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JULY 1995

SPAWNING BIOMASS OF THE NORTHERN ANCHOVY IN 1995 AND STATUS OF THE COASTAL PELAGIC FISHERY DURING 1994

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ADMINISTRATIVE REPORT LJ-95-11

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**SPAWNING BIOMASS OF THE NORTHERN ANCHOVY IN 1995 AND
STATUS OF THE COASTAL PELAGIC FISHERY DURING 1994¹**

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SUMMARY

The estimated spawning biomass for northern anchovy in the central subpopulation during the middle of February, 1995 is 388,000 mt (CV 38%). Total US commercial landings of coastal pelagic species increased from 1993 to 1994, due to a record harvest of market squid although landings of sardine, mackerel and anchovy declined. Mexican landings of coastal pelagic species decreased in 1994 due primarily to a sharp decline in sardine.

¹ file = ADMN95A.13

PURPOSE

This report describes a biomass estimate for northern anchovy (*Engraulis mordax*) spawning in the central subpopulation during February of 1995. The estimate is used by the Pacific Fishery Management Council to set harvest quotas for northern anchovy taken in US waters during the 1995 fishing season (Pacific Fishery Management Council 1991).

An appendix summarizes current conditions in the coastal pelagic species fishery. The fishery harvests market squid (*Loligo opalescens*), Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*), jack mackerel (*Trachurus symmetricus*), northern anchovy and other species. Updated landings, revenue and participation data for US, Mexican, commercial and recreational segments are presented.

DATA

Fishing seasons begin on July 1, end on June 30 and are identified by the first calendar year. For example, the 1993 season began on July 1, 1993 and ended on June 31, 1994. The assessment model for anchovy included data for the 1963 to 1994 fishing seasons.

Five indices of abundance (Table 1 and Figure 1) used to estimate anchovy biomass are described in Jacobson et al. (1994a). Abundance data available for recent years, which are most important, include an index based on fish spotter data (SPOTTER, Lo et al. 1992) and an egg production index (EPI, Jacobson et al. 1994a) based on ichthyoplankton data. The SPOTTER index measures relative schooling biomass, while the EPI index measures relative egg production and spawning biomass.

SPOTTER data indicate that anchovy abundance increased during the 1993-1994 seasons. SPOTTER data are imprecise (CV of 43% for the 1994 season), however, so short term changes in the index may be due to measurement error alone.

EPI data also indicate that anchovy abundance increased during the 1993-1994 seasons. The EPI index for the 1994 season is based on data from a CalCOFI cruise during January (eggs from CalVET nets plus egg and larvae data from bongo nets), and a CalCOFI cruise during April (eggs from CalVET nets only). Bongo net data for the second CalCOFI cruise were not available. EPI

data (CV of 25% in 1994) tend to be more precise than SPOTTER data.

Total landings (tables 1-2 and Figure 2) during the 1993 season (the most recent year with complete data) were 3,809 mt and lower than during the 1992 season (4,741 mt). Preliminary data indicate that landings were low in the 1994 season as well.

Northern anchovy are taken in Mexican, as well as US, waters. Knowledgeable sources report that landings in Mexico during recent years mt (tables 1-2) were low because anchovy were not available. Landings in the U.S. were low because reduction fishery quotas have been zero since the 1988 fishing season.

METHODS

The assessment model and methods are described in Jacobson et al. (1994a). Modeling procedures include bias corrections that reduce a tendency to overestimate anchovy biomass during periods of low abundance and underestimate biomass during periods of high abundance. We evaluated two potential improvements to fish spotter data and modeling procedures.

Fish Spotter Data

There is a discrepancy of three months between the annual time periods used in the assessment model and the annual time periods used to aggregate SPOTTER data. July-June seasons are used as annual time steps in the assessment model. Fish spotter data for April-June are, however, typically unavailable when anchovy biomass is estimated in June. Thus, an April-March annual period must be used to base the SPOTTER index value for the most recent season on a full twelve months of data.

The advantage in using April-March annual periods is a reduction in variance for the most recent season (Table 1 and see below). We fit the assessment model using SPOTTER data for April-March and July-June to determine which gave the most reliable results. Comparisons involved trends in estimated biomass, variance in biomass estimates, and outlier analysis.

Algorithms and Convergence Criteria

Adequacy of the simplex/axial search algorithm and convergence criteria used to fit the assessment model (Jacobson et al. 1994a) were checked by comparison to results using a modified Newton algorithm and more stringent convergence

criteria. The simplex/axial search algorithm is robust and sufficiently quick when convergence criteria are not stringent. The modified Newton approach and stringent convergence criteria give relatively precise results but at the expense of more computer time. Computer time is an important issue because bootstrap bias corrections and variance estimates, which involve fitting the model thousands of times, are used in assessing northern anchovy (Jacobson et al. 1994a). In addition, the modified Newton algorithm may be more sensitive to problems (less robust) in fitting complex models to limited data.

The simplex algorithm is based on subroutine "AMOEBA" in Press et al. (1990). Convergence is defined using a hybrid criteria (Cuthbert 1987):

$$\frac{|F_{\text{WORST}} - F_{\text{BEST}}|}{1 + |F_{\text{BEST}}|} < 0.0001,$$

where F_{BEST} is the objective function at the current best parameter estimates and F_{WORST} is the objective function at the simplex vertex farthest from the minimum. Once convergence occurs, "axial searches" (Mittertreiner and Schnute 1985) are used to find better parameter estimates outside the final simplex. If the axial search is successful, then the algorithm starts over at the new point.

The modified Newton algorithm estimates parameters by maximizing an objective function using the IMSL subroutine "DU2IDH" (Visual Numerics, Inc. 1994) with derivatives calculated numerically by central differences (IMSL subroutine DCDGRD). Convergence is defined using a scaled gradient criteria for each parameter:

$$\frac{|g_i| |x_i|}{|F_{\text{BEST}}|} < 0.000006,$$

where x_i is the current estimate for the i^{th} parameter and g_i is its gradient.

The assessment model was fit to a preliminary data set with twenty bootstrap iterations using the simplex and modified Newton algorithms. Best fit parameter estimates and the average and variance of parameter and biomass estimates from bootstrap runs

were compared to determine if the two approaches gave different results. All calculations were double precision FORTRAN on either a personal computer (MS-DOS) or workstation (UNIX).

RESULTