch (in mt)-Table 1 and Figure-1; (2) catch-at-age in numbers of fish; and (3) estimates of weight-at-age. Fishery-independent data (time series) from research surveys included the following indices, which were developed from data collected from Area 1 (*Inside Area*, primarily waters off southern California) and used as relative abundance measures (Table 2): (1) index (proportion-positive stations) of sardine egg abundance from California Cooperative Oceanic and Fisheries Investigations (CalCOFI) survey data

(*CalCOFI Index*)-Figure 2; (2) index of spawning biomass (mt) based on the Daily Egg Production Method (DEPM) survey data (*DEPM Index*)-Figure 3, see Lo et al. (1996); (3) index of spawning area (Nmi^2) from CalCOFI and DEPM survey data (*Spawning Area Index*)-Figure 4, see Barnes et al. (1997); and (4) index of pre-adult biomass (mt) from aerial spotter plane survey data (*Aerial Spotter Index*)-Figure 5, see Lo et al. (1992). Time series of sea-surface temperatures (Figure 6) recorded at Scripps Pier, La Jolla, California were used to determine appropriate harvest guidelines (*Sea-surface Temperature Index*), see Amendment 8 of the Coastal Pelagic Species Fishery Management Plan, Option J, Table 4.2.5-1, PFMC (1998).

Survey indices of relative abundance were re-estimated using generally similar techniques as was done in previous assessments (Hill et al. 1999 and Conser et al. 2001). The final model configuration was based on equally 'weighted' indices except for the CalCOFI index, which was downweighted to 0.7 (relative to 1.0 for the other indices). The relative weight used for the CalCOFI index (0.7) was consistent with previous assessments in which the proportion of the total spawning area covered by the CalCOFI surveys (~70%) was used to determine its relative weighting in the model. Further the CalCOFI Index has undergone considerable saturation in recent years due to the higher frequency of positive stations as the sardine stock expanded throughout and beyond the southern California Bight. As in the previous assessment, the CalCOFI index was fit with a non-unity exponent (0.3547) to allow for a nonlinear relationship between the index and sardine spawning biomass. This procedure produced a better fit to these data and a more acceptable residual pattern than assuming the classical linear relationship between the index of abundance and population size. As in the previous assessment, the Aerial Spotter Index was assumed to primarily track pre-adult fish (ages 0 and 1 plus a portion of age 2 fish). All of the other fishery-independent indices were used as indices of the spawning stock biomass, which can be approximated by the biomass of ages 1+ sardine.

It is important to note that survey indices used in fishery assessments are often based on variable and biased data; however, we assumed that biases were generally consistent from year to year, which in effect, allows the trend indicated in an index to be interpreted in relative terms and ultimately, useful in statistical modeling.

Results

Pacific sardine landings for the directed fisheries off California, U.S. and Ensenada, Mexico decreased from the high levels that were reached during 2000 (109,000 mt), with a total 2001 harvest of roughly 86,000 mt (Table 1, Figure 1); however, note that semester 2 landings in 2001 reflect projected estimates based on landing patterns observed in the fisheries during the mid to late 1990s (Table 1). Both California and Ensenada landings in 2001 are expected to decrease from the 2000 level, with a more notable decrease in the projected Ensenada landings (51,000 mt in 2000, decreasing to 35,000 mt in 2001). Currently, the U.S. fishery (California landings) is regulated using a quota (harvest guideline) management scheme and the Mexico fishery (Ensenada landings) is essentially unregulated. Since the mid 1990s, actual landings from the California fishery have been less than the recommended quotas.

As was the case in recent years, landings from the U.S. Pacific sardine fishery (California, Oregon, and Washington) are well below the harvest guideline recommended for 2001 (135,000 mt), with roughly 62,000 mt (46% of harvest guideline) landed through September 2001 and over 72,000 mt of the quota remaining (the fishing year ends on December 31, 2001).

Estimated stock biomass (≥1-year old fish on July 1, 2001) from the assessment conducted this year indicated the sardine population has remained at a relatively high abundance level, with a bias-corrected estimate of nearly 1.1 million mt (Table 3 and Figure 7). Estimated recruitment (age-0 fish on July 1) during the past three years has declined considerably from that estimated for the strong 1998 year-class (Table 3 and Figure 8). However, it should be noted that recent recruitment (6-11 billion recruits) is not estimated precisely (Figure 8), and another 2-3 years of data may be needed to ascertain whether the sardine population biomass has reached a plateau at the 1.1 million mt level (Figure 7).

Estimates of Pacific sardine biomass from the 1930's (Murphy 1966 and MacCall 1979) indicate that the sardine population may have been more than three times its current size prior to the population decline and eventual collapse in the 1960's (Figure 9). Considering the historical perspective, it would appear that the sardine population, under the right conditions, may still have growth potential beyond its present size. However, per capita recruitment estimates derived from the current assessment (Figure 10) show a downward trend in recruits per spawner that may be indicative of a stock that has reached a plateau under current environmental conditions.

Harvest Guideline for 2002

The harvest guideline recommended for the U.S. (California, Oregon, and Washington) Pacific sardine fishery for 2002 is 118,442 mt. Statistics used to determine this harvest guideline are discussed below and presented in Table 4. To calculate the proposed harvest guideline for 2002, we used the maximum sustainable yield (MSY) control rule defined in Amendment 8 of the Coastal Pelagic Species-Fishery Management Plan, Option J, Table 4.2.5-1, PFMC (1998). This formula is intended to prevent Pacific sardine from being overfished and maintain relatively high and consistent catch levels over a long-term horizon. The Amendment 8 harvest formula for sardine is:

HG_{2002} = (TOTAL STOCK $BIOMASS_{2001}$ - CUTOFF) • FRACTION • U.S. DISTRIBUTION,

where HG_{2002} is the total U.S. (California, Oregon, and Washington) harvest guideline recommended for 2002, TOTAL STOCK $BIOMASS_{2001}$ is the estimated stock biomass (ages 1+) from the current assessment conducted in 2001 (see above), CUTOFF is the lowest level of estimated biomass at which harvest is allowed, FRACTION is an environment-based percentage of biomass above the CUTOFF that can be harvested by the fisheries (see below), and U.S. DISTRIBUTION is the percentage of TOTAL STOCK $BIOMASS_{2001}$ in U.S. waters.

The value for FRACTION in the MSY control rule for Pacific sardine is a proxy for F_{msy} (i.e., the fishing mortality rate that achieves equilibrium MSY). Given F_{msy} and the productivity of the sardine stock have been shown to increase when relatively warm-water ocean conditions persist, the following formula has been used to determine an appropriate (sustainable) FRACTION value:

$$\text{FRACTION or } F_{msy} = 0.248649805(T^2) - 8.190043975(T) + 67.4558326,$$

where T is the running average sea-surface temperature at Scripps Pier, La Jolla, California during the three preceding years. Ultimately, under Option J (PFMC 1998), F_{msy} is constrained and ranges between 5% and 15% (Figure 11).

Based on the T values observed throughout the period covered by this stock assessment (1983-2001), the appropriate F_{msy} exploitation fraction has consistently been 15% (see Figures 6 and 11); and this remains the case under current oceanic conditions (T_{2001} = 17.24 □C). However, it should be noted that the decline in sea-surface temperature observed in recent years (1998-2001) may invoke environmentally-based reductions in the exploitation fraction as early as next year (i.e. in setting the harvest guideline for the 2003 fishing season) – see Figure 11.

Finally, although the 2002 harvest guideline (118,442 mt) is less than the 2001 level (134,737 mt), recent fishery practices indicate that it may not be constraining with regard to fishery landings (Figure 12). However, should the recent declining recruitment trend estimated in this assessment be confirmed with future work, and should the sea-surface temperature continue to decline, it is likely that harvest guidelines in the out years will constrain fishery practices and removals.

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Table 1. Pacific sardine time series of landings (mt) by semester (1 is January-June and 2 is July-December) in California and Baja California (Ensenada), 1983-2001. Semester 2 (2001) estimates are projections.

	CALIFORNIA			ENSENADA			
Year	Semester 1	Semester 2	Total	Semester 1	Semester 2	Total	Grand Total
83	245	244	489	150	124	274	762
84	188	187	375	<1	<1	0	375
85	330	335	665	3,174	548	3,722	4,388
86	804	483	1,287	99	143	243	1,529
87	1,625	1,296	2,921	975	1,457	2,432	5,352
88	2,516	1,611	4,128	620	1,415	2,035	6,163
89	2,161	1,561	3,722	461	5,763	6,224	9,947
90	2,272	1,033	3,305	5,900	5,475	11,375	14,681
91	5,680	3,354	9,034	9,271	22,121	31,392	40,426
92	8,021	13,216	21,238	3,327	31,242	34,568	55,806
93	12,953	4,889	17,842	18,649	13,396	32,045	49,887
94	9,040	5,010	14,050	5,712	15,165	20,877	34,927
95	29,565	13,925	43,490	18,227	17,169	35,396	78,886
96	17,896	18,161	36,057	15,666	23,399	39,065	75,121
97	11,865	34,331	46,196	13,499	54,941	68,439	114,636
98	21,841	19,215	41,055	20,239	27,573	47,812	88,868
99	31,791	24,956	56,747	34,760	23,810	58,569	115,316
00	35,174	22,761	57,935	25,800	25,373	51,173	109,108
01	29,491	21,131	50,622	9,327	25,645	34,973	85,594

Table 2. Pacific sardine time series of survey indices of relative abundance and sea-surface temperature, 1983-2001.

Year	CalCOFI (% positive)	DEPM (mt)	Spawning area (Nmi^2)	Spotter plane (mt)	Sea-surface temperature (C)
83	na	na	40	na	17.25
84	4.4	na	480	na	17.58
85	2.7	na	760	na	17.80
86	1.3	7,659	1,260	23,393	17.87
87	4.3	15,705	2,120	12,294	17.71
88	6.7	13,526	3,120	59,455	17.55
89	9.1	na	3,720	34,915	17.24
90	3.6	na	1,760	22,543	17.19
91	12.8	na	5,550	43,147	17.35
92	10.8	na	9,697	52,149	17.61
93	6.1	na	7,685	89,462	17.84
94	17.0	111,493	24,539	224,109	17.97
95	10.8	na	23,816	200,266	18.04
96	28.0	83,176	25,889	127,108	18.06
97	17.9	356,300	40,592	70,995	18.06
98	17.4	313,986	33,447	125,500	18.44
99	16.7	282,248	55,173	42,827	18.04
00	5.6	1,063,837	32,785	51,157	17.73
01	14.8	790,925	31,663	na	17.24

Table 3. Pacific sardine time series of stock biomass (>age-1 fish in mt) and recruitment (age-0 fish in 1,000s) Area 1 (Inside) and the Total Area of the stock. The 95% CIs for Total Area biomass and recruitment estimates are also presented.

	Stock biomass				Recruitment		
Year	Area 1	Total Area	Lower CI	Upper CI	Total Area	Lower CI	Upper CI
83	5,160	5,160	2,838	10,593	136,715	81,424	247,317
84	12,631	12,697	8,633	21,818	219,570	140,150	380,174
85	20,229	20,700	14,833	33,546	214,612	144,140	355,474
86	29,015	30,549	23,149	47,123	881,452	626,663	1,376,263
87	73,890	77,335	59,908	114,700	848,884	606,457	1,272,934
88	107,881	117,451	94,475	161,783	1,514,815	1,068,053	2,360,016
89	165,712	184,806	150,033	257,873	1,137,582	774,913	1,922,349
90	178,364	212,005	172,399	294,998	4,557,052	2,967,789	8,105,133
91	218,867	255,720	192,889	400,869	5,419,305	3,386,492	9,434,244
92	331,042	396,653	296,490	613,863	3,853,609	2,423,474	6,997,714
93	310,159	414,063	316,699	627,553	8,438,703	5,672,733	14,107,041
94	452,187	597,933	469,907	871,270	11,079,031	7,774,557	17,875,746
95	498,620	699,738	555,514	1,001,197	7,349,791	5,138,966	11,552,173
96	551,579	801,400	655,898	1,109,174	5,967,108	4,188,319	9,481,244
97	512,049	799,611	667,520	1,071,563	9,702,305	6,703,749	15,457,928
98	489,991	814,152	670,965	1,106,158	18,533,895	12,607,022	29,697,885
99	717,496	1,128,472	887,194	1,598,895	8,735,328	5,417,935	15,248,587
00	681,209	1,136,424	878,663	1,640,441	10,645,970	5,819,861	20,781,050
01	595,901	1,057,599	750,750	1,648,778	5,537,943	2,937,915	11,255,609

Table 4. Proposed harvest guideline for Pacific sardine for the 2002 fishing season. See ***Harvest Guideline for 2002*** section for methods used to derive the harvest guideline.

Total stock biomass (mt)	Cutoff (mt)	Fraction (%)	U.S. Distribution (%)	Harvest guideline (mt)
1,057,599	150,000	15%	87%	**118,442**

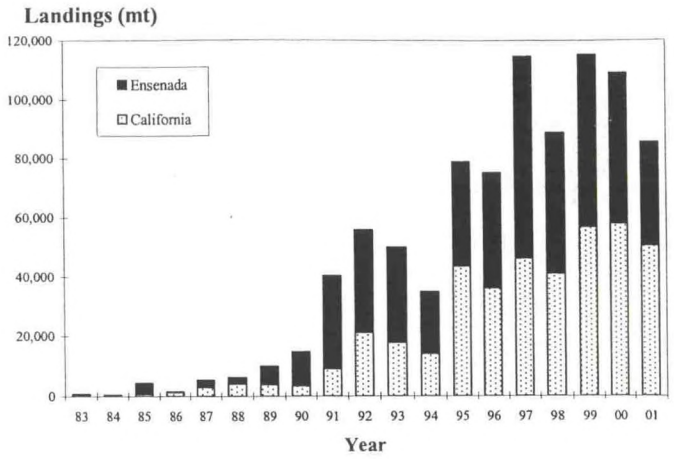

Figure 1. Pacific sardine landings (mt) in California and Baja California (Ensenada), 1983-01.

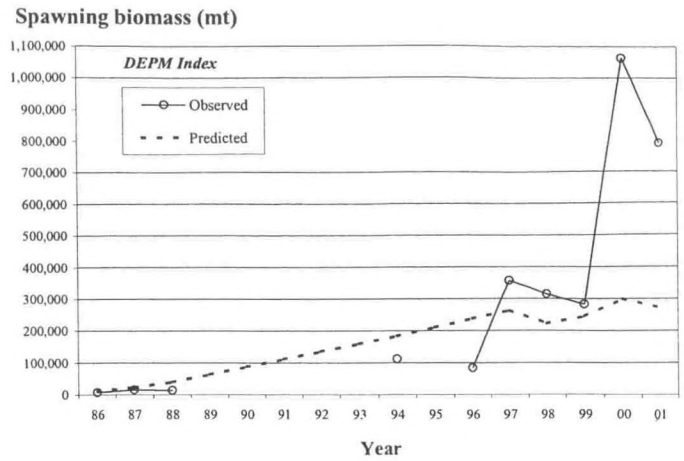

Figure 3. Index of relative abundance of Pacific sardine spawning biomass (mt) off California based on daily egg production method (DEPM) estimates from ichthyoplankton survey data (1986-01). Note no sample data (Observed estimates) were available for years 1989-93 and 1995.

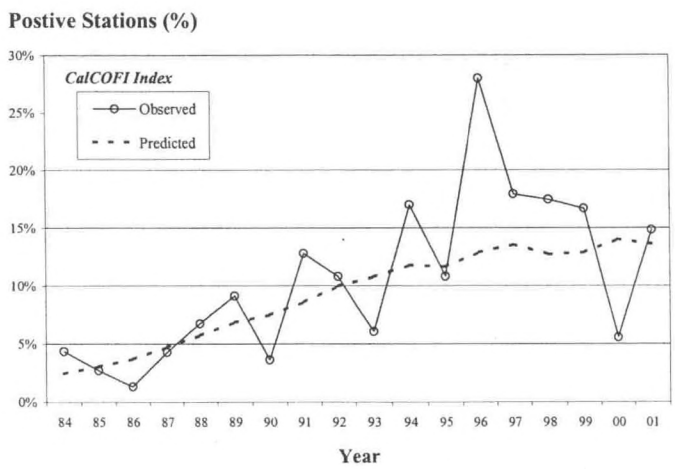

Figure 2. Index of relative abundance of Pacific sardine eggs (proportion-positive stations) off southern California based on CalCOFI bongo-net survey (1984-01).

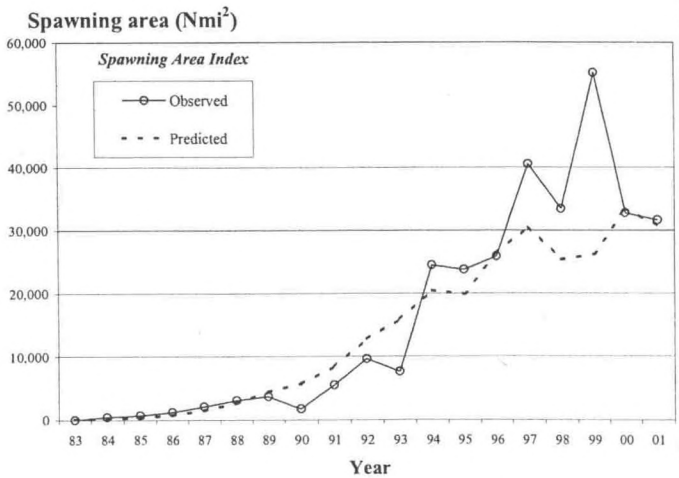

Figure 4. Index of relative abundance of Pacific sardine spawning stock size based on estimates of spawning area (Nmi^2) calculated from CalCOFI and DEPM survey data (1983-01).

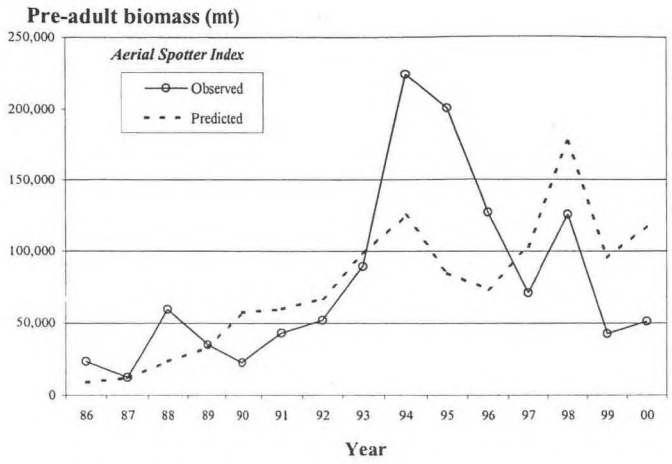

Figure 5. Index of relative abundance of Pacific sardine pre-adult biomass (primarily age 0-2 fish in mt) off California based on aerial spotter plane survey data (1986-01). Note that no sample data were available for 2001.

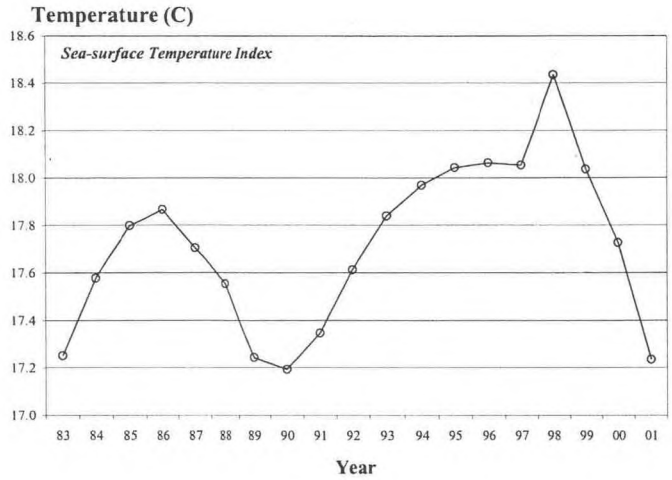

Figure 6. Time series of sea-surface temperature (C) recorded at Scripps Pier, La Jolla (1983-01). Annual estimates reflect 3-year 'running' averages, see Jacobson and MacCall (1995).

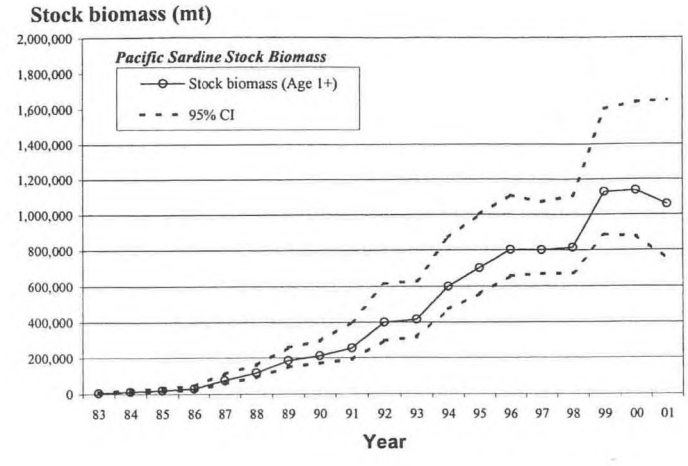

Figure 7. Time series (1983-01) of Pacific sardine stock biomass (≥ 1-yr old fish on July 1 of each year in mt) estimated from an age-structured stock assessment model (CANSAR-TAM, see Hill et al. 1999).

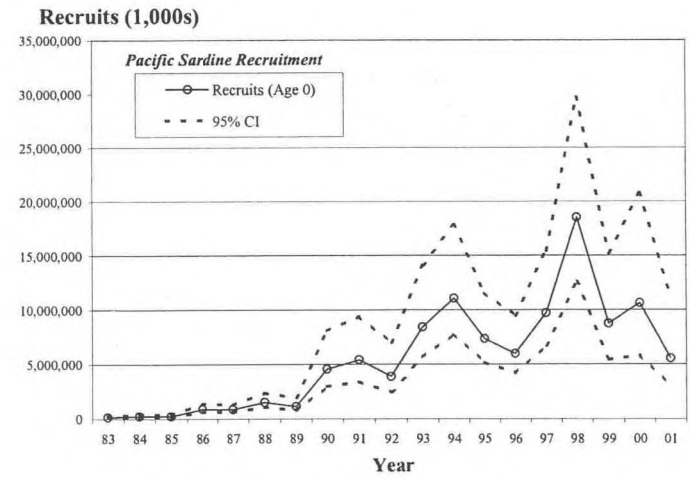

Figure 8. Time series (1983-01) of Pacific sardine recruitment (0-yr old fish on July 1 of each year in 1,000s) estimated from an age-structured stock assessment model (CANSAR-TAM, see Hill et al. 1999).

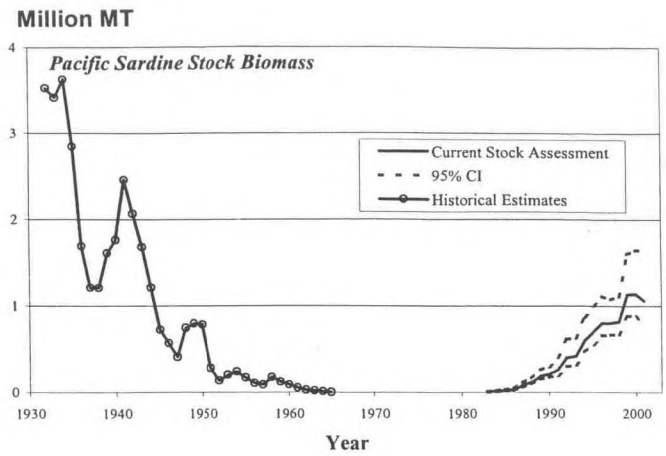

Figure 9. Time series (1983-2001) of Pacific sardine stock biomass (>1-yr old fish on July 1 of each year in million mt) and associated 95% confidence intervals estimated in the current stock assessment (cf. Figure 7); and historical stock biomass estimates (1932-65) from Murphy (1966). Confidence intervals or other measures of precision are not available for the historical estimates. No stock assessment-based estimates are available for the period 1966-82. The sardine fishery was closed much of this period and biomass was at very low levels.

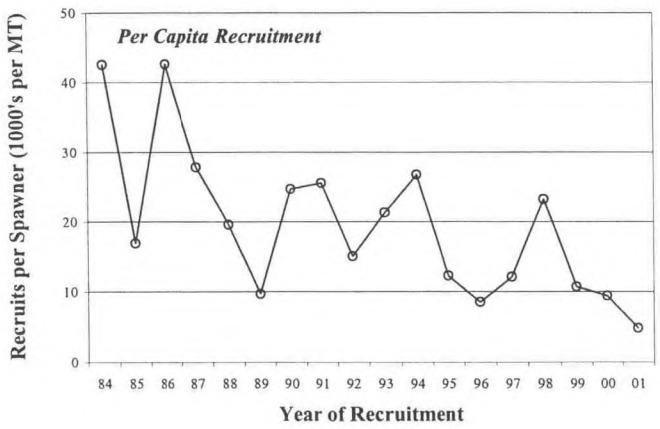

Figure 10. Ratio of Pacific sardine recruitment (1000's of 0-yr old fish) to stock biomass (Age 1+ in MT) during the previous year. Estimates of recruitment and Age 1+ biomass are taken from the stock assessment model (see Figures 7 and 8). Age 1+ biomass is used as a proxy for the spawning stock biomass of Pacific sardine.

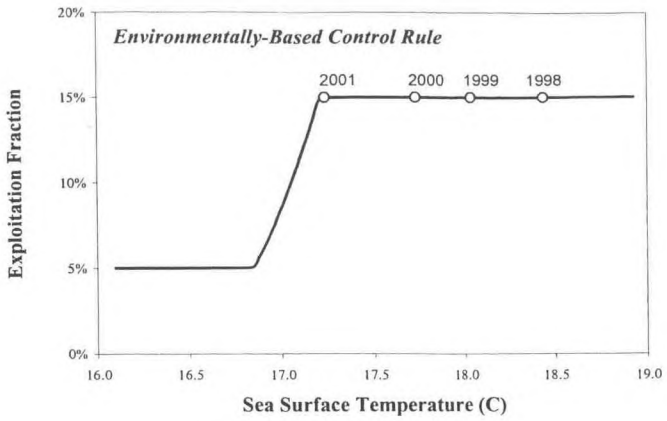

Figure 11. Environmentally-based harvest rate control rule for Pacific sardine as specified in the Coastal Pelagic Species Fishery Management Plan (PFMC 1998). For any given year, sea surface temperature (X-axis) is the running average sea surface temperature at Scripps Pier (La Jolla, CA) during the three preceding years. The exploitation fraction (Y-axis), which can range between 5-15%, is an explicit part of the algorithm used to determine the annual harvest guideline (quota) for the coastwide U.S. fishery – see Table 4. Open circles illustrate the sea surface temperature and exploitation fraction for recent years (1998-2001).

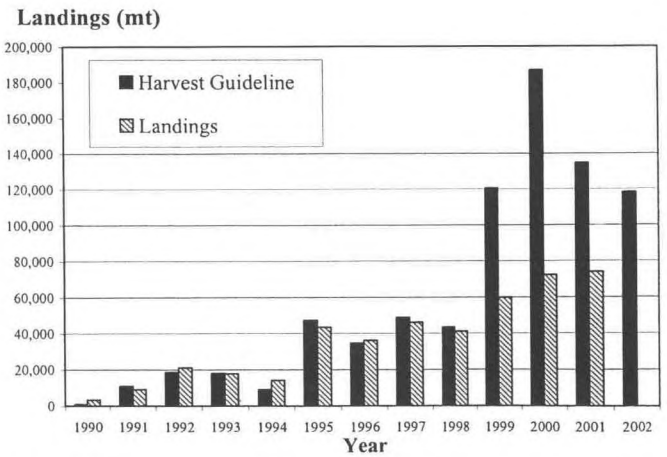

Figure 12. Time series (1990-02) of Pacific sardine harvest guidelines ('quotas') and actual landings (mt). State-based (California) regulations were in place for 1990-99, with federal-based (California, Oregon, and Washington) regulations beginning in 2000. Note that landings in 2001 represent an estimate projected through the end of the year. The 2002 harvest guideline is based on the 2001 stock biomass estimated in this assessment (Figure 7).

2001 Washington Trial Sardine Fishery Summary
Abstract

Brian Culver

The trial fishery began on May 15 and continued through October 31, 2001; however, the first landing into Washington occurred on June 19. The fishery was managed to a state harvest guideline of 15,000 mt. A total of 10,837 mt of sardines were landed into Washington which left 4,163 mt remaining in the Washington harvest guideline. The Washington Department of Fish and Wildlife issued a total of 40 permits and 13 permit holders participated in the fishery. A total of 299 landings were made and 128 occurred within the month of July. The majority of the landings (79%) were made into Ilwaco, and 43% of the catch occurred in waters adjacent to Washington.

Department staff collected and processed 58 biological samples of 25 sardines each (1,450 sardines total). Otoliths were extracted which measured about 1.5-3 mm in length; these otoliths were sent to the California Department of Fish and Game (CDFG) Laboratory in La Jolla for age-reading. Data sheets accompanied the otoliths which included the catch date, vessel name, standard lengths of the sardines, individual weights, sex, and maturity. Fifty percent of the samples analyzed were males, with most of them having a sexual maturity of 2 (maturing virgins or recovering spent). Standard lengths of sardine samples were taken and ranged between 116 mm and 250 mm. In general, the average lengths of the samples decreased slightly over time. Average length overall was 211 mm. Individual weights of sardine samples (n=50) were also taken and the average weight was 152 g.

The Department is in the process of working with industry members to develop options for a limited entry fishery. The Washington Fish and Wildlife Commission is expected to consider these options in early 2002.

Brian Culver, Coastal Marine Fish Policy Coordinator
Washington Department of Fish and Wildlife

Washington Department of FISH and WILDLIFE

Summary Report of the 2001 Trial Purse Seine Fishery for Pacific Sardine (*Sardinops sagax*)

Washington Department of Fish and Wildlife
Intergovernmental Policy
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WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
SUMMARY REPORT OF THE 2001 TRIAL PURSE SEINE FISHERY
FOR PACIFIC SARDINE (*Sardinops sagax*)

Background

In Washington, sardines are managed under the Emerging Commercial Fishery provisions as a trial commercial fishery. A trial commercial fishery allows the harvest of a newly classified species, or harvest of a previously classified species in a new area or by new means (WAC 220-88-010). In February 2001, in response to a request from Washington-based fishers and processors, the Washington Fish and Wildlife Commission approved a trial ocean purse seine sardine fishery for 2001.

The target of the trial fishery was sardines; however, anchovy, mackerel, and squid could also be landed. These coastal pelagic species (CPS) are managed by the Secretary of Commerce through the Pacific Fishery Management Council (PFMC) under a federal fishery management plan (FMP). By definition, a Washington trial commercial fishery cannot limit participation, and under current law, an experimental fishery (which allows participation to be limited) cannot be established for any fishery under the jurisdiction of the Secretary of Commerce (i.e., a federally managed fishery) (WAC 220-88-020).

Current limited entry provisions and direct harvest controls have been developed in the FMP for waters south of 39° N latitude which encompasses most of the distribution of the CPS stocks and fisheries. This leaves specific management measures north of 39° N latitude (Oregon and Washington) up to the state management agencies, as long as those management measures conform to the overall guidelines of the FMP. PFMC develops and adopts separate annual harvest guidelines for the two areas which take into account the biological and ecological impacts of harvesting forage fish. State fishery management measures must be developed to ensure that the harvest guidelines are not exceeded.

Goals and Objectives

The goals for this trial fishery were to provide fishing opportunity consistent with the Pacific Fishery Management Council's CPS FMP and Washington Department of Fish and Wildlife (WDFW) policy, collect information on sardines off Washington to improve the coastwide stock assessment, and document the extent of bycatch occurring in the fishery.
Objectives include:

- Collect length, weight, age, sex, and maturity data from the catch landed into Washington.
- Document bycatch, in terms of species, amount, and condition. Recommend management measures to reduce bycatch, as necessary.
- Document harvest methods, distribution of harvest, and catch per unit of effort.

Fishery Regulations

The trial fishery began on May 15 and continued through October 31, 2001. The fishery was managed to a harvest guideline of 15,000 mt. Purse seine fishers were regulated by a set of permit conditions (see Appendix A).

Fishery Description

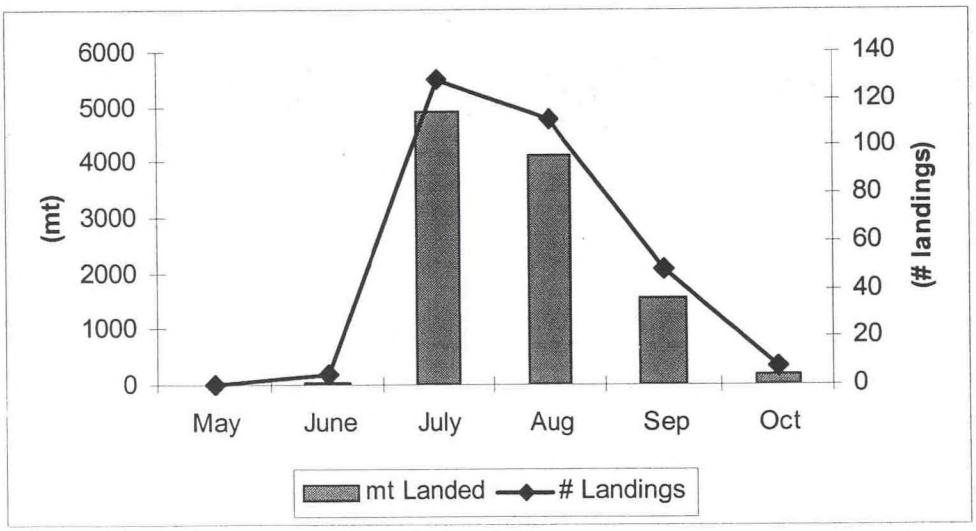
The fishery opened on May 15, 2001; however, the first landing into Washington occurred on June 19. The Department issued a total of 40 permits and 13 permit holders participated in the fishery.

A total of 10,837 mt of sardines were landed into Washington which left 4,163 mt remaining in the Washington harvest guideline. A total of 299 landings were made and 128 occurred within the month of July. The majority of the landings (79%) were made into Ilwaco, and 43% of the catch occurred in waters adjacent to Washington. A comparison between the 2000 and 2001 seasons is contained in Table 1.

Table 1. Catch comparisons between 2000 and 2001 trial sardine fisheries.

	2000	**2001**
Sardine Harvest	4,791.4 mt	10,837 mt
# of Landings	153	299
# Vessels Participating	3 (88%)	13

Figure 1. Number and amount of sardine landings by month.



Observer Coverage/Logbooks

The purpose of requiring observer coverage is to document total catch and bycatch in the purse seine fishery. Bycatch has been recorded in terms of species, amount, and condition; observers noted whether the fish were released or landed, and whether the fish were alive, dead, or in poor condition. The Department was aiming for 30% coverage and averaged about 24% overall.

All of the vessels participating in the fishery chose to utilize Department observers, rather than contract with private observer companies. A "sardine hotline" was established for fishers to notify the Department of their planned fishing activities so observer coverage could be scheduled accordingly. Observers were in daily contact with the vessels to schedule onboard trips directly.

Fishers were cooperative in allowing observers on board and in scheduling departure times and locations. In general, logbooks were completed and submitted as requested.

Bycatch

Based on observer data, the bycatch of non-targeted species was fairly low. Bycatch included chinook and coho salmon, spiny dogfish, blue shark, and other species. Salmon and shark were the primary bycatch species of concern. Salmon and shark species accounted for 1.8% of the overall bycatch, and there were 23 observed chinook mortalities.

The preliminary expanded total bycatch of these species (in numbers of individuals) for the fishery, based on observer data, is contained in Table 2.

Table 2. Preliminary expanded observed bycatch data (in numbers of individuals) for the 2001 trial fishery and comparison to the 2000 trial fishery.

	Chinook (live)	Chinook (dead)	Coho (live)	Coho (dead)	Unident. salmon (live)	Shark (live)	Shark (dead)
2001	449	170	571	504	80	150	50
2000	38	3	276	116	7	169	31

Biological Samples

Department staff have collected and processed 58 biological samples of 25 sardines each (1,450 sardines total). Otoliths were extracted which measured about 1.5-3 mm in length; these otoliths were sent to the California Department of Fish and Game (CDFG) laboratory in La Jolla for age-reading.

Data sheets accompanied the otoliths which included the catch date, vessel name, standard lengths of the sardines, individual weights, sex, and maturity.

Sex and maturity were determined by using the CDFG Standard Maturity Guide for Wetfish which was based on Hjort, J. (1914) State of Sexual Organs. Sexual maturity codes 1-4 were used for the sardine samples:

Code	Description
(1)	Virgin individuals.
(2)	Maturing virgins or recovering spent.
(3)	Sexual organs becoming swollen.
(4)	Ovaries and testis nearly filling 2/3 of ventral cavity.

Fifty percent of the samples analyzed were males, with most of them having a sexual maturity of 1 or 2. The highest subcategory overall were females with a sexual maturity of 2. There were two males and two females with a sexual maturity of 4.

Standard lengths of sardine samples were taken and ranged between 116 mm and 250 mm. In general, the average lengths of the samples decreased slightly over time. Average length overall was 211 mm. Individual weights of sardine samples (n=50) were also taken and the average weight was 152 g.

Summary of WDFW Activities

Coastal Marine Fish staff developed the processes to implement the trial fishery and administered the observer program, notification process, port sampling, data recording, and biological analyses. Two additional full-time observers were hired and existing staff were utilized to augment our observer program and conduct dockside sampling. The observers worked onboard commercial fishing trips to document bycatch, determine catch composition, and collect market samples.

Samplers monitored unloading at processing plants for incidental catch data, weighed sub-samples of the sardine catch, and collected logbooks to determine harvest distribution, CPUE, and unobserved bycatch information. Additional staff time was spent extracting otoliths, measuring, weighing, and determining sex and maturity of samples, and summarizing observer and logbook information.

2001 TRIAL PURSE SEINE FISHERY FOR PACIFIC SARDINES
DEPARTMENT STAFF RECOMMENDED PERMIT CONDITIONS

As adopted by the Fish and Wildlife Commission on February 9, 2001

Permits

- Participants are required to have an Emerging Commercial Fisheries License ($185 for residents; $295 for non-residents) and a trial commercial fishery permit issued by the Director.

- Permits are non-transferable and must be carried on the fishing vessel during harvest and sale of catch.

- The permit is subject to revocation by the Director for failure to abide by the conditions of the permit, violation of other fishing regulations, or other valid reason.

- Permits will not be issued to (and may be revoked from) those who: 1) have an outstanding balance of fees owed to the Department for greater than 30 days; or 2) did not comply with the permit conditions of the previous years' fisheries. This decision will be at the discretion of the Director and may be waived if special circumstances warrant.

Season

- Permits would be valid during the time period of May 15, 2001 to October 31, 2001.

Harvest Guideline

- The fishery would be managed to a harvest guideline of 15,000 mt landed into Washington. If the fishery is projected to exceed the guideline, the Director may adjust the harvest guideline or close the fishery.

Observer Coverage

- WDFW retains the right to require certified observers to be on-board for the duration of any trip harvesting sardines and the Director has the discretion to recover costs for observer coverage.

- Options for observer coverage are:

1. Use a Department-provided observer - The Department will have observers available; fishers electing this option would need to reimburse the Department at a rate of $100 per landing (even if the trip was not observed) and payment must be received by the 10th day of each month for the previous month's landings; OR

2. Hire a NMFS-certified observer - Fishers may contract with an independent observer company to hire NMFS-certified observers; these observers would need to complete a training session with the Department prior to observing a trip. Fishers electing this option are required to have a minimum of 50% of their trips observed and their first fishing trip observed.

- Fishers must notify the Department which option they are electing for observer coverage at least 48 hours prior to their first fishing trip of the season; this option cannot be changed during the season without approval by the Director.

Notification

- Each fisher participating in the trial fishery must contact the Department's fishing hotline during official business hours (Monday-Friday; 8:00 a.m.-5:00 p.m.) at least 48 hours prior to departing for their first fishing trip, and at least 24 hours prior to departing for their subsequent fishing trips. On the message hotline, fishers are required to provide the following information:
- Name
  - Phone number to contact fisher
  - Time and location of departure
  - Estimated time of return

NOTE: This notification requirement may be waived if other arrangements are made with individual fishers and/or processors.

Data Collection

- Participants must identify the vessel to be used in the fishery and agree to carry WDFW employees on board the fishing vessel whenever fishing under the permit. Agency employees will be granted full access to the catch and be allowed to gather biological data as needed. Up to 500 sardine per day may be retained by WDFW for biological information.

- Logbooks are required and will be provided by WDFW. Logbooks must be returned to WDFW by November 15, 2001.

Gear

- The trial fishery is open to purse seine gear only, and gear specifications will be detailed to ensure that the net meets a purse seine definition.

- Legal purse seine gear must be onboard the vessel making the landing.

Species

- Participants may retain and sell sardine and incidental catches of mackerel, squid, and anchovy. All other species must be released immediately and care taken to minimize damage to prohibited species.

- No salmon may be landed on the boat's deck but must be released or dip netted directly from the net before the completion of each set.

- Consistent with standards in the offshore whiting fishery, a mortality greater than 1 chinook per 20 mt of Pacific sardine would be sufficient to rescind a permit or close the trial commercial fishery.

Fishing Area

- The fishery would be restricted from the area inside 3 miles to minimize bycatch, conserve forage fish, and reduce conflicts with the existing baitfish fishery.

Landings

- All landings made under the authority of this permit into Washington must comply with existing state and federal regulations and requirements including observers.

- The transfer of catch from one vessel to another vessel is prohibited.

"DIAGNOSTICO DE LA PESQUERIA DE PELAGICOS MENORES DE LA COSTA OCCIDENTAL DE B.C. DURANTE LA TEMPORADA DEL 2000"

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RESUMEN

Se presenta el diagnostico de la pesquería de pelágicos menores para la costa occidental de Baja California, a partir de la temporada del 2000, la cual esta constituida principalmente por sardina monterrey (*Sardinops caeruleus*), macarela (*Scomber japonicus*) y anchoveta (*Engraulis mordax*). Para este diagnostico se utilizó información que se ha generado de 1989 al 2000. A partir de la cual se determinó que todas las especies que conforman esta pesquería registraron una caída en las capturas respecto a las temporada anterior. De la estructura de las capturas por especies durante el 2000, la sardina monterrey aportó el 85.4 %, la macarela el 12.0 %, en tanto que la anchoveta solo aportó el 2.6 % del total, se señala además que el esfuerzo de pesca y la flota comercial disminuyeron de manera paralela a las capturas.

Las fluctuaciones interanuales e intra anuales de las existencias de pelágicos menores en la costa occidental de Baja California, establecidas a partir del seguimiento de las captura comercial, constituyen un indicador de los efectos que provoca la variabilidad ambiental sobre la distribución, abundancia y disponibilidad de estos recursos en la costa occidental de Baja California.

Del análisis de la información, se estimaron los parámetros referentes a la tasa de explotación (E), mortalidad total (Z), por pesca (F) y natural (M), siendo para la sardina monterrey de E0.5 = 0.402, Z= 2.48, F= 1.93 y M= 0.55 y para macarela E0.5 = 0.412, Z = 3.32, F = 0.61 y M = 0.61. Sobre la base de esto se estima una captura máxima sostenible para sardina monterrey de 61,000.0 t y para macarela una captura máxima sostenible de 14,000.0 t. Así mismo se recomienda que las tallas de captura para sardina monterrey no sean menores a 16.5 cm de LP, y para macarela de 25.5 cm de LP, lo que de acuerdo a este análisis permitirá un manejo sano de las existencias.

SUMMARY

A diagnosis of the of small pelagic fisheries, along the west cost of Baja California, Mexico is presented. These include pacific sardine (*Sardinops caeruleus*), pacific mackerel (*Scomber japonicus*) and northern anchovy (*Engraulis mordax*) for the 2000 fishing season. It is observed a decrement in catches during that fishing season, which as basically supported by the pacific sardine and pacific mackerel, while those of northern anchovy were drastically reduced. It's also reported that the fishing effort as well as the fishing fleet decreased in a parallel fashion to the catch during this fishing period.

The observed inter and intra annual fluctuation of the populations, are indicators of the environmental impact on the population distribution, abundance and availability of the oceanographic event which affect the abundance of those off the west coast of Baja California.

From the information, we estimated the exploitation rate (E), total mortality (Z), fishing mortality (F) and the natural one (M), being for pacific sardine: E0.5 = 0.402, Z = 2.48, F = 1.60 and M = 0.55, the corresponding parameters estimates for pacific mackerel were as follows E0.5 = 0.412, Z = 3.32, F = 2.71 and M = 0.61. Based on this, we estimate a MSY for pacific sardine of 61,000 MT and 14,000 MT for pacific mackerel. Also we recommend a minimum catch size for pacific sardine of 16.5 cm of SL, and for pacific mackerel 25.5 cm of SL, we consider these a better management scenario for the existing stocks.

INTRODUCCION

Durante la temporada de pesca del 2000 se registró nuevamente una disminución en las capturas de pelágicos menores en la costa occidental de Baja California, lo cual no concuerda con las estimaciones establecidas por investigadores estadounidenses para las existencias del sur de California durante el año 2000, que reportan un crecimiento explosivo particularmente de sardina monterrey en el sur de California (Hill, 2000). En este contexto si consideramos que los movimientos de expansión y repliegue de las poblaciones están determinado por procesos de calentamiento - enfriamiento que se da en el medio ambiente en forma cíclica en periodo que van desde los intra anuales, ínter anuales y de mayor plazo, en el proceso de enfriamiento registrado durante el 2000 denominado como "La Niña" aparentemente no provocó un corrimiento o repliegue de las existencias de sardina monterrey hacia el sur (Baja California), por lo que no obstante contrario a lo esperado y considerando que las capturas de pelágicos menores en condiciones "normales" están conformadas por una porción de mas del 90 % de las existencias de Bahía San Sebastián Vizcaino y de menos al 10 % de las existencias del sur de California, durante años fríos como el 2000, las capturas de sardina monterrey registraron una disminución significativa (del 17.9 %) la cual estuvo constituida por 85.4 % por sardina monterrey (*Sardinops caeruleus*), el 12.0 % por macarela (*Scomber japonicus*) y solo el 2.6 % por anchoveta (*Engraulis mordax*), respectivamente durante esta temporada.

Así mismo, de manera paralela a la caída en las capturas de pelágicos menores en la costa occidental de Baja California y como consecuencia de esto, se registró (al igual que el año antepasado) una disminución en él numero de embarcaciones en operación en un 29.4 % y del esfuerzo en un 22.3 % respectivamente.

En cuanto al registro de variaciones mensuales de las tallas máxima, mínima y promedio de sardina monterrey y macarela durante la temporada del 2000 presentan una tendencia a incrementarse lo que constituyen un indicador de condiciones ambientales favorables enfatizando que durante los años en que se han registrado incrementos en las tallas promedio de los individuos, esto coincide con una mayor acumulación de grasa que se refleja en desoves y reclutamientos exitosos, por el contrario, cuando se registran disminuciones en las tallas, de manera paralela se registra una disminución en la acumulación de grasa de los individuos, que se manifiesta en fallas en el desove y en el reclutamiento, además de una interrupción y en algunos casos reducción drástica de la biomasa, esto se ha observado particularmente en la pesquería de sardina monterrey, lo cual se asocia a la disponibilidad, abundancia y calidad del alimento.

En cuanto al uso de las capturas en procesos de transformación, se determinó que el 64.7 % de las descargas, se orientaron hacia la industria empacadora en la elaboración de productos que se destinaron para el consumo humano directo en diferentes presentaciones y al fresco congelado, en tanto que el 35.4 % restante, se utilizó en la industria reductora para la elaboración de harina y aceite de pescado.

METODOLOGIA

La información utilizada, comprende las temporadas de pesca 1989 al 2000, particularmente de esta última. Para el análisis, se utilizó el paquete denominado FISAT (FAO Stock Assessment Tool), que funciona a partir de la frecuencia de tallas, en el se compilan los programas que fueron desarrollados por D. Pauly, (1990) y Gallanilo, et. al (1988). Este paquete se utilizó para evaluar las poblaciones de sardina monterrey y macarela, estimando los parámetros de crecimiento mediante la aplicación del modelo de Von Bertalanfy, con estimadores de máxima

verosimilitud. De la curva de captura se derivaron los valores de mortalidad total (Z), mortalidad natural (M) y se estimó la tasa de mortalidad por pesca (F). En cuanto a la estimación del rendimiento por recluta, se aplicó el modelo de Beverton y Holdt derivado de la frecuencia de tallas.

A partir del Análisis de Población Virtual (APV) contenido en el paquete, se estimó la abundancia histórica de las cohortes y la tasa de mortalidad por pesca de manera independiente de los cambios en el esfuerzo, finalmente tomando como base el modelo de Thompson y Bell, se efectúo una simulación para las dos pesquerías (sardina y macarela) utilizando diferentes tasas de mortalidad por pesca y de esfuerzo, lo que permitió generar varios niveles de rendimiento por recluta (Y/R) y de biomasa por recluta (B/R).

RESULTADOS

Las capturas comerciales registradas en Ensenada, B.C. durante la temporada del 2000 fueron de 59,916.8 t, de las cuales el 85.4 % (51,172.8 t) correspondió a sardina monterrey (*Sardinops caeruleus*), el 12.0 % (7,181.8 t) a macarela (*Scomber japonicus*) y el 2.6 % (1,562.1 t) a anchoveta (*Engraulis mordax*) respectivamente (Cuadro 1).

Cuadro 1.- Relación de capturas comerciales registradas durante el periodo de enero a diciembre del 2000, en la costa occidental de Baja California.

Mes/Sp	sardina	macarela	anch.	charrito	bonita	Total/Mes	Capt. Ac.	Barcos	Viajes
En.	5,002.5	0.0	34.0	0.0	0.0	5,036.5	5,036.5	10	108
Feb.	5,454.8	95.0	0.0	0.0	0.0	5,549.8	10,586.3	13	116
Mar.	4,498.1	52.2	323.7	0.0	0.0	4,874.0	15,460.3	11	104
Ab.	4,221.7	0.0	186.8	0.0	0.0	4,408.5	19,868.8	12	82
May.	3,636.7	779.9	693.0	0.0	0.0	5,109.6	24,978.4	12	97
Jun.	2,985.7	1,596.9	223.1	0.0	0.0	4,805.7	29,784.1	14	100
Jul.	4,051.4	722.6	101.5	0.0	0.0	4,875.5	34,659.6	15	104
Ag.	2,780.3	657.3	0.0	0.0	0.0	3,437.6	38,097.2	8	59
Sept.	5,663.2	1,381.8	0.0	0.0	0.0	7,045.0	45,142.2	12	99
Oct.	3,693.5	744.5	0.0	0.0	0.0	4,438.0	49,580.2	11	79
ov.	5,005.2	844.4	0.0	0.0	0.0	5,849.6	55,429.8	13	108
Dic.	4,179.8	307.2	0.0	0.0	0.0	4,487.0	59,916.8	12	88
Total	51,172.9	7,181.8	1,562.1	0.0	0.0	59,916.8			1,144

Al comparar las capturas registradas en las dos últimas temporadas, se estableció que en el 2000 las capturas cayeron en un 17.9 % respecto a la temporada de 1999, (variando de 73,023.7 t en 1999 a 59,916.8 t en el 2000). Respecto a las especies dominantes registradas en cada temporada, se señala que en la del 2000, la sardina monterrey se mantuvo como la especie dominante ya que la macarela y la anchoveta contribuyeron con solo el 12.0 % y el 2.6 % respectivamente, en tanto que la sardina monterrey aporto el 85.4 % del total capturado. (García et al, 2000).

Con respecto al volumen de captura que registraron las principales especies para las últimas dos temporadas, se destaca que las de sardina disminuyó en un 12.6 % (pasando de 58,568.4 t en 1999 t a 51,172.9 t en el 2000), así mismo, para la macarela se documentó una caída del 29.4 % (pasando de 10,167.7 t en 1999 a 7,181.8 t en el 2000) respectivamente (Figura 1).

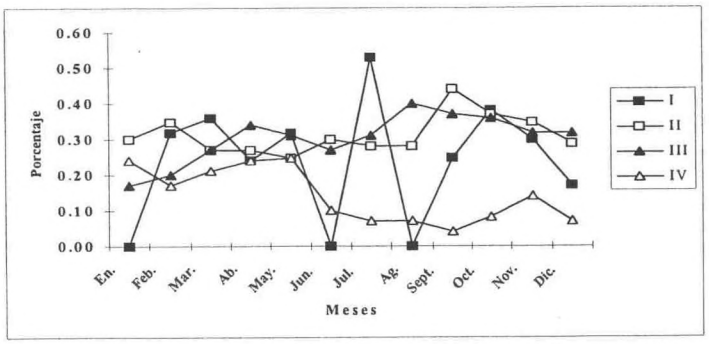


Figura 1.- Relación de capturas registradas de enero a diciembre de las tres principales especies durante las temporadas de 1999 y 2000 en la costa occidental de B.C.

En cuanto a las capturas de pelágicos menores documentadas en los últimos 23 años, nos muestran una gran variabilidad interanual, además de un proceso claro de sustitución de especies, que se observa a partir de 1983, destacando que de 1982 a la fecha, las capturas de anchoveta registran una clara tendencia a la disminución que alcanza el volumen más bajos de sus capturas durante la temporada de 1990, manteniéndose en este nivel hasta la fecha. En el caso de la sardina se registra su presencia con una clara tendencia a crecer y a partir de la temporada de 1990, se constituyen como la especie dominante de esta pesquería lo cual se ha sostenido hasta la actualidad, en tanto que la macarela presenta una gran variabilidad con crecimientos explosivos (1990 y 1998) y declinaciones marcadas que se registran en forma cíclica (García et al, 1999).

Se señala además, que desde mediados de los 70's, se presenta un proceso evidente de calentamiento que ha afectado negativamente a la población de anchoveta y ha favorecido el crecimiento de la sardina monterrey y la macarela, esto se ha mantenido hasta la fecha con algunas fluctuaciones que se ha reflejado en variaciones importantes de la captura de las especies que conforman la pesquería de pelágicos menores (García, et al 1998) (Figura 2 y Cuadro 2).

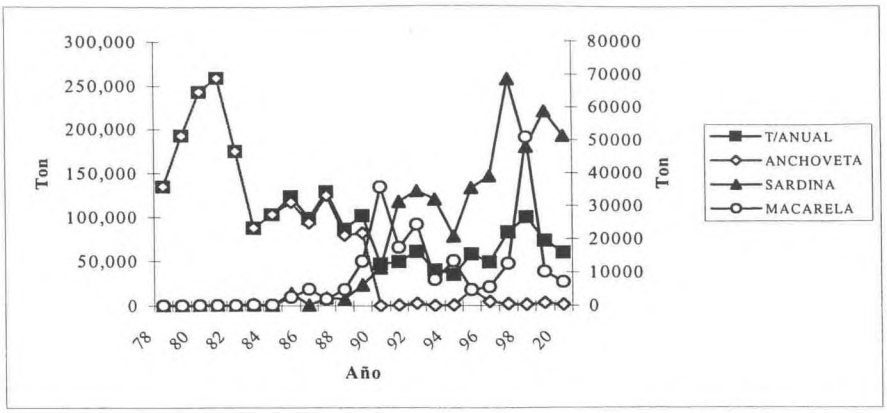


Figura 2.- Relación de capturas anuales de pelágicos menores de 1978 al 2000 en la costa occidental de B.C.

Cuadro 2.- Capturas anuales de pelágicos menores documentadas en los últimos 23 años en la costa occidental de B.C.

AÑOS	T/ANUAL	ANCHOVETA	SARDINA	MACARELA	No BARCOS
78	135,036	135,036	0	0	60
79	192,476	192,476	0	0	51
80	242,907	242,907	0	0	46
81	258,745	258,745	0	0	58
82	174,634	174,634	0	0	50
83	87,838	87,429	274	135	40
84	103,059	102,931	0	128	41
85	123,496	117,192	3,722	2,582	38
86	98,673	93,547	243	4,883	27
87	128,996	124,482	2,432	2,082	21
88	86,414	79,495	2,035	4,884	38
89	101,421	81,810	6,224	13,387	37
90	47,241	99	11,375	35,767	19
91	49,672	831	31,391	17,450	18
92	61,237	2,324	34,568	24,345	17
93	40,070	284	32,045	7,741	17
94	35,071	875	20,877	13,319	14
95	57,996	17,772	35,396	4,821	7
96	48,884	4,168	39,064	5,603	7
97	82,828	1,823	68,439	12,477	14
98	100,016	972	47,812	50,726	19
99	73,024	3482	58,569	10,168	10
00	59,917	1,562	51,172	7,182	12

La variabilidad en disponibilidad y abundancia de las poblaciones de pelágicos menores en la costa occidental de Baja California, está asociada a las variaciones de disponibilidad y abundancia que se registran en otras regiones en el mundo, esta asociación se da a través de teleconecciones que mantienen un flujo de energía, en las que las poblaciones fluctúan en forma cuasi sincrónicas, debido precisamente a las

conexiones entre estas regiones oceánicas, que además en general, corresponden a las de más alta productividad en el mundo (Antezana, 1994).

DISTRIBUCION DE LAS CAPTURAS

En relación con la distribución de las capturas en la zona de pesca comercial de la costa occidental de Baja California durante la temporada del 2000, se estableció que el 76.6 % se obtuvieron en el área II, que se localiza frente a Ensenada y que abarca de Pta. Salsipuedes a Pta. Santo Tomas, el 19.7 % en el área I, que comprende desde la frontera con los EUA a Pta. Salsipuedes, el 3.6 % en el área III ubicada entre Pta. Santo Tomas a Pta. Colonet y el 0.1 % en las áreas IV que abarca desde Pta. Colonet a Is. San Martín (Figura 3 y Cuadro 3).

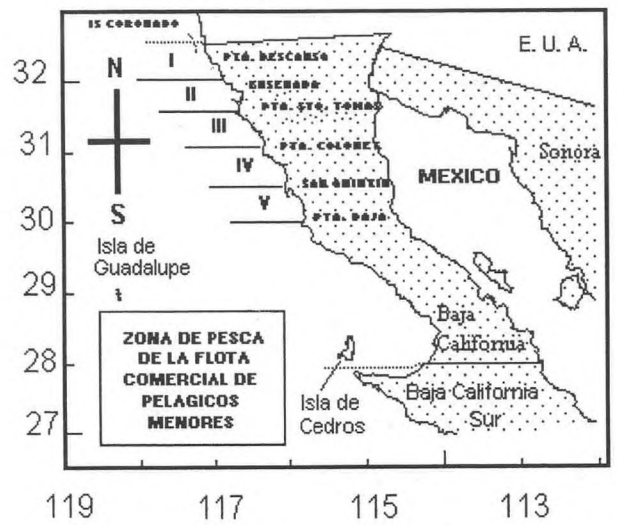


Figura 3.- Zona de pesca de la flota de pelágicos menores en la costa occidental de Baja California.

Cuadro 3.- Distribución de las capturas comerciales registradas por áreas durante la temporada del 2000 en la costa occidental de B.C.

MES/Area	I	II	III	IV	V	Total/Mes
En.	0.9	6.3	0.2	0.0	0.0	7.4
Feb.	1.0	7.5	0.8	0.0	0.0	9.3
Mar.	2.5	5.1	0.6	0.0	0.0	8.2
Ab.	0.9	5.8	0.6	0.1	0.0	7.4
May.	2.4	6.0	0.7	0.0	0.0	9.1
Jun.	1.9	6.1	0.1	0.0	0.0	8.1
Jul.	1.0	6.8	0.4	0.0	0.0	8.2
Ag.	1.3	4.2	0.2	0.0	0.0	5.8
Sept.	2.4	9.4	0.0	0.0	0.0	11.8
Oct.	2.0	5.4	0.0	0.0	0.0	7.4
Nov.	1.1	8.7	0.0	0.0	0.0	9.8
Dic.	2.2	5.3	0.0	0.0	0.0	7.5
Total/Area	19.7	76.6	3.6	0.1	0.0	100.0

ESFUERZO

En cuanto al esfuerzo aplicado en la pesquería de pelágicos menores en la costa occidental de Baja California durante el año 2000, se señala que se registró una disminución del 22.3 % respecto a la temporada pasada, ya que variaron de 1,473 viajes con captura en 1999 a 1,144 en el 2000.

Respecto a la distribución del esfuerzo en la zona de pesca, se estableció que el 76.9 % de los viajes con captura, se efectuaron en el área II, el 18.8 % en el área I, el 4.1 % en la III y el 0.1 % restante en la IV respectivamente (Cuadro 4).

Cuadro 4.- Distribución del esfuerzo pesquero efectuado por la flota comercial en la costa occidental de B.C. durante el 2000.

Mes/A.	I	II	III	IV	V	T./Mes
En.	0.4	6.0	1.1	0.0	0.0	7.4
Feb.	1.2	8.5	0.8	0.0	0.0	10.5
Mar.	3.1	5.6	0.7	0.0	0.0	9.4
Ab.	1.0	5.7	0.6	0.1	0.0	7.4
May.	1.5	6.0	0.4	0.0	0.0	7.9
Jun.	1.9	7.0	0.1	0.0	0.0	9.0
Jul.	1.4	7.7	0.3	0.0	0.0	9.4
Ag.	1.4	3.7	0.2	0.0	0.0	5.3
Sept.	1.7	7.2	0.0	0.0	0.0	8.9
Oct.	2.2	5.0	0.0	0.0	0.0	7.1
Nov.	1.1	8.7	0.0	0.0	0.0	9.7
Dic.	2.0	6.0	0.0	0.0	0.0	7.9
Tot/Mes	18.8	76.9	4.1	0.1	0.0	100.0

FLOTA

La flota comercial que participó en los procesos de captura durante la temporada de 2000, registra una disminución del 29.4 % respecto a la temporada anterior, (de 17 embarcaciones en 1999 a 12 en el 2000). De las embarcaciones documentadas durante esta temporada, el 6.3 % correspondieron al grupo I, que incluye a las embarcaciones más pequeñas de hasta 75 t de capacidad de acarreo, que generalmente operan en áreas cercanas a la costa y al puerto de desembarco, el 50.3 % al grupo II, con capacidad entre 76 a 150 t, el 30.8 % al grupo III con capacidad entre 151 a 225 t. y el 12.6 % al grupo IV que incluye a las embarcaciones más grandes con capacidad entre 226 a 300 t. Las capturas obtenidas por cada uno de estos grupos en este año, fueron: del 1.7 % por el grupo I, el 35.8 % por el II, el 33.5 % por el III y el 29.0 % por el IV respectivamente.

TALLAS

De la distribución por tallas de las especies de pelágicos menores que conforman la pesquería en Baja California, establecida a partir de muestras provenientes de la captura comercial, se determinó tanto en sardina como en macarela que durante las temporadas de 1989 al 2000 se han registrado oscilaciones cíclicas de los intervalos máximos y mínimos de las tallas de los individuos muetreados, estableciendo que entre 1989 a 1992 las tallas promedio de sardina monterry, fueron superior a 20.0 cm de LP, de 1993 a 1994, se registran

individuos por abajo de los 17.0 cm de LP y entre 1995 y 1997 las tallas se incrementaron nuevamente a 21.0 cm de LP. Durante la temporada del 2000, se registró un ligero incremento, siendo talla promedio de 18.1 cm de LP, registrando además que solo el 26.5 % de las capturas estuvieron por debajo de los 16.5 cm de LP durante esta temporada del 2000 (Figura 4).

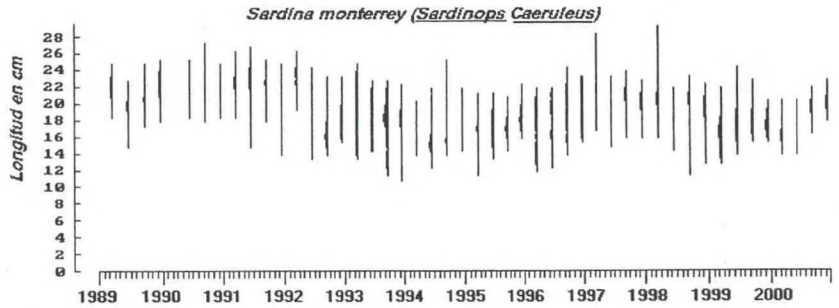


Figura 4.- Composición por tallas de sardina monterrey (S. caeruleus) en la costa occidental de B.C. de 1989 al 2000.

En el caso de la macarela, la talla promedio registrada en esta temporada, fue de 36.6 cm de LP, lo que constituye un incremento respecto a la temporada anterior (de 5.4 cm de LP).

Así mismo el 19.9 % de las capturas registraron tallas menores a 25.5 cm de LP, además se observa un patrón semejante al de la sardina respecto a la variabilidad en las tallas registradas de 1989 al 2000, en esta última las tallas al igual que en el caso de la sardina, registraron un ligero incremento de4.4 cm de 32.2 cm de LP en 1999 a 36.6 cm de LP en el 2000 LP (Figura 5).

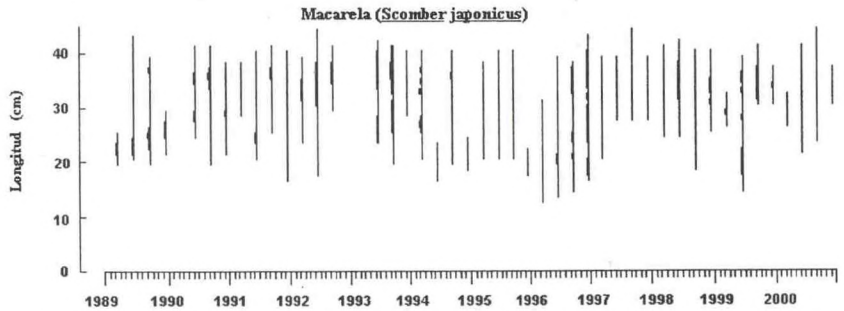


Figura 5.- Composición por tallas de macarela (S japonicus) determinada para la temporadas de 1989 al 2000, en la costa occidental de B. C.

CRECIMIENTO Y MORTALIDAD

Los parámetros de crecimiento (Lα, k y t.) estimados previamente para sardina, macarela y anchoveta a partir de la ecuación de crecimiento de Von Bertalanffy fueron los siguientes: para sardina Lα = 28.555, k = 0.690 y t. = -0.150, para macarela: Lα = 49.480, k = 0.281 y t. = -1.165 (García, 1995).

Los valores estimados a partir de la curva de captura para cada una de las especies que fueron analizadas respecto a la tasa de mortalidad total (Z anualizada), el coeficiente de mortalidad por pesca (F = Z - M) y la tasa de explotación (E = F/Z) cuyos valores presentan variaciones con respecto a los registrados la temporada anterior (Cuadro 5).

Cuadro 5.- Valores estimados de mortalidad natural (M), por pesca (F), total (Z) y de explotación (E0.5) para sardina, macarela y anchoveta en 1999.

SP/PARÁMETROS	M	F	Z	E0.5
SARDINA	0.55	1.93	2.48	0.402
MACARELA	0.61	2.71	3.32	0.412

Las tasas de explotación estimadas para cada pesquería fue la siguiente: En el caso de la sardina monterrey la tasa calculada fue de E0.5 = 0.402 y para la macarela fue de E0.5 = 0.412. Estos valores a pesar de ser altos, corresponden a estimaciones relativamente razonables que están dentro de un rango optimo de aprovechamiento.

Para el análisis del rendimiento en biomasa y por recluta, se utilizaron los parámetros de Lα, M/k y Lc, obtenidos a partir de las isopletas de rendimiento que genera el modelo, de las cuales se establecen diferentes tasas de rendimiento en función a la mortalidad por pesca, así como las tasas de explotación. A partir de esto, se determinó que para la pesquería de sardina monterrey es posible aumentar la tasa de explotación, manteniendo sin modificaciones la talla actual de extracción (Figura 6, Cuadro 6).

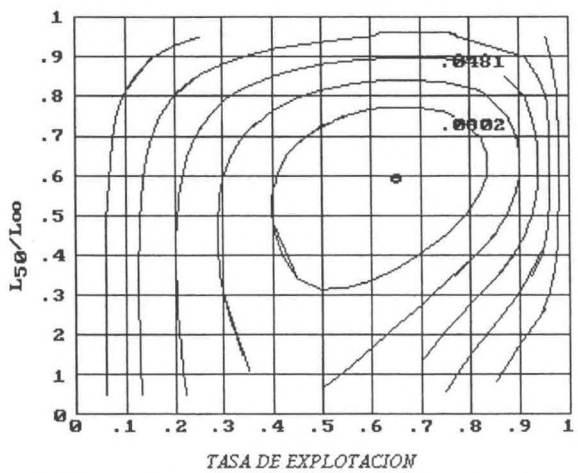


Figura 6.- Isopletas de rendimiento en equilibrio estimadas para sardina (S. caeruleus) en la costa occidental de B.C.

Cuadro 6.- Rendimiento por recluta para sardina (S. caeruleus) bajo condiciones optimas Lc =17.5, Lα = 28.555, Lc/Lα = 0.77, M/k =0.45, L50 = 18.912, E05 = 0.402, Emax = 0.862.

E	Y'/R	B'/R	E	Y'/R	B'/R
0.05	0.0208272	0942433	0.55	0.2001163	0.389940
0.10	0.0412961	0.885149	0.60	0.2132483	0.338578
0.15	0.0613668	0.828182	0.65	0.2249141	0.288427
0.20	0.0809934	0.771568	0.70	0.2348560	0.239712
0.25	0.1001228	0.715351	0.75	0.2427584	0.192716
0.30	0.1186933	0.659581	0.80	0.2482347	0.147798
0.35	0.1366325	0.604316	0.85	0.2508169	0.105413
0.40	0.1538553	0.549628	0.90	0.2499550	0.066143
0.45	0.1702609	0.495599	0.95	0.2450578	0.030717
0.50	0.1857292	0.442329	1.00	0.2356647	0.000000

En cuanto a la pesquería de macarela, la talla de explotación actual es de 36.6 cm de LP, se señala que esta talla es posible reducirla, (aunque no se recomienda) en tanto que la tasa de explotación fue menor a la calculada la temporada pasada de: E0.5 = 0.427, en 1999 a 0.412 en el 2000, la cual es conveniente mantener alrededor de este nivel, aún cuando es posible tolerar algunos incrementos sin que la población se vea afectada (Figura 7, Cuadro 7).

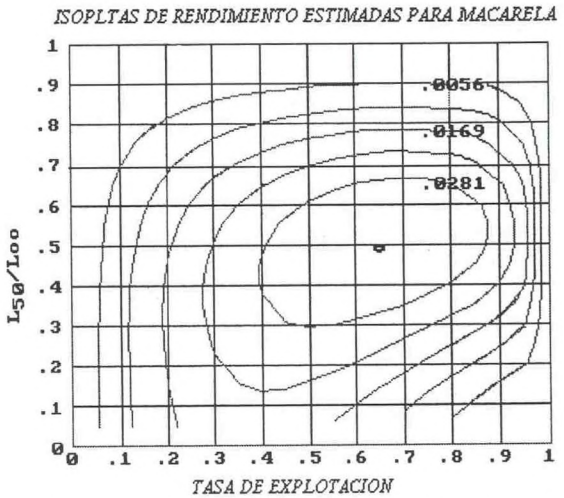


Figura 7.- Isopletas de rendimiento en equilibrio estimadas para macarela (S. japonicus) en la costa occidental de B. C.

Cuadro 7.- Rendimiento por recluta para macarela (S. japonicus) bajo condiciones optimas Lc = 34.58, E0.5 = 0.412, Lα 49.480, Lc/Lα = 0.73, M/k = 1.85, L50 = 36.6, E max = 1.000

E	Y'/R	B'/R	E	Y'/R	B'/R
0.05	0.0025056	0.938658	0.55	0.0236229	0.381084
0.10	0.0049489	0.878190	0.60	0.0252659	0.332106
0.15	0.0073270	0.818637	0.65	0.0268080	0.284614
0.20	0.0096370	0.760044	0.70	0.0282462	0.238683
0.25	0.0118758	0.702459	0.75	0.0295764	0.194385
0.30	0.0140401	0.645930	0.80	0.0307953	0.151797
0.35	0.0161266	0.590510	0.85	0.0318998	0.110994
0.40	0.0181319	0.536256	0.90	0.0328872	0.072048
0.45	0.0200522	0.483226	0.95	0.0337560	0.035030
0.50	0.0218838	0.431480	1.00	0.0345057	0.000000

Aplicando el modelo de Thompson y Bell, que utiliza los parámetros estimados a través del análisis de cohortes (APV), permitió generar pronósticos entre la relación Existencias - Rendimiento, que fueron estimadas para las tres pesquerías (sardina y macarela). Esto permite recomendar en relación a las tallas de captura y tasas de explotación óptima que puedan soportar la pesquería sin afectar su estabilidad.

Con base a este análisis y al resultado de la aplicación del modelo para la sardina monterrey (S. caeruleus), se recomienda que las tallas en las que se sustenten las capturas en la próxima temporada, no sea inferior a los 16.5 cm LP, además, se sugiere que se mantenga el esfuerzo actual sobre esta pesquería, lo que contribuirá a que no se afecte su ritmo de crecimiento. Se pronostica una captura estimada de 61,000 t (Figura 8).

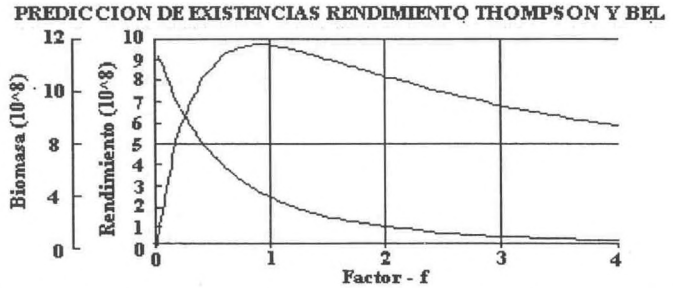


Figura 8.- Curva de existencias - Rendimiento estimadas a partir del modelo de Thompson y Bell para sardina monterrey (S. caeruleus)

En el caso de macarela, se recomienda mantener las tallas de explotación actual de 36.6 cm de LP, evitando la captura de individuos menores a 25.5 cm de LP. En cuanto al esfuerzo se recomienda reducirlo o al menos mantenerlo en el nivel actual. Se pronostica que estas medidas no afectaran la capacidad de reposición y contribuirá a estabilizar esta pesquería. Se estima una captura máxima sostenible para la macarela de 14,000 t (Figura 9).

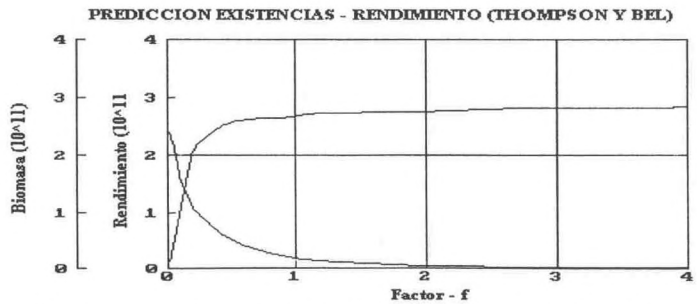
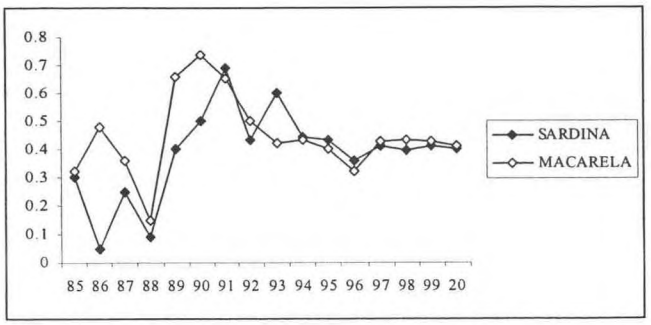


Figura 9.- Curva de existencias - Rendimiento estimada a parir del modelo de Thompson y Bell para macarela (S. japonicus).

Las tasas de explotación estimadas entre 1985 a 1996 de las pesquerías de sardina y macarela, nos muestran una gran inestabilidad interanual, se destaca que en ambos casos se registra un incremento substancial a partir de 1989, se observa un máximo en 1990 en el

caso de sardina monterrey, en tanto que para macarela, el máximo se observa en 1991, estableciendo que en los últimos siete años (temporadas 92 - 20) las tasas de explotación registran una tendencia clara a estabilizarse (Figura 10).

Figura 10.- Tasas de explotación registradas en las temporadas de 1985 a 2000. en la costa occidental de Baja California.



En cuanto al destino, es decir, al aprovechamiento de las capturas por la planta industrial durante la temporada del 2000, se estableció que el 64.7 % fueron destinadas a la industria empacadora para la elaboración de diferentes productos de consumo humano directo (enlatada en diferente presentaciones y fresca congelada), en tanto que el 35.3 % restante fue utilizado en la industria reductora para la elaboración de harina y aceite de pescado (Cuadro 8).

Cuadro 8 - Relación de capturas destinadas al uso industrial registradas durante la temporada de 2000.

MES/USO	EMPAQUE	HARINA	TOT./MES
En.	3,721.6	1,314.1	5,035.7
Feb.	3,221.9	2,327.9	5,549.8
Mar.	2,268.4	2,605.6	4,874.0
Ab.	2,479.4	1,929.1	4,408.5
May	2,277.3	2,832.3	5,109.6
Jun.	2,726.5	2,079.2	4,805.7
Jul.	3,380.3	1,495.3	4,875.6
Ag.	2,768.7	668.9	3,437.6
Sept.	4,484.2	2,560.9	7,045.1
Oc.	3,350.7	1,087.3	4,438.0
Nov.	4,124.5	1,725.1	5,849.6
Dic.	3,934.0	553.0	4,487.0
TOTAL	38,737.5	21,178.7	59,916.2

CONCLUSIONES

Durante la temporada del 2000, el número de unidades de pesca que participaron en operaciones de captura, diminuyo en un 29.4 % respecto a la temporada anterior, disminuyendo de manera paralela el esfuerzo (representado por el número de mareas o viajes vía la pesca), en un 22.3 % en el mismo período, lo cual se refleja en las capturas, que cayeron en un 17.9 %. Esta caída no es posible explicarla solo en función a la

disminución de las capturas de sardina, macarela y anchoveta, ni tampoco al comportamiento del clima ya que considerando que se registró un evento frío denominado como "La Niña" la expectativa fue de un corrimiento de las existencias del sur de los EUA que de acuerdo a las estimaciones de biomasa obtenida por investigadores norteamericanos las existencias de sardina en California EUA han registrado un incremento explosivo, lo cual no se refleja en un incremento en la biomasa y disponibilidad de sardina en las costas de Baja California de acuerdo a lo esperado.

El área II (localizada entre Pta. Salsipuedes a Pta. Santo Tomas), se mantuvo al igual que en las temporadas anteriores como la más importante con el 76.6 % de las capturas, en tanto que el otro 23.4 % proviene del resto de las áreas, de las cuales el 19.7 % fue capturado en el área I, localizada entre la frontera con los EUA y Pta. Salsipuedes, en el área III se capturó el 3.6 % y el 0.1 % en el área IV, señalando que corresponde a la mas distante al puerto de desembarco.

Del análisis por tallas de los individuos muestreados de las capturas comerciales, se destaca que las de sardina monterrey, estuvieron sustentadas en un 26.5 % en individuos menores a 16.5 cm de LP, con una talla promedio de 18.1 cm de LP. Para la macarela, el 19.9 % de las capturas registraron tallas menores a la mínima reglamentaria de 25.5 cm de LP, en tanto que el promedio fue de 36.6 cm de LP. De acuerdo a lo anterior, se recomienda evitar la captura de individuos jóvenes que no rebasen la talla mínima recomendable, que en el caso de sardina monterrey es de16.5 cm de LP y para macarela de 25.5 cm de LP, en tanto que para la anchoveta es de 10.0 cm de LP, lo que nos permitirá mantener un manejo sano de las existencias.

Los individuos de la población de sardina monterrey han presentado variaciones importantes tanto en las tallas promedio como en las máximas y mínimas, durante el periodo que abarca este análisis (1989 al 2000), que se ha manifestado en incrementos y decrementos en disponibilidad, accesibilidad y abundancia, como se observa entre los años de 1989 a 1992 durante el cual se registró un aumento paulatino de las tallas, que coincide con un periodo de crecimiento en abundancia de la población, de 1993 a 1994 (Barnes, 1996), las tallas promedio de sardina disminuyó, lo que coincide con una interrupción del proceso de crecimiento de la población y nuevamente de 1995 al 2000, se observa un incremento en las tallas, que coincide con un crecimiento de la biomasa de la población. Lo mismo se ha registrado en los casos de macarela y anchoveta. Estas variaciones en la condición biológica de los pelágicos menores, aparentemente esta asociado a factores ambientales, que pueden afectarla, como pueden ser; cambios en la temperatura, calidad y cantidad de alimento entre muchos otros factores.

En cuanto al uso de las capturas en procesos industriales, se señala que el 64.7 % de las descargas registradas durante el 2000 se destinaron a la industria empacadora para el consumo humano directo, a través de una gran diversidad de productos enlatados en diferentes presentaciones, hasta productos fresco congelados que se utiliza como carnada, en tanto que el 35.3 % restantes, se destinó a la producción de harina y aceite de pescado.

Otro de los aspectos importantes, es él referente a la pesquería de macarela y en menor proporción a la de anchoveta, que han registrado cambios mas marcados en los últimos años, particularmente durante las temporadas de 1989 - 1990, periodo en que se

documenta una caída de las capturas de anchoveta de casi el 100.0 % (de 81,810.0 t en 1989 a solo 100.0 t en 1990), manteniendo niveles de capturas muy bajos hasta la fecha. En el caso de la macarela se registra un crecimiento sostenido de 1983 a 1990 que se sostiene hasta 1995 y que cae bruscamente en 1996, creciendo nuevamente en 1997 y 1988 en esta ultima temporada se registran las mayores capturas de esta especie, sin embargo, durante 1999 y 2000 las capturas nuevamente registraron una caída que se ha acentuado en esta ultima temporada. Estos cambios están asociados a eventos ambientales; que se han denominado como "calentamiento de latitudes medias", "El Niño Oscilación del Sur" (ENOS) y "La Niña" Oscilación del Norte (LANON), entre otros, que han afectado drásticamente a estas pesquerias y ha contribuido a las variaciones que registran las existencias de estas poblaciones en cuanto a su distribución, abundancia y disponibilidad.

Por todo lo anterior, se recomienda aplicar medidas administrativas, tales como hacer respetar las tallas mínimas de captura y las capturas máximas recomendadas, que son resultado del análisis de la información obtenida de la pesquería, el aplicar estas medidas nos permite suponer un mejor aprovechamiento de estos recursos desde el punto de vista biológico y económico, esto ultimo para evitar el riesgo de una inversión excesiva que lleve a una sobre capitalización por sobre dimencionamiento de la flota y de la planta industrial.

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AVANCES DE TEMPORADA DEL 2001 DE LA PESQUERIA DE PELAGICOS MENORES DE LA COSTA OCCIDENTAL DE BAJA CALIFORNIA

Por

Walterio García Franco
Francisco Javier Sánchez Ruis

En este documento se presenta la información generada de la pesquería de pelágicos menores para la costa occidental de Baja California en los ocho meses que van de la temporada del 2001, particularmente respecto a la obtenida durante el mes de agosto, la cual ha sido recabada a través de tres fuentes, la primera de ellas mediante un sistema de bitácoras pesqueras que nos han permitido efectuar un seguimiento de las capturas, de los barcos y las áreas de extracción, además de datos ambientales que algunas embarcaciones nos proporcionan y que constituye una herramienta importante para entender el funcionamiento de este sistema, la segunda fuente la constituyen los reportes de producción de las plantas procesadoras, y la tercera las muestras biológicas tomadas al azar directamente de las bodegas de las embarcaciones que nos permite conocer la estructura por tallas y la condición biológica de los ejemplares capturados.

Con relación a las capturas registradas de enero a agosto de este año, se señala que estas han disminuido en un 56.8 % respecto al mimo periodo de la temporada anterior, estableciendo que esta disminución se debió a la caída en las capturas de todas las especies que conforman esta pesquería, siendo en el caso de sardina monterrey de un 57.1 %, para la macarela de un 39.7 % y para la anchoveta en un 95.2 %. De manera paralela, el esfuerzo pesquero registró una disminución de un 33.8 % respecto al mismo periodo del año anterior.

En cuanto a la estructura de las capturas por especie registradas durante los ocho meses que van de esta temporada, se estableció que estas se sustentaron en un 85.1 % en sardina monterrey, en un 14.3 % en la macarela y solo en un 0.5 % de las capturas en anchoveta.

En cuanto a la flota comercial que operó en la pesquería de pelágicos menores durante lo que va de esta temporada, se determinó que esta disminuyó en un 26.7 % respecto al mimo periodo del año anterior. En este contexto se establece que tanto la caída en las capturas como la reducción de la flota en operación se explica en función a que dos de las empresas más importantes en cuanto a volumen que procesan no han operado durante los últimos cuatro meses, además de que el resto de la planta industrial ha reducido significativa sus operaciones.

Respecto a las tallas de los individuos en las que se sustentaron las capturas, se estableció que el 30.6 % de los ejemplares de sardina monterrey registraron tallas inferiores a la mínima reglamentaria de 16.5 cm de LP, con un intervalo de tallas de 15.0 cm a 20.0 cm de LP y una talla

promedio de 17.4 cm de LP.

En el caso de la macarela el 30.3 % de los ejemplares maestreados presentaron tallas inferiores a la mínima reglamentaria de 25.5 cm de LP, registrando un rango de tallas de 10.9 cm de LP a 30.5 cm de LP, con una talla promedio de 26.9 cm de LP. En tanto que para la anchoveta no se Contó con muestras biológicas durante este mes.

Con respecto al uso industrial de las capturas durante esta temporada, se determinó que el 91.9 % han sido utilizadas por la industria conservera para la elaboración de diferentes productos para consumo humano directo en varias presentaciones de enlatado, así como para elaboración de fresco congelado, en tanto que el 8.1 % restante se destinó a la industria. reductora par la fabricación de harina y aceite de pescado

RESULTADOS

Capturas

Las capturas acumuladas de enero a agosto de este año, se señala que estas han sido de 16,450.0 t, de las cuales 14,001.4 t corresponden a sardina monterrey (Sardinops caeruleus), y constituyen el 85.1 % del total, de macarela (Scomber japonicus se han capturado 2,363.0 t que representan el 14.4 % y de anchoveta (Engraulis mordax solo se han capturado 75.8 t que constituye el 0.5 % de lo acumulado en los ocho meses que van de esta temporada (Cuadro 1).

Cuadro 1.- Relación de capturas mensuales por especie, No. de barcos y esfuerzo, registrados de enero a agosto del 2001 en la costa occidental de B.C.

Mes/Sp	sardina	mac	anch.	charrito	Jurel	Total/Mes	Capt. Ac.	Barcos	Viajes
En.	3,132.9	591.3	0.0	0.0	0.0	3,724.2	3,724.2	11	88
Feb.	902.0	262.8	0.0	0.0	0.0	1,164.8	4,889.0	9	34
Mar.	1,068.1	58.2	47.0	0.0	0.0	1,173.3	6,062.3	11	37
Ab.	837.2	6.1	0.0	0.0	0.0	843.3	6,905.6	7	31
May.	1,161.5	653.6	0.0	0.0	19.8	1,834.9	8,740.5	8	41
Jun.	2,205.7	300.4	0.0	0.0	0.0	2,506.1	11,246.6	11	76
Jul.	2,260.9	312.2	28.8	0.0	0.0	2,601.9	13,848.5	9	50
Ag.	2,433.1	168.4	0.0	0.0	0.0	2,601.5	16,450.0	10	45
Total	14,001.4	2,353.0	75.8	0.0	19.8	16,450.0		11	402

Comparando las capturas de pelágicos menores registradas en el período de enero a agosto de las últimas dos temporadas (2000 - 2001), se estableció que estas disminuyeron en un 56.8 %, señalando que todas las especies que conforman esta pesquería registraron bajas en las capturas en diferentes proporciones, que en el caso de la sardina monterrey la disminución fue del orden del 57.1 %, las de la macarela en un 39.7 % en tanto que las de la anchoveta las capturas documentadas presentan una diminución de un 95.2 %

respecto a las registradas en el mismo periodo de la temporada anterior (Figura 1).

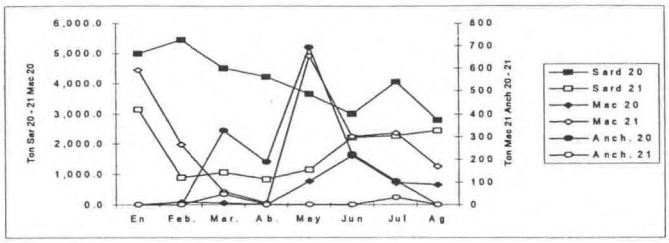

Figura 1.- Relación de capturas registradas de enero a agosto del 2000 y 2001 en la costa occidental de B.C.

Con relación a la distribución de las capturas en la zona de pesca durante el período de enero a agosto de esta temporada, se destaca que el área II, ubicada entre Pta. Salsipuedes y Pta. Santo Tomas, se ha mantenido como la más importante con el 62.1 % de las capturas, siguiendo en importancia el área I con el 33.4 %, el área III con el 2.5 %, la IV con el 0.4 % y la V con el 1.6 % (Figura 2, Cuadro 2).

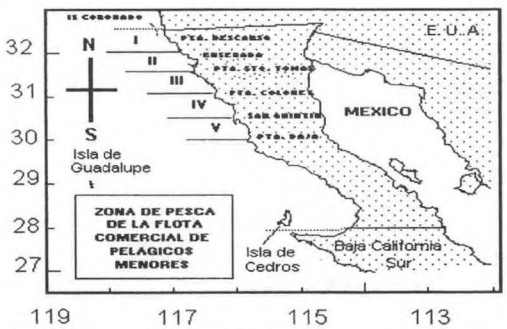

Figura 2.- Zona de pesca de la flota comercial de pelágicos menores en la costa occidental de B.C

Cuadro 2.- Distribución de las capturas registradas de enero a agosto del 2001 en la costa occidental de B.C.

MES/Area	I	II	III	IV	V	Total/Mes
En.	4.5	18.2	0.0	0.0	0.0	22.7
Feb.	1.4	5.0	0.0	0.0	0.7	7.1
Mar.	2.3	4.3	0.6	0.0	0.0	7.1
Ab.	1.8	3.4	0.0	0.0	0.0	5.1
May.	6.5	4.3	0.4	0.0	0.0	11.2
Jun.	6.2	8.8	0.3	0.0	0.0	15.3
Jul.	5.2	9.0	0.1	0.4	0.9	15.7
Ag.	5.5	9.2	1.1	0.0	0.0	15.8
Total/Area	33.4	62.1	2.5	0.4	1.6	100.0

Flota

La flota que ha participado en operaciones de captura durante esta temporada, disminuyó en un 26.7 % respecto al mismo periodo de la temporada anterior, pasando de 15 barcos registrados en el 2000 a solo 11 en la del 2001. Determinando que en esta ultima temporada el mayor numero de barcos se documento durante los meses de enero, marzo, junio y agosto del 2001 (Cuadro 3).

Cuadro 3.- Participación de los grupos de embarcaciones durante el período de enero a agosto del 2001.

Mes/Cat.	I	II	III	IV	% Total
En.	9.1	36.4	45.5	9.1	100.0
Feb.	0.0	33.3	55.6	11.1	100.0
Mar.	9.1	54.5	27.3	9.1	100.0
Ab.	0.0	42.9	42.9	14.3	100.0
May.	12.5	37.5	37.5	12.5	100.0
JUN.	6.1	40.9	41.7	11.2	100.0
JUL	11.1	55.6	22.2	11.1	100.0
Ag.	11.1	55.6	22.2	11.1	100.0
Barcos/Cat.	7.4	44.6	36.9	11.2	100.0

La capacidad de acarreo desplazada por la flota de enero a agosto de este año, ha sido de 68,700 t con un aprovechamiento del 23.9 % de esta capacidad, en tanto que durante el mes de agosto únicamente, se desplazó un total de 7,350 t, de las cuales se utilizó el 35.4 %. Al comparar la capacidad de acarreo desplazada por la flota durante el período de enero a agosto de este año respecto al mismo periodo del año anterior, se determino que disminuyó en un 53.2 % particular significativa esta disminución durante los primeros meses del 2001 (Cuadro 4).

Cuadro 4.- Relación mensual de capturas por grupo de embarcación de enero a agosto del 2001

Mes/Capt/Cat.	I	II	III	IV	Total/Mes
En.	0.1	8.7	13.4	0.5	22.8
Feb.	0.0	2.7	4.3	0.1	7.1
Mar.	0.1	5.1	1.7	0.2	7.1
Ab.	0.0	2.7	2.3	0.1	5.1
May.	0.9	4.8	4.7	0.7	11.2
Jun.	1.6	5.6	5.5	2.5	15.2
Jul.	1.6	12.2	1.2	0.7	15.6
Ag	0.7	13.1	1.3	0.7	15.8
Total/Area	5.0	55.0	34.6	5.4	100.0

La eficiencia con la que han venido operando los diferentes grupos de embarcaciones, que han conformado la flota de pelágicos menores en la costa

occidental de Baja California durante esta temporada, se han mantenido en niveles de entre 5 a 57 % de su capacidad desplazada, con variaciones para cada grupo o categoría, sin embargo las embarcaciones intermedias es decir los grupos II y III, con capacidad de acarreo entre 76 a 150 t y el de 156 a 225 t en tanto que el grupo de los mas grandes y mas pequeños (de hasta 75 ton y de 226 a 300 t de capacidad), han obtenido los mas bajos rendimientos, particularmente durante el mes de agosto (Figura 4).

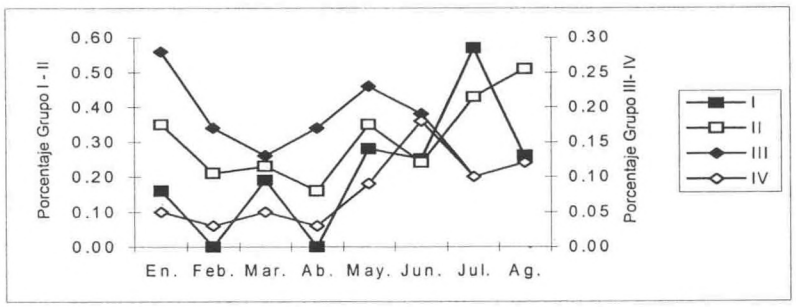

Figura 4- Eficiencia de la flota registrada durante el periodo de enero a agosto del 2001 en la costa occidental de Baja California

Esfuerzo

El esfuerzo nominal (No. de viajes con captura) efectuado durante esta temporada disminuyó en un 33.4 %, respecto al esfuerzo registrado en el mismo período de la temporada anterior, ya que estos pasaron de 607 viajes acumulados hasta el mes de agosto del 2000 a 402 viajes con captura para el mismo periodo del 2001. Con relación a la distribución del esfuerzo en la zona de pesca (o número de viajes con captura) efectuado durante esta temporada, se destaca que el 65.6 % de los viajes se han realizado en el área II, que abarca de Pta. Salsipuedes a Pta. Santo Tomás, en el área I que abarca de la frontera con los Estados Unidos a Pta. Salsipuedes, se registró el 30.9 % de las capturas, en tanto que el restante 3.4 % han sido documentados en las áreas III, IV y IV respectivamente (Cuadro 5).

Cuadro 5.- Distribución del esfuerzo pesquero de enero agosto del 2001 en la costa occidental de B.C.

Mes/A.	I	II	III	IV	V	T./Mes
En.	4.5	17.5	0.0	0.0	0.0	21.9
Feb.	1.7	6.0	0.0	0.0	0.5	8.2
Mar.	2.7	6.0	0.5	0.0	0.0	9.2
Ab.	3.2	4.5	0.0	0.0	0.0	7.7
May.	5.5	4.2	0.5	0.0	0.0	10.2
Jun.	6.5	11.7	0.7	0.0	0.0	19.0
Jul.	3.5	8.0	0.2	0.2	0.5	12.5
Ag.	3.2	7.7	0.2	0.0	0.0	11.2
Tot/Mes	30.9	65.6	2.2	0.2	1.0	100.0

Composición de las Capturas por Tallas

En lo que va de esta temporada se han efectuado un total de 41 muestreos de los 402 viajes registrados con captura, lo que representa una cobertura del 10.2

% de las descargas realizadas hasta la fecha.

Con relación a la estructura por tallas de los ejemplares de sardina monterrey muestreada durante los meses de enero a agosto, se determinó que el 30.6 % de estos presentaron tallas inferiores a la mínima reglamentaria de 16.5 cm de LP, así mismo se estableció que las tallas variaron entre 15.0 cm y 20.0 cm de LP con una talla promedio de 17.4 cm de LP, lo que representa una disminución de 1.4 cm respecto al mimo periodo de la temporada pasada (Figura 5).

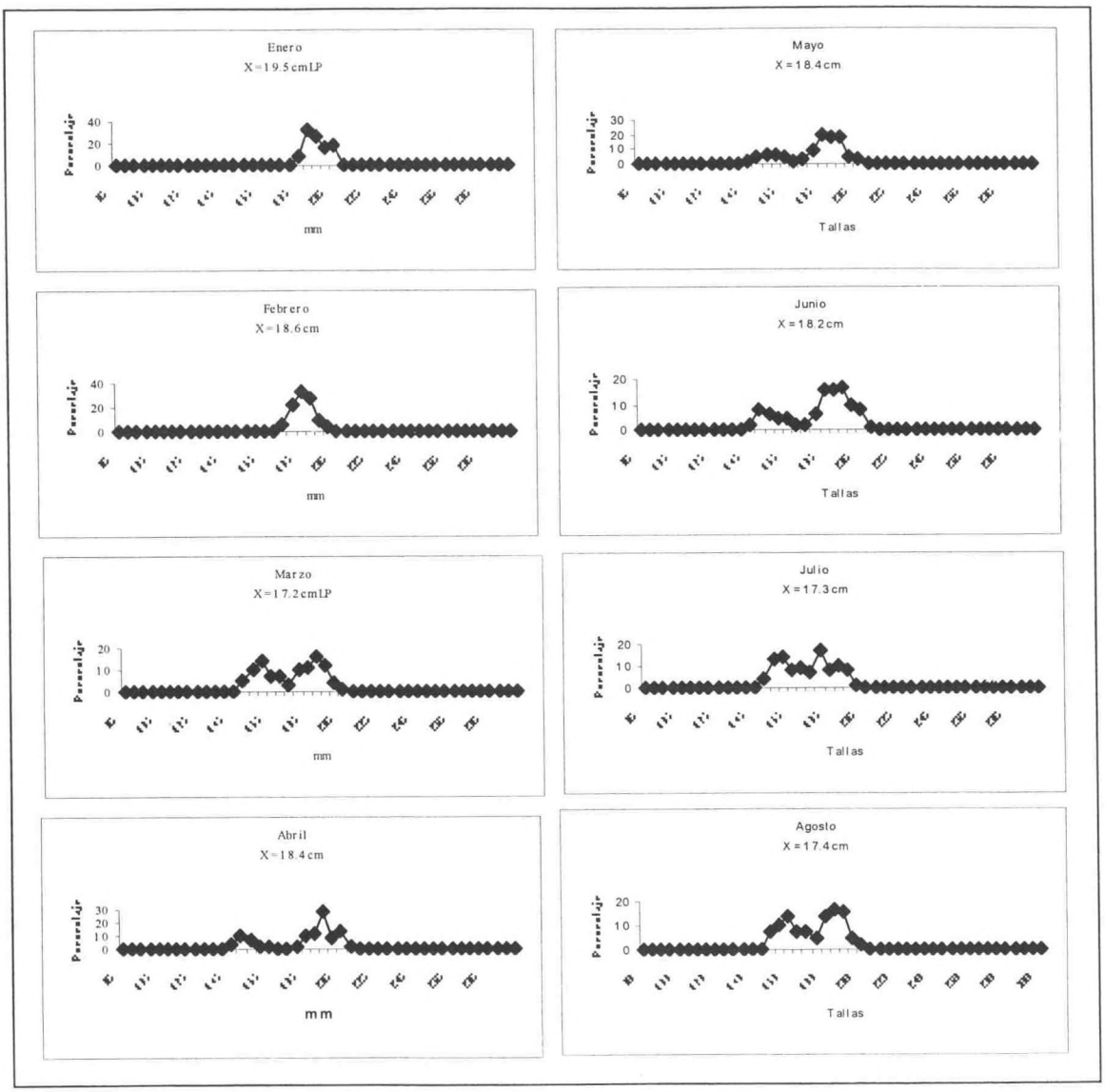

Figura 5.- Estructura por tallas de sardina monterrey (S. caeruleus) durante agosto del 2001.

En el caso de la macarela, durante el mes de agosto se determinó una talla promedio de 26.9 cm de LP, registrando una talla mínima de 10.9 cm de LP y una máxima de 30.5 cm de LP, así mismo se estableció que el 30.3 % de los ejemplares muestreados presentaron tallas inferiores o iguales a 25.5 cm de LP es decir que una buena parte de las

capturas se sustentaron en individuos jóvenes que aun no han participado en los proceso de reproducción (Figura 5).

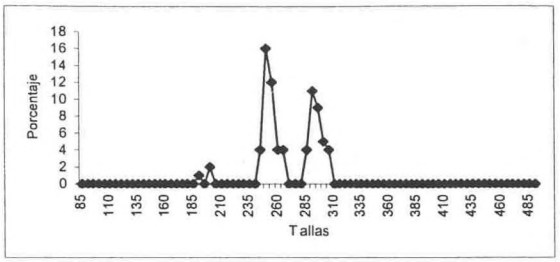

Figura 5.- Estructura por tallas de las capturas de macarela (S. japonicus) durante agosto del 2001.

Así mismo se estableció que solo durante los meses de marzo y julio de este año, se logró obtener muestras de anchoveta, por lo que no fue posible efectuar una comparación entre las dos últimas temporadas en cuanto a las características meristicas de los ejemplares.

Utilización Industrial de las Capturas

De las 16,450.0 t capturadas durante los ocho meses que van de esta temporada, se destaca que la planta empacadora local, ha utilizado en la elaboración de productos enlatados para consumo humano directo y fresco congelados el 91.9 % (15,110.8 t), en tanto que la industria reductora, ha utilizado el 8.1 % (1,339.2 t) restantes que se destinaron a la elaboración de harina y aceite de pescado (Cuadro 6).

Cuadro 6.- Relación de capturas destinada a la industria empacadora y reductora de enero a agosto del 2001.

MES/USO	EMPAQUE	HARINA	TOT./MES
En.	3,354.9	392.9	3,747.8
Feb.	1,164.8	0.0	1,164.8
Mar.	1,156.8	16.5	1,173.3
Ab.	843.3	0.0	843.3
May	1,809.9	25.1	1,835.0
Jun.	2,201.1	281.3	2,482.4
Jul.	2,151.3	450.6	2,601.9
Ag	2,428.7	172.8	2,601.5
TOTAL	15,110.8	1,339.2	16,450.0

CONCLUSIONES

Las capturas registradas en la pesquería de pelágicos menores de la costa occidental de Baja California durante el periodo de enero a agosto del 2001, han registrado una disminución de un 56.8 % respecto al mismo periodo de la temporada pasada (de 38,097.2 t en el 2000 a solo 16,450.0 t en el 2001). De manera paralela a la caída en las capturas, el esfuerzo pesquero bajo en un 33.8 % pasando de 607 viajes con captura en el 2000 a solo 402 viajes en el

2001. De manera semejante se registró un decremento en él numero de barcos de un 26.7 % respecto al mismo periodo del año anterior.

En cuanto a la composición de las capturas por especies documentadas en los primeros ocho meses de esta temporada, se destaca que la sardina monterrey es la que ha aportado el mayor volumen con el 85.1 %, las de macarela mantiene su tendencia clara a decrecer con el 14.3 % y la anchoveta con solo el 0.5 % de las capturas registradas durante este periodo.

Del análisis de los ejemplares de sardina monterrey muestrados, se determinó que estos presentan una talla promedio de 17.4 cm de LP, con rangos que variaron entre 15.0 cm de LP a 20.0 cm de LP, enfatizando que el 30.3 % de las capturas de sardina monterrey presentaron tallas por abajo de la mínima reglamentaria de 16.5 cm de LP, en tanto que para macarela la talla promedio fue de 26.9 cm de LP con intervalos de talla entre 10.9 cm de LP a 30.5 cm de LP, estableciendo además que el 30.6 % de las capturas se sustentaron en individuos por debajo de la talla mínima reglamentaria de 25.5 cm de LP. En tanto que no se registraron capturas de anchoveta por lo que no se cuenta con puntos de comparación.

Así mismo se enfatiza que las especies que conforman esta pesquería, responden de manera distinta a los cambios en el medio ambiente, así como a los efectos de su explotación.

Respecto a la capacidad de acarreo desplazada por la flota durante los ocho meses que van de esta temporada, ha sido de 68,700 t de las cuales solo se ha aprovechado el 23.9 % de esta capacidad, esto significa que la flota actualmente se encuentra sobre diseccionada con respecto al nivel de capturas actuales, ya que con un poco menos de la mitad de la flota operando al 100 % de su capacidad es posible obtener dos veces mas de las capturas actuales, se señala además que durante el mes de agoto de este año se desplazaron 7,350 t, de las cuales solo se aprovecho el 35.4 %, lo que confirma este sobre dimencionamiento de la flota.

Con relación al uso industrial de las capturas en procesos de transformación por la industria pesquera local, se estableció que en el caso de la industria empacadora para consumo humano directo y de fresco congelado, disminuyeron en un 33.9 % pasando de 22,844.1 t en el 2000 a 15,110.8 t en el 2001, así mismo las capturas que han sido destinadas a la industria reductora, han decrecido en un 91.2 %, ya que estas pasaron de 15,252.4 t en el 2000 a solo 1,339.2 t en el 2001.

Esta situación ha sido provocada por un decremento en la demanda de los productos elaborados por la industria pesquera local y no en función de la falta de accesibilidad y disponibilidad de estos recurso a la flota comercial como ya fue señalado, estableciendo que la disminución de las capturas, del esfuerzo pesquero (viajes con captura) y del número de barcos en operación durante este periodo, esta mas asociado con la desaceleración económica que ha afectado a las empresas, que a la condición de abundancia de las poblaciones de pelágicos menores en la costa occidental de Baja California.

Estimate of the Spawning Biomass of Monterey Sardine by Larval Census for 1997-1999 IMECOCAL Cruises.

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The necessity to obtain estimations of the reproductive biomass of the Monterey sardine from Baja California, Mex. to San Francisco Ca., USA was a result of the Trinational Sardine Forum.

The IMECOCAL program has conducted oceanographic expeditions every three months since 1997 to date with the aim to monitor the southern region of the California Current, by means of similar methodology to that implemented for the CALCOFI program. CTD, the CUFES system for plankton sampling and Bongo and CalVET nets have been used as sampling devices.

Fish larvae obtained with oblique bongo tows (60 cm diam. and 500 μ mesh), fish larvae were separated and identified to the minimum possible taxon. The sardine larvae so identified were grouped into four development stages, namely: preflexion, flexion, postflexion and transformation.

The larval abundance was normalized to 10 m^2 sea surface and larval indexes were computed for CalCOFI regions 11, 12, 13, 14, 16 and 17. The census estimations were adjusted to the area in order to prevent that the area factor would augment them.

Two estimators have been proposed to transform the sardine larval indexes to adult biomass (Smith & McCall). However, despite the fact that these estimations differ by a factor of 2.25, both estimators were utilized.

The reproductive biomass thus estimated fluctuated between 1185 metric tons and 104,594 metric tons. (Fig. 1)

The eggs were found in October 1998 from Punta Colonett to Punta Canoas; January 1999 the eggs were found in an oceanic station off Punta Baja and in August, eggs were found in large quantities in Bahia Sebastián Vizcaino and Punta Santo Domingo, B.C.S.

Larvae were found from Punta Colonett to Punta Santo Domingo, B.C.S. in most expeditions, but they were most abundant in August 1999 and most scarce in September 1997.

As far as the sea surface temperature is concerned, the sardine eggs were more abundant at higher temperatures, whereas larvae abundance did not show a clear tendency. However, latitudinal, both eggs and larvae were more abundant from Sebastian Vizcaino Bay to Punta Santo Domingo.

Spawning occurred at least two different temperature intervals: one occurred between 14–16 °C (Jan. and April 1999) and the other occurred above 18 °C in the other months of the year. (Fig. 2)

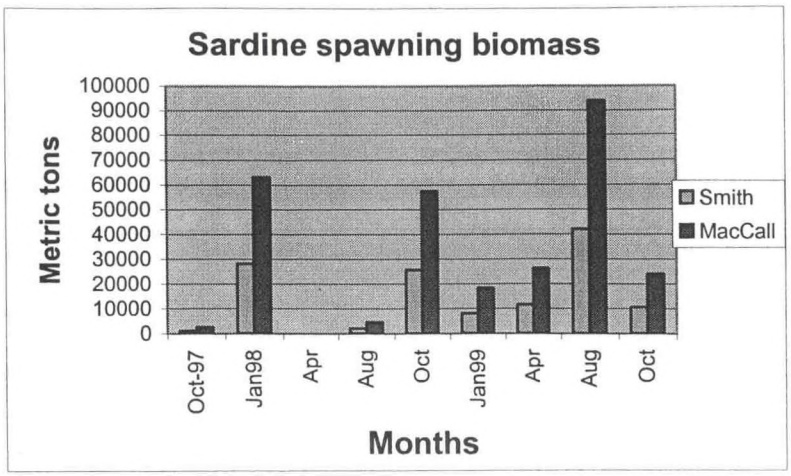


Figure 1. Spawning biomass in the IMECOCAL cruises.

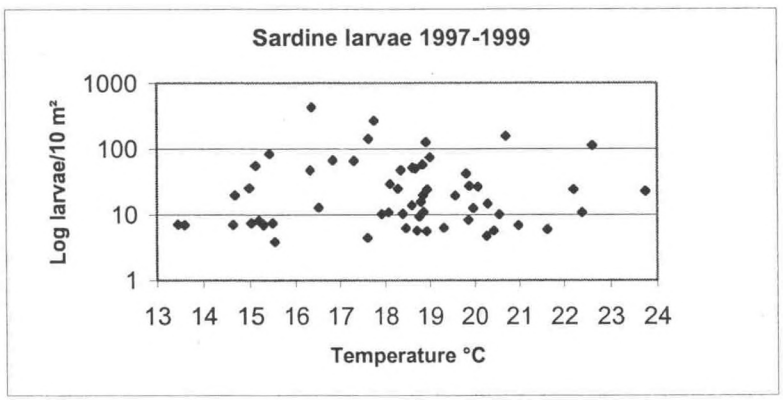


Figure 2. Larval abundance by temperature in IMECOCAL cruises.

Literature cited:

MacCall, Alec D. 1979. Populations estimates for the waning years of the Pacific Sardine fishery. CalCOFI Reps. Vol. XX, 72-82.

Smith, Paul. E. 1972. The increase in spawning biomass of northern anchovy, *Engraulis mordax*. Fish. Bull. 70(3):849-874.

Oregon's Sardine Fishery, 2001 Preliminary Summary.

Jean McCrae Oregon Department of fish and wildlife.

Oregon's Sardine Fishery, 2001
Preliminary Summary
Jean McCrae
Oregon Department of Fish and Wildlife

In 2001, over 28.2 million pounds (12,798 mt) were landed into Oregon, through October. Eighteen seine vessels made 453 landings averaging 62,260 lb per landing. Of the 18 vessels targeting sardines, seven made 90 % of the landings. Each of these seven worked during 13 - 17 weeks of the fishery. Six vessels made only one landing; just enough to qualify their permit for renewal.

Landings began in early June and continued through mid-October. Ocean conditions and weather were a major factor determining the start and end of the fishery and overall landings in August and September. The terrorist attacks of September 11 also slowed landings by grounding the spotter planes for nine days. Final landings were made in early October.

Five additional vessel permits were added in 2001 to encourage interest by processors. Three additional plants bought fish in 2001 for a total of five processors. Average ex-vessel price was $0.06 per pound.

The area of catch in 2001was similar to the area fished in 2000, but extended slightly farther to the south. Depths in the harvest area averaged 49 fm. Based on log data, 73 % of the pounds landed were taken off Oregon and 27 % off Washington.

Based on both observer and logbook data, bycatch was low. Bycatch included chinook, coho, and pink salmon, dogfish, blue, and thresher sharks, and herring. Observed salmon averaged 1.0 salmon per trip, with 64 % being released alive. The estimated total catch of salmon for the fishery, based on observer data, was 491 salmon, down from an estimated 663 in 2000. Incidental catch (landed non-target species) recorded on fish tickets consisted of 52.8 mt of Pacific mackerel and 1.2 mt of jack mackerel, for a total of 0.4 % of the total catch.

Biological samples had an overall average of 154 gm and an overall average standard length of 212 mm. Large amounts of very small fish (3 - 4 in) were seen by fishers during the latter half of the season, however these small fish were not captured in the biological samples. The overall sex ratio of samples was 41/59 M/F. The majority of fish samples were of maturity condition 2. Most condition 3's and 4's were seen at the beginning of the season and condition 1's toward the end of the season.

Foreign Fishing
And
The Coastal Pelagic Species Fishery Management Plan

James J. Morgan, National Marine Fisheries Service, Long Beach, California

Foreign fishing has been a part of the Magnuson-Stevens Fishery Conservation and Management Act (Act) since its passage in 1976. The Act extended U.S. jurisdiction over fishery resources by creating an Exclusive Economic Zone (EEZ), within which substantial foreign fishing existed at the time. Among the goals of the Act are realizing the full potential of the nation's fishery resources and to permit foreign fishing consistent with the provisions of the Act, goals that remain to this day. Basically, the amount of fish available for domestic harvest that will not be utilized by the U.S. fishing industry can be made available to foreign nations; however, many conditions must be met, and coastal pelagic species such as Pacific sardine (*Sardinops sagax*) present special problems. In addition to the uncertainties about the size of the current biomass and the future markets for a species such as sardine, the planned harvest strategy in the fishery management plan is just being met, even though there is a significant amount of the resource available to U.S. fishermen that is not being utilized.

Background

The domestic fishing industry was expected to displace foreign fishing over time and for the most part this has happened. Strong opposition to foreign vessels fishing in U.S. waters can be anticipated in almost all circumstances, even though the goal of foreign fishing is clearly to benefit the U.S. fishing industry, not foreign nations. Foreign fishing off the coast of the U.S. has changed from: (1) extensive direct harvest by foreign vessels, to (2) significant joint venture operations in which fish is delivered to foreign processing vessels by U.S. catcher vessels, to (3) small joint venture operations today with some small directed fishing, such as that in the northwest Atlantic. An example of this transition can be found in the Pacific whiting (*Merluccius productus*) fishery off the Pacific coast. Extensive foreign fishing by the Soviet Union existed off the Pacific coast in 1976. A combination of directed fishing by Soviet vessels and joint ventures resulted in the 1980s, which eventually included vessels from Poland and Japan. Directed foreign fishing was completely displaced in 1989 by joint ventures. In 1990, shorter fishing seasons in the Alaska groundfish fishery led to increased fishing capacity off the Pacific coast, and, in 1991, a determination was made that the entire Pacific whiting quota could be taken by U.S. at-sea processors. Since then, the harvest of Pacific whiting has been divided between domestic offshore and shore-side processing.

Basic Principles

Foreign fishing can take place only after the signing of a Governing International Fishery Agreement (GIFA) between the United States and the applicant country. This agreement is a binding commitment of the foreign nation and its vessels to comply with a number of terms and conditions. Among these are: comply with all regulations, allow authorized officers to board and inspect a vessel at any time, pay fees, permit observers to be stationed aboard vessels, and install

position fixing and identification equipment. An agent representing the vessels must be located in the United States, who is authorized to receive and respond to any legal process issued with respect to any owner or operator. All agreements are submitted to the U.S. Congress for review.

Once this agreement is in place, each nation must submit to the Secretary of State an application for each fishing vessel. Detailed information on the attributes of each vessel is included, as well as information on where the vessel intends to fish and the estimated amount of fish to be harvested. A notice of the receipt of any application is published in the *Federal Register*, and applications are reviewed by the National Marine Fisheries Service, the Coast Guard, and the appropriate fishery management council. If a permit is approved, various conditions and restrictions may be applied to a vessel, some of which are general and some that may be contained in specific fishery management plans. Reasonable poundage fees must be paid by each vessel for the resources harvested. If an observer for the vessel is required, the vessel must cover the necessary costs.

A reciprocity condition is included in the Act that clearly states that no foreign fishing will be authorized for vessels of any nation unless that nation extends substantially the same fishing privileges to fishing vessels of the United States as the United States extends to foreign fishing vessels. If foreign vessels are allowed to fish in U.S. waters, then U.S. vessels should be able to fish in the waters of the foreign country under similar arrangements.

Allocations

The foregoing provides a summary of the conditions that must be met for a foreign nation to obtain the opportunity to fish in the EEZ off the United States. What resources are available for harvest is addressed in the Act and in the fishery management plan under which the desired resources fall. The Act states that the total allowable level of foreign fishing is that portion of the optimum yield that will not be harvested by vessels of the United States. Two components need to be considered when making this determination. One is the harvesting capacity of the U.S. fleet targeting the resource, and the other is the capacity of the processing industry. If there is sufficient U.S. harvesting capacity to take all of the resource available, then clearly no directed foreign fishing will be approved. If U.S. processors do not have the processing capability to process all of the fish available or have the capability but have no plans to process all of the available resource, then there is a potential for joint venture operations, that is, U.S. vessels delivering fish to foreign processing vessels.

Once a GIFA has been signed and the determination has been made that there is resource available for foreign fishing, allocations are made according to guidelines in the Act. First, only up to fifty percent of any available allocation is initially released to a foreign nation. Subsequent releases are based on a number of factors, among which are: to what extent the nation imposes barriers to the importation of U.S. fishery products, to what extent the nation increases existing and new opportunities for fisheries exports from the United States through the purchase of fishery products from U.S. processors and the purchase of fish and fishery products from U.S. fishermen, and to what extent the nation is cooperating with the U.S. in fishery research. These and other factors, including any that the Secretary of State, in cooperation with the Secretary of

Commerce, believe appropriate can be used to reduce an individual nation's allocation or limit the following year's allocation.

In addition to the general provisions of the Act, fishery management plans and the permits that are eventually issued to foreign vessels may contain guidance for specific fisheries. To emphasize the point at the beginning of this piece that foreign fishing under the Act is designed to benefit the U.S. fishing industry, foreign fishing can take place only if there is (1) a country to country agreement on general principles, (2) the U.S. fishing industry cannot utilize all of the resource available, and (3) the foreign vessels receiving U.S. fish contribute to the development of the U.S. fishing industry. A common perception of the public is that the Act makes possible the sale to foreign harvesters of fishery resources in U.S. waters, but there is much more to foreign fishing under the authority of the Act.

Pacific Sardine

The Coastal Pelagic Species Fishery Management Plan contains one significant admonition regarding foreign fishing. Joint venture or foreign fisheries for coastal pelagic species may not be conducted within the limited entry area south of 39° N latitude. There is little additional guidance in the plan with regard to foreign fishing. Nevertheless, the features of a productive fishery like Pacific sardine can be examined to make some guesses about how the foreign fishing provisions of the Act might apply in this instance. First, the formula used to set the U.S. harvest guideline must be considered. The formula is as follows:

U.S. harvest guideline = Estimated biomass - 150,000 mt x 15% x 87%

Estimated biomass = biomass of age 1+ animals
Cutoff = 150,000 mt
Harvest rate = 15%
Portion of resource in U.S. waters = 87%

The two important factors in this discussion are the harvest rate and the portion of the resource in U.S. waters. The harvest rate varies between 5% and 15%, depending on a three-year average of sea surface temperature. Environmental influence on this species adds uncertainty as to how much of the resource will be available for harvest, especially in view of the recent decline in ocean temperature. There also is a wide coefficient of variation around the most recent biomass estimates.

Another factor that increases uncertainty is that the sardine fishery is virtually a new fishery. As the harvest guideline has increased, harvests have increased, but the resource has grown faster than markets for it have developed. Without a reasonable history of markets, how much of the resource will be utilized the next year is uncertain. A jump of 10,000 or more above the previous year would not be surprising.

Table 1 shows the U.S. harvest guideline from 1997 to 2001 based on the estimated biomass and the formula in the plan. In every year, the U.S. harvest is below the harvest guideline. In fact,

the unharvested portion in 2000 and the estimated unharvested portion in 2001 suggests the possibility of a foreign fishery, especially if the biomass continues to increase. If there were concern about taking the harvest from any particular year, an average of the unused amount over a period of years could be used.

The harvest strategy in the plan was arrived at through a sardine simulation model, and the formula chosen by the Pacific Fishery Management Council is expected to lead to the results depicted in Table 2. The average catch is expected to be 145,000 mt. The mean biomass is expected to be 1.9 million mt. The biomass will be above 400,000 mt 96 percent of the time. And, significant to the fishing industry, the years with no catch is expected to be only 0.5 percent.

Examining this subject in detail presents complications. The plan states that there is enough U.S. harvesting capacity to land all of the coastal pelagic species likely to be available, so the potential for directed foreign fishing is not possible. The question of how much U.S. processors will utilize during any given year is uncertain. The sardine biomass has increased at a rate that challenges the development of markets. As can be seen in Table 3, sardine landings on the Pacific coast in 1997 totaled 46,000 mt and are estimated to increase to 76,000 mt by the end of 2001. There was virtually no sardine fishery in Oregon and Washington in 1998, but more than 23,000 mt was landed by the middle of November 2001.

The uncertainties about the expansion or decline of sardine and developing markets are not the only uncertainties. If foreign fishing had been allowed under the current conditions, the harvest strategy in the plan might have been compromised. The Magnuson-Stevens Act requires that stocks be managed throughout their range; therefore, the fishery management plan makes an attempt to account for sardine fisheries beyond U.S. jurisdiction. The formula in the plan attempts to make some accounting of the amount of the resource that might be harvested in Mexican waters, and since the development of the plan, sardine fishing has expanded into Canadian waters. Landings beyond U.S. jurisdiction have been above those estimated by the harvest formula. Table 4 shows the performance of the fishery in relation to the harvest strategy in the plan. The harvest formula was applied to the recent biomass estimates from 1997 to 2001. The U.S. harvest guidelines, the harvest beyond U.S. jurisdiction, and total estimated removals according the formula are depicted. The actual landings, including the estimated figure for 2001, are compared to the removals allowed by the formula. Comparing the potential unharvested resource in this table to the unharvested amount in Table 1 for the U.S. fishery alone is revealing. Although there appears to be a significant portion of the U.S. harvest guideline that is not harvested and could be made available for foreign fishing, the reality is that the various fisheries are performing close to the design in the plan. Adding up the deficit and surplus amounts over the recent five years shows that there has been an overharvest of 12,511 mt.

The result of this review is that even if all parties could agree on basic principles for foreign vessels operating in U.S. waters, such a fishery is not likely to be considered under the current biomass and harvest levels

Table 1. U.S. Pacific sardine harvest guidelines compared to U.S. landings

Year	U.S. harvest guideline (HG)	U.S. harvest	HG - harvest
1997	83,487	46,197	+ 37,290
1998	80,316	41,056	+ 39,260
1999	76,747	59,852	+ 16,895
2000	121,993	72,253	+ 49,740
2001	134,737	76,000[1]	+ 58,737

[1]Total estimated landings through December 31, 2001, as of November 19, 2001

Table 2. Some key performance factors of the sardine control rule adopted by the Pacific Fishery Management Council

Factor	Performance
Average catch	145,000 mt
Mean biomass	1,952,000 mt
Percent of years biomass > 400,000 mt	96%
Percent of years with no catch	0.5%

Table 3. Harvests of Pacific sardine off California, Oregon, and Washington, 1997 - 2001

Year	California	Oregon	Washington	Yearly totals
1997	46,197	0	0	46,197
1998	47,055	1	0	47,056
1999	59,076	776	0	59,852
2000	57,935	9,526	4,792	72,253
2001	53,000[1]	12,842[1]	10,428[1]	76,000[1]

[1]Estimated landings through December 31, 2001, as of November 19, 2001.

Table 4. Estimated removals based on Pacific sardine harvest formula (Coastal Pelagic Species Fishery Management Plan) compared to actual removals.

Year	Biomass Est.	Calculated harvest outside U.S.	Calculated U.S. harvest guideline	Calculated Total removals	Actual removals	Calculated removals - Actual Removals
1997	789,746	12,475	83,487	95,962	114,670	- 18,708
1998	765,450	12,001	80,316	92,318	89,614	+ 2,704
1999	738,098	11,468	76,747	88,215	119,671	- 31,456
2000	1,082,465	18,229	121,993	140,222	125,143	+ 15,079
2001	1,182,465	20,133	134,737	154,870	135,000[1]	+ 19,870

*All weights in metric tons.

[1]Total estimated landings through December 31, 2001, as of November 19, 2001.
Actual removals include Mexico, California, Oregon, Washington, and Canada.

Schweigert, J., Chalmers, D., and G. McFarlane. 2001. Summary of the Canadian Sardine Fishery and Stock Assessment for 2002.

The Canadian commercial fishery for Pacific sardine ended in the late 1940s as a result of declining abundance off California. After an absence of almost 50 years sardine re-appeared in British Columbia (BC) in the early 1990s and an experimental fishery commenced in 1996. As interest in re-establishing a commercial fishery has grown small increments in the experimental fishery have occurred to present with 10 licensees (7 seine, 2 trap, 1 gillnet) harvesting a quota of 1600 tons in 2001. Catches were primarily from inshore waters and distributed throughout the west coast of Vancouver Island and into Queen Charlotte Sound. The largest fish were taken in the north (24-25 cm) decreasing southward (21-22 cm). By-catch consisted primarily of mackerel (53%) but was less than 1% of the entire sardine catch. Oil content increased slightly over the summer averaging about 25% of body weight. Ongoing summer trawl surveys provide an index of relative abundance in the offshore waters and indications for 2001 are that sardines were distributed further to the south and were less abundant than in 1997 and 1999 surveys. These results are consistent with the U.S. assessment which indicates a slight decline in abundance in 2001. Canada has adopted the U.S. harvest rate of 15% which is based on recent water temperature at Scripps and is related to sardine productivity. The Canadian stock assessment is based on the U.S. abundance forecast and assumes that on average about 10% of the sardine population migrates into BC waters. Details are provided in Schweigert and McFarlane (2001). On this basis, it is expected that 105,760 tonnes of sardine could migrate into BC waters in 2002, depending on variation in other oceanographic factors that may impact dispersal into northern waters.

Paul Smith

Sardine Demographic Groups

There are at least 2 transboundary stocks of sardine. One referred to as the 'southern' overlaps the Mexico-US border. The other, referred to as the 'northern', overlaps the Mexico-U.S. and the U.S.-Canada borders. Issues of harvest guidelines and allocation of catches among harbors will undoubtedly arise.

It would appear that custom management of these stocks of sardines will require methods to identify the groups in the catch. The method of identification will be determined whether these stocks are genetically distinct or merely reflect differing responses of the stock to its environment at spawning or at maturation.

This note explores some of the literature on stock heterogeneity and the genetic, demographic, and environmental characteristics. It augments classical data on vertebral count with 4 new sets of vertebral counts from the Southern California Bight and Oregon. Research vessels took three sets from the U.S. and Canada and the fourth is a sample from Pacific Raider off Oregon.

APPENDIX III.

CONTRIBUTED "PAPER COPY" SUBMISSIONS

SITUACION ACTUAL DE LA PESQUERIA DE PELAGICOS MENORES EN EL GOLFO DE CALIFORNIA

SAGARPA - INSTITUTO NACIONAL DE LA PESCA

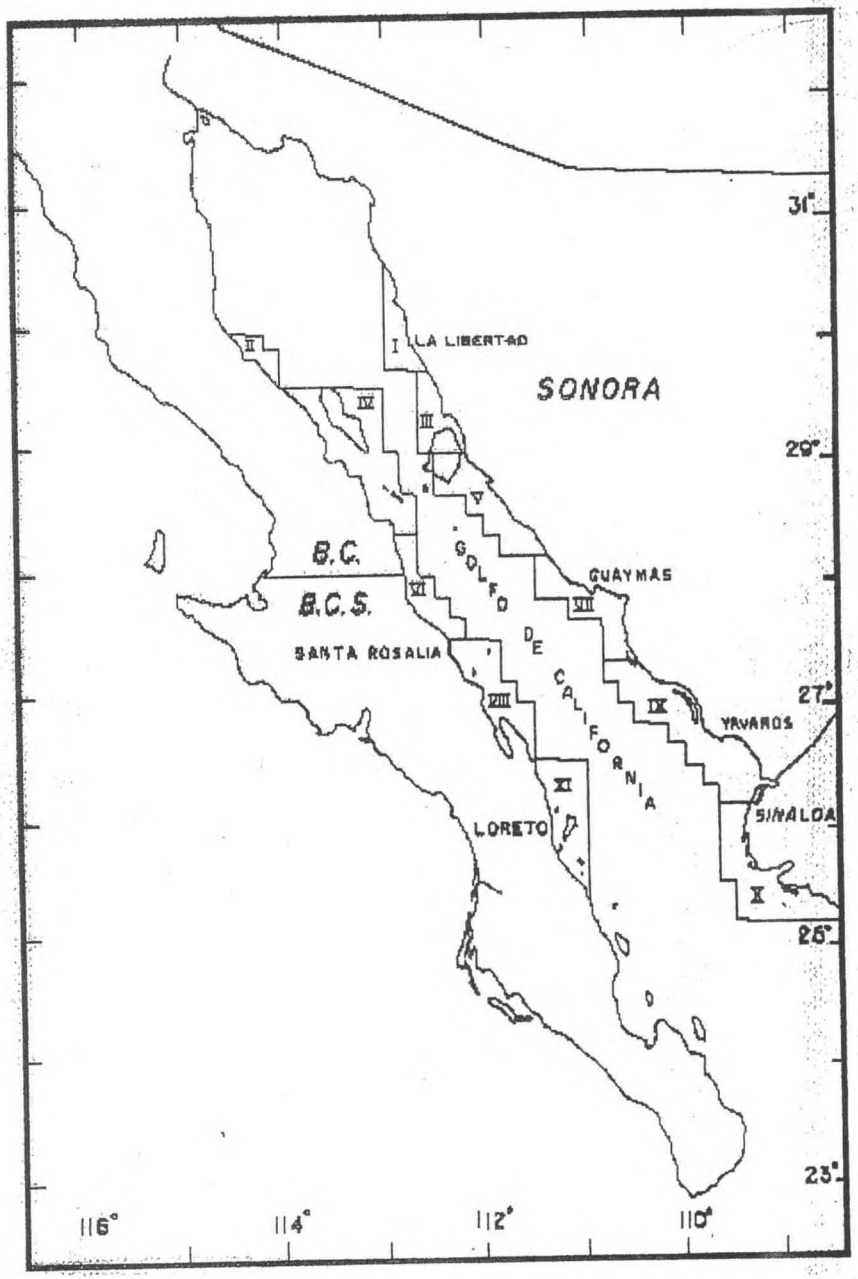
CENTRO REGIONAL DE INVESTIGACIÓN PESQUERA

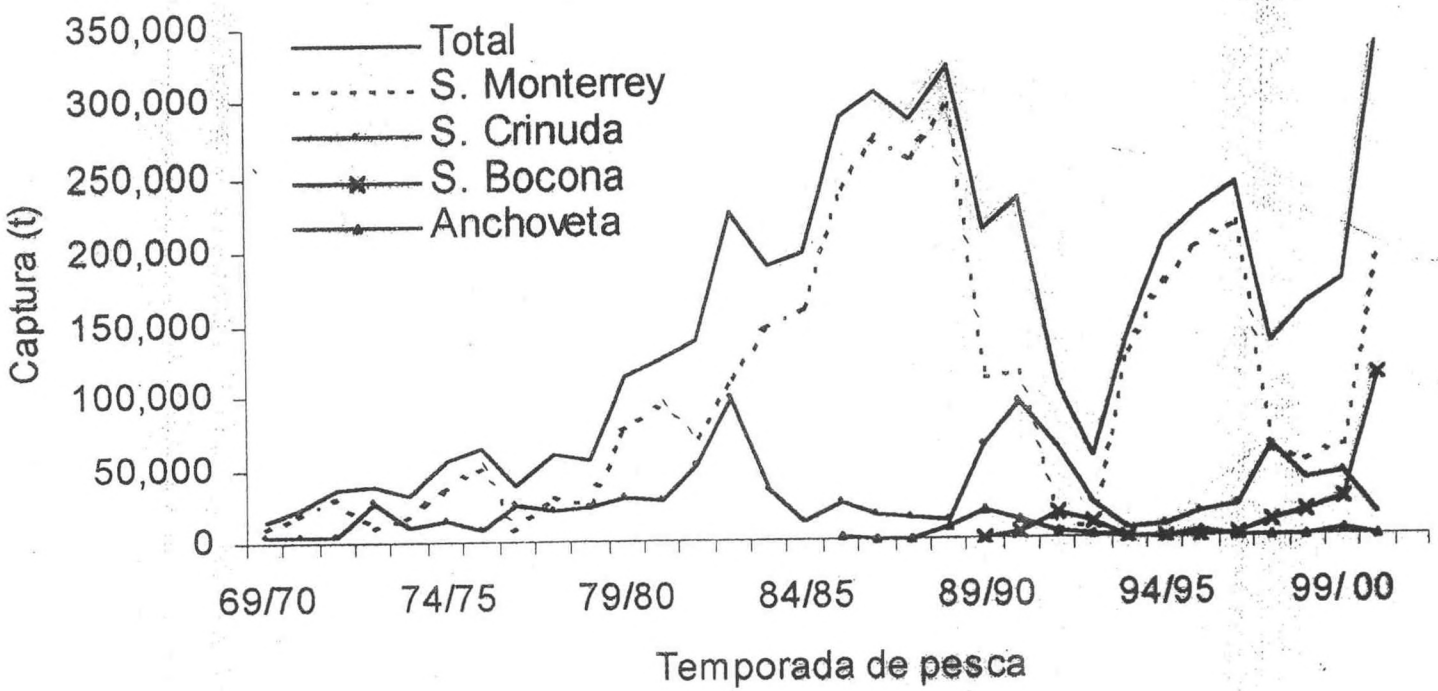
GUAYMAS, SON.

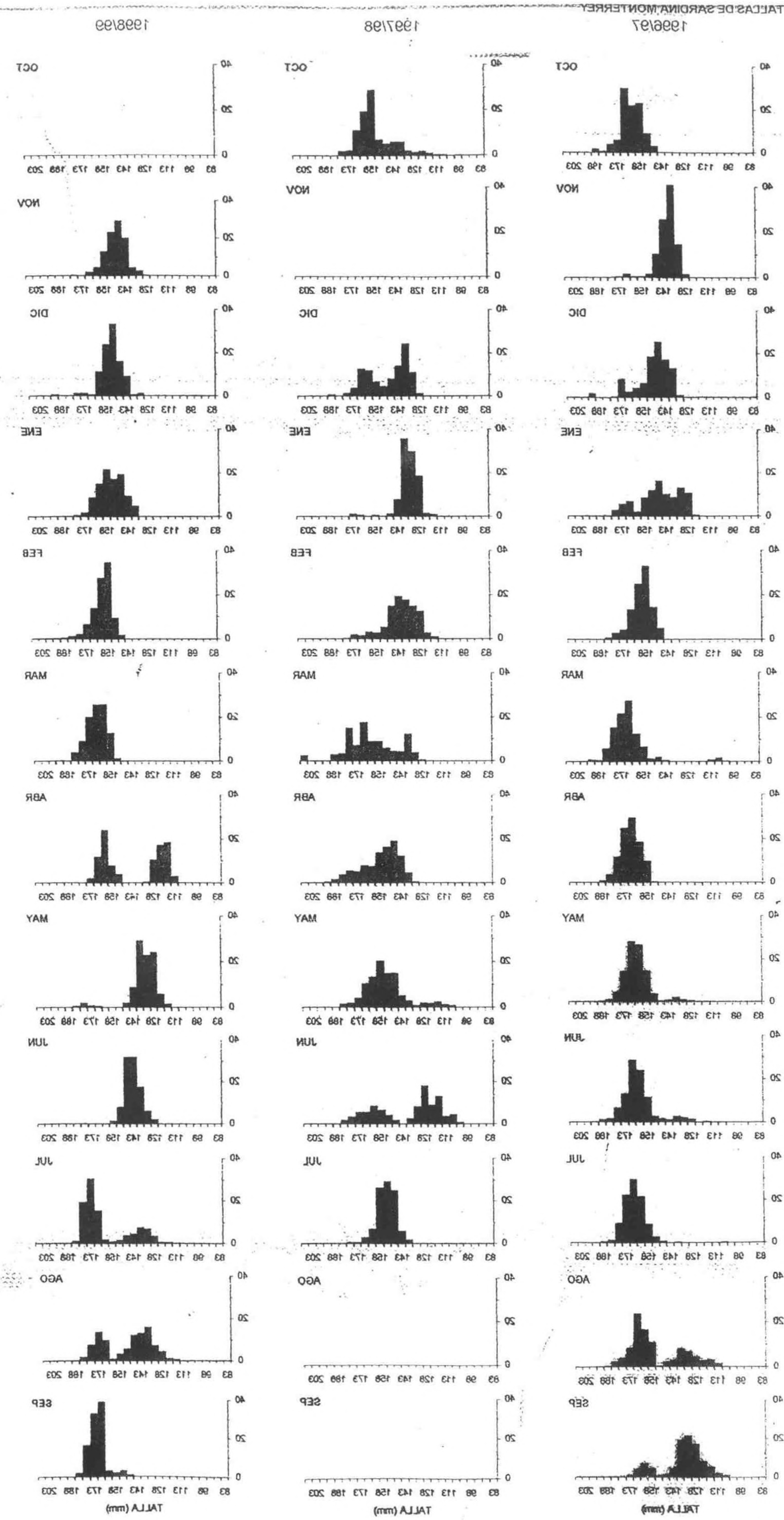
Manuel O. Nevárez Martínez, Ma. Ángeles Martínez Zavala, Myrna Anguiano Carrazco, Pablo Santos Molina, Miguel A. Cisneros y Angel R. Godínez Cota

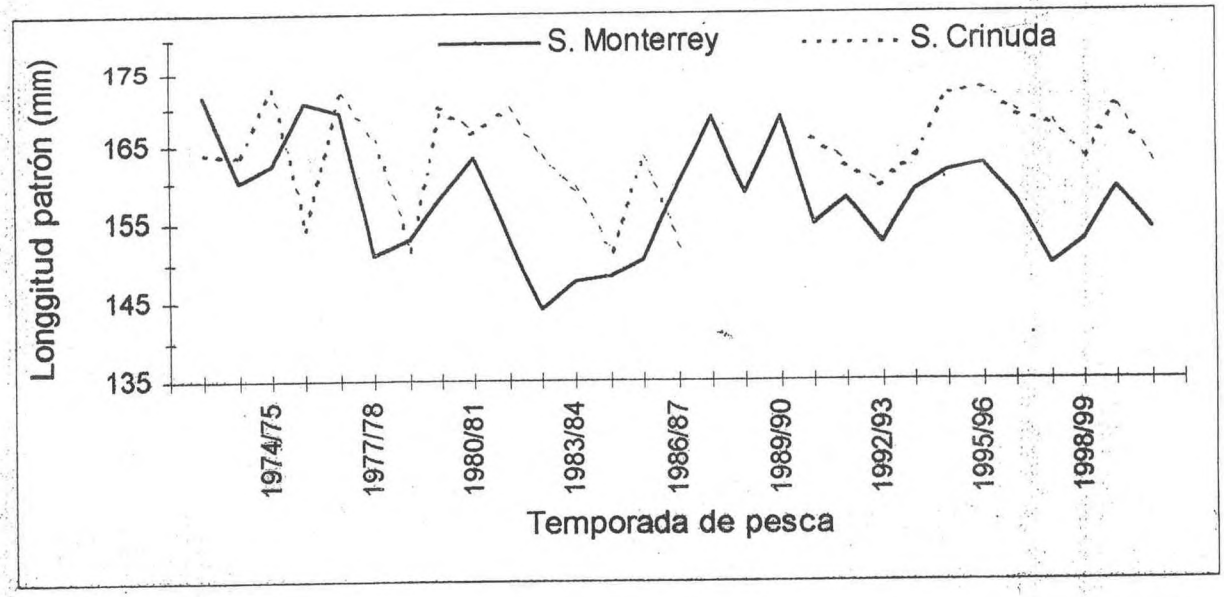
SEMARNAP

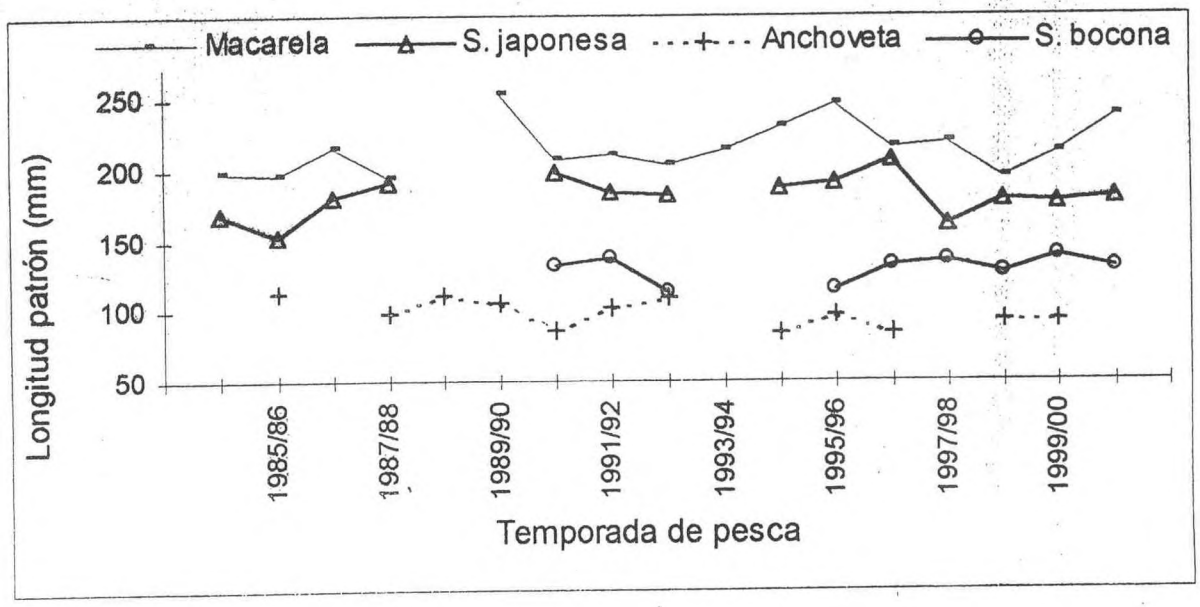
e-mail: nevarez@gys.megared.net.mx
nevarezm@gys.megared.net.mx

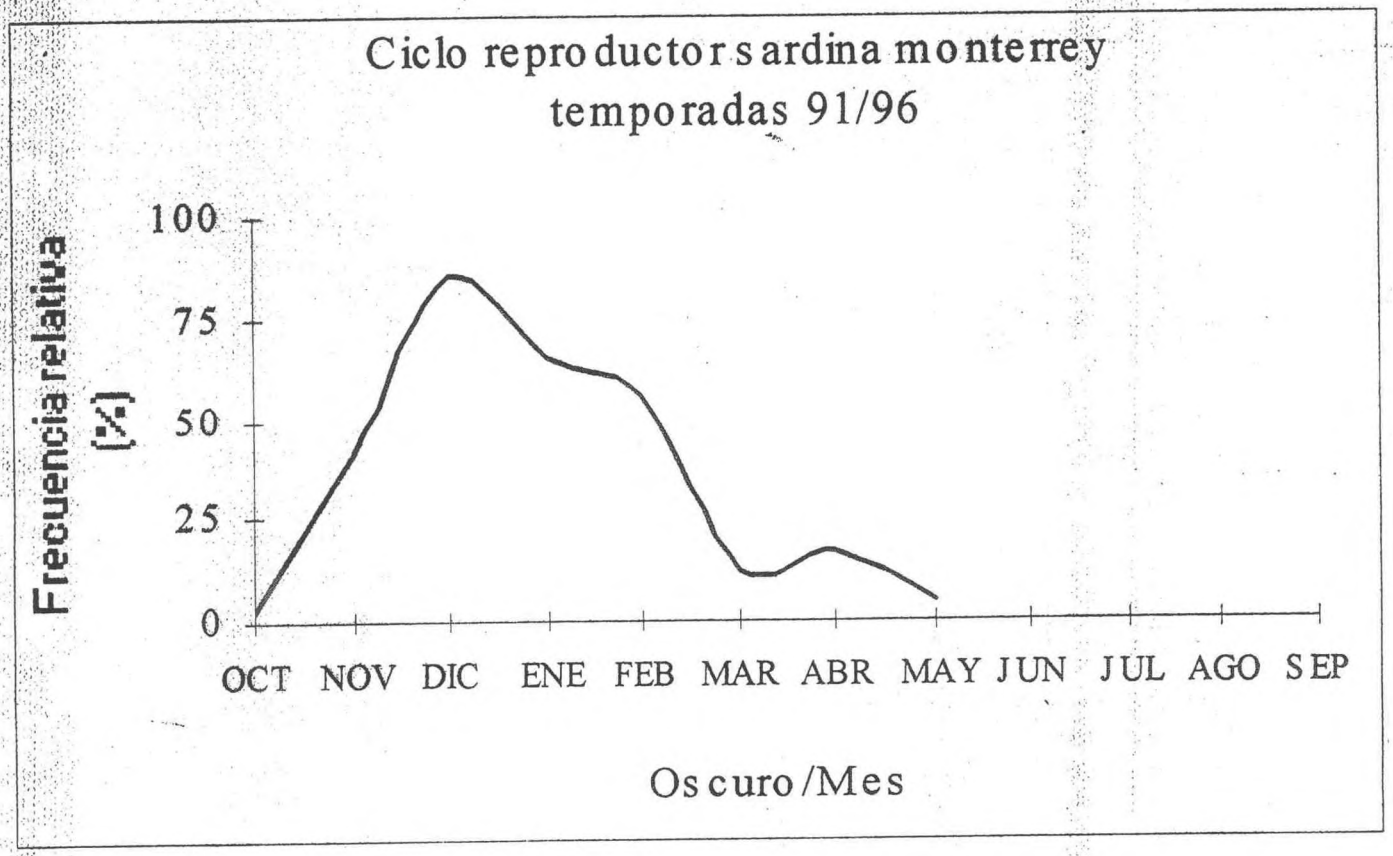

31°
29°
27°
25°
23°
116°
114°
112°
110°
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
LA LIBERTAD
SONORA
B.C.
B.C.S.
SANTA ROSALIA
GOLFO DE CALIFORNIA
GUAYMAS
YAVAROS
SINALOA
LORETO


350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Captura (t)
Total
S. Monterrey
S. Crinuda
S. Bocona
Anchoveta
69/70
74/75
79/80
84/85
89/90
94/95
99/00
Temporada de pesca




S. Monterrey
S. Crinuda
Longgitud patrón (mm)
175
165
155
145
135
1974/75
1977/78
1980/81
1983/84
1986/87
1989/90
1992/93
1995/96
1998/99
Temporada de pesca


Macarela
S. japonesa
Anchoveta
S. bocona
Longitud patrón (mm)
250
200
150
100
50
1985/86
1987/88
1989/90
1991/92
1993/94
1995/96
1997/98
1999/00
Temporada de pesca


Ciclo reproductor sardina monterrey
temporadas 91/96
Frecuencia relativa
(%)
100
75
50
25
0
OCT NOV DIC ENE FEB MAR ABR MAY JUN JUL AGO SEP
Oscuro/Mes

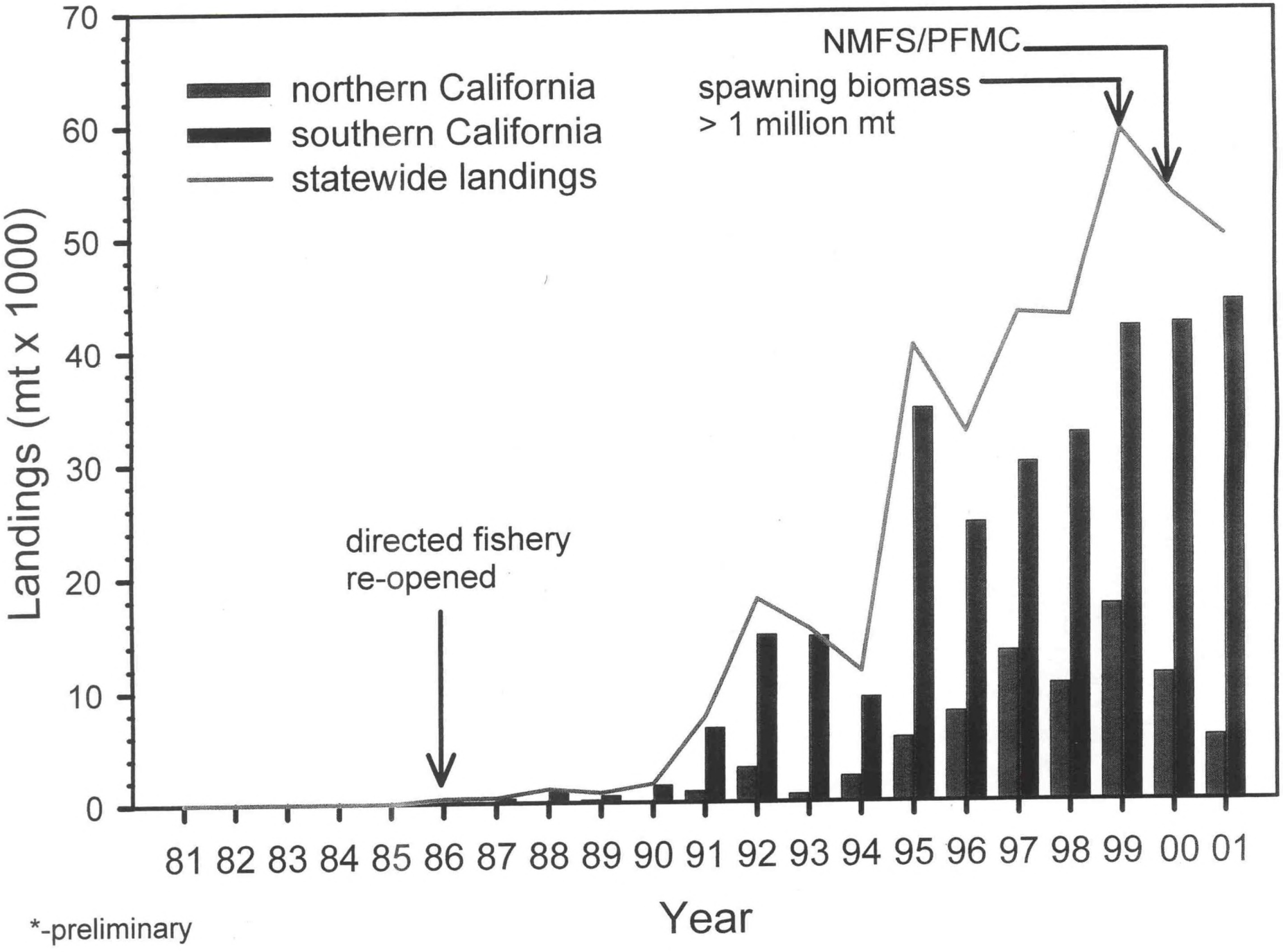
Overview of California's 2001 Pacific Sardine Fishery

Second Trinational Sardine Forum
November 29th-November 30th

California Department of Fish and Game
4665 Lampson Avenue, Suite C
Los Alamitos, California 90720

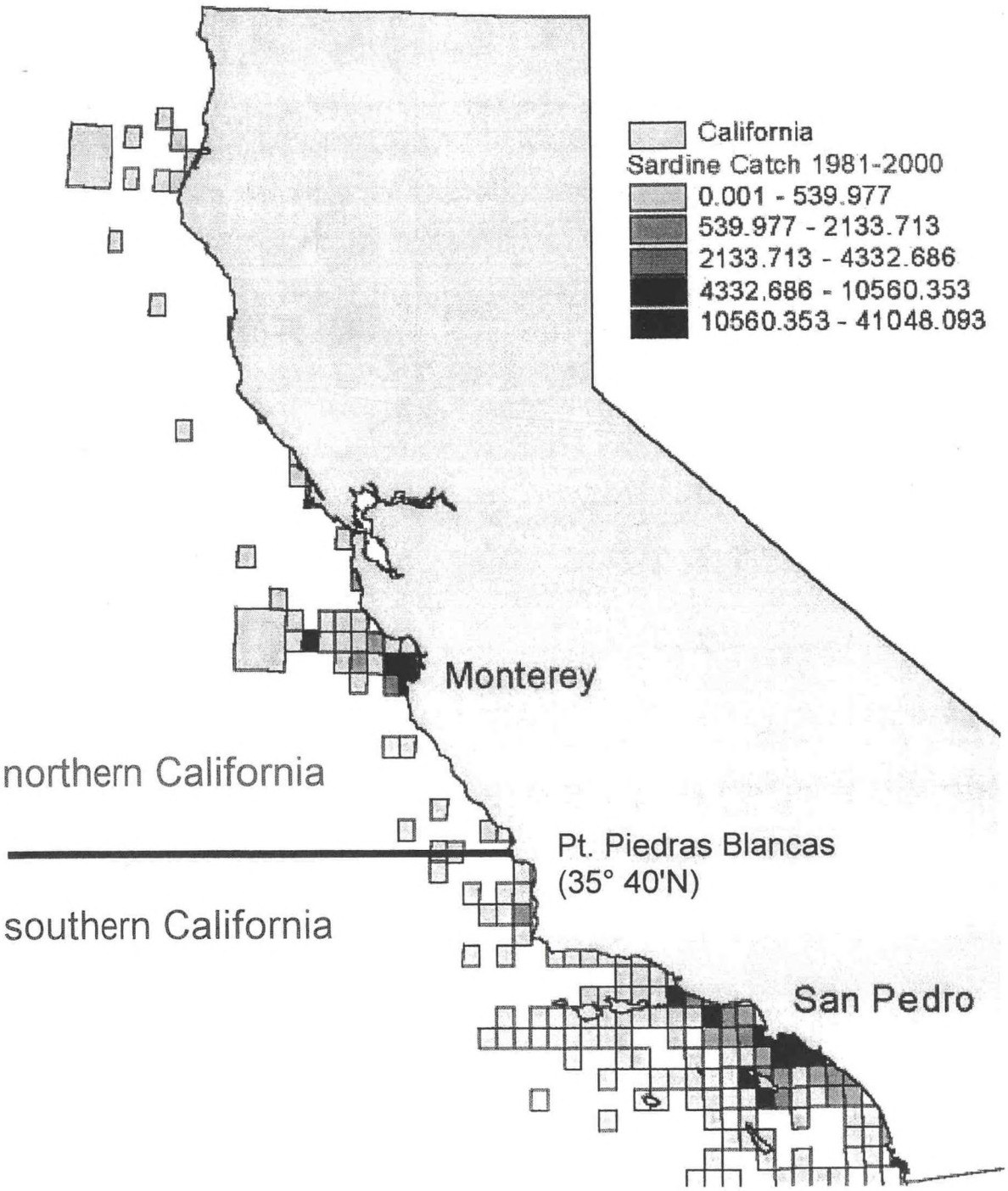
Stephen P. Wertz
swertz@dfg.ca.gov

California's commercial Pacific sardine landings from 1981-2001*

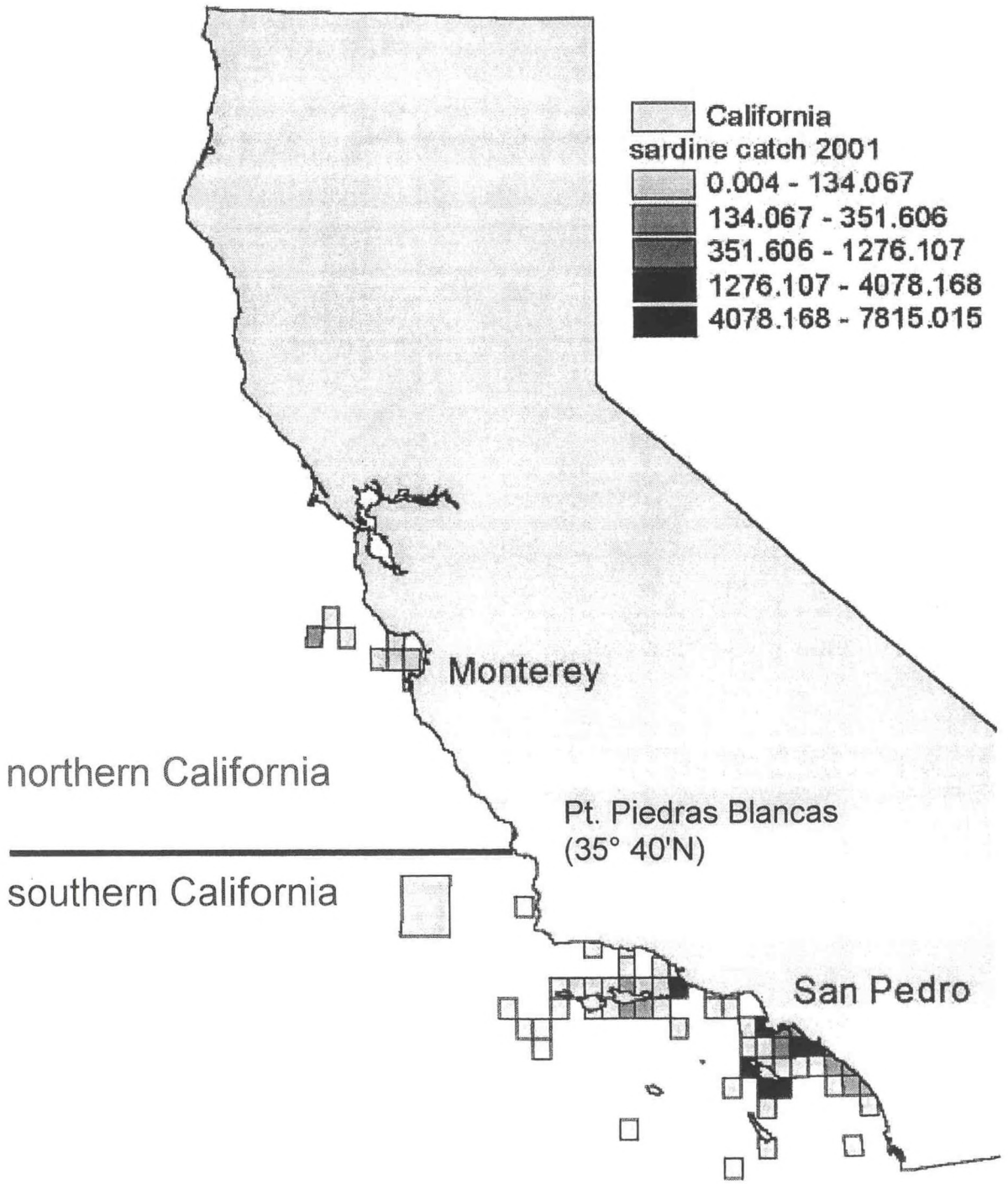


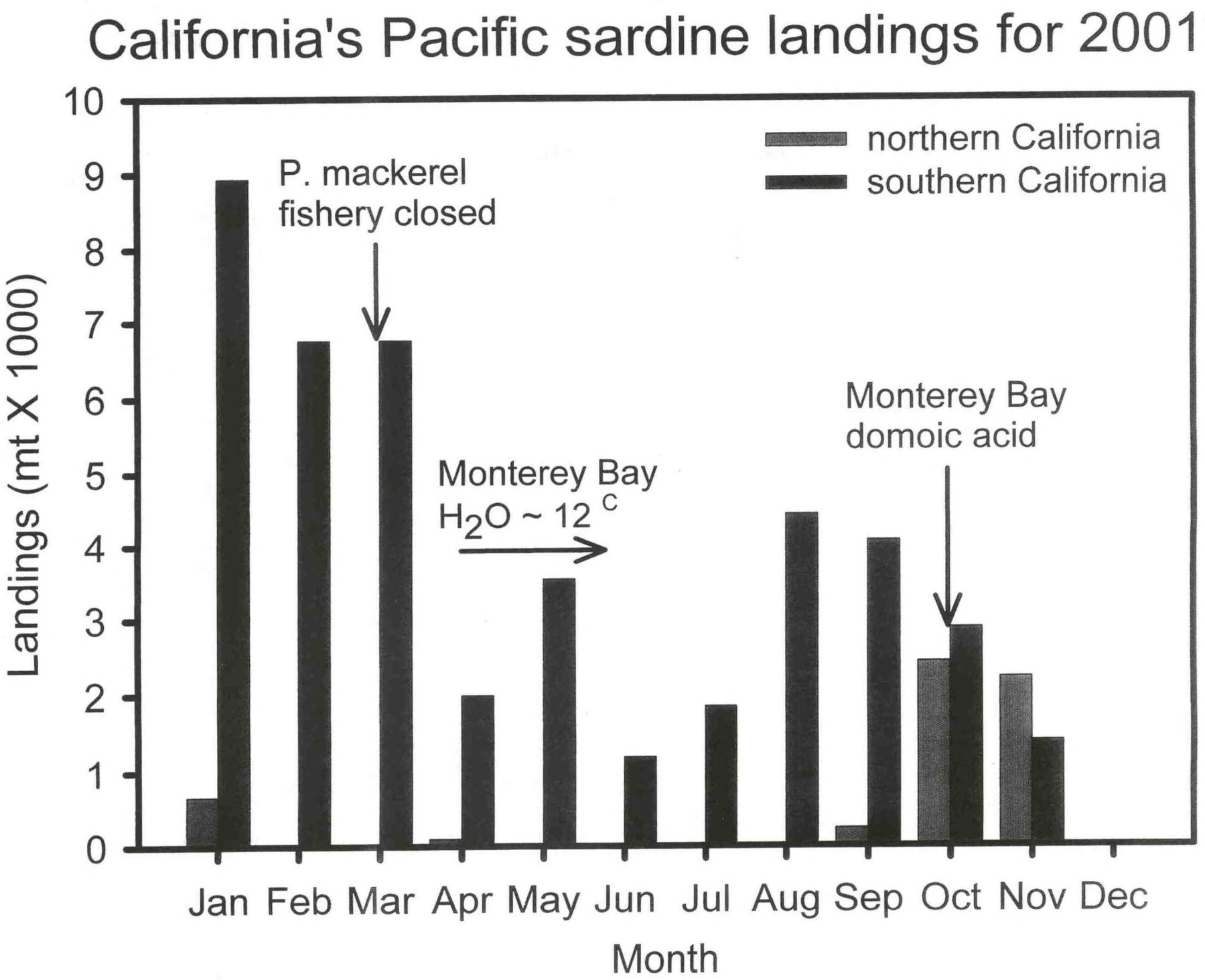
*-preliminary

Pacific Sardine Catch Locations
California - 1981 to 2000



Pacific Sardine Catch Locations
California - 2001




California's Pacific sardine landings for 2001*
Landings (mt X 1000)
10
9
8
7
6
5
4
3
2
1
0
northern California
southern California
P. mackerel
fishery closed
Monterey Bay
H2O ~ 12 C
Monterey Bay
domoic acid
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

Summary of Landings for 2001

Region	Allocation (mt)	Landings (mt)	Percentage of Harvest Guideline
northern California	44,913	5,695	4
southern California	89,824	44,313	34
Total	134,737	50,008	38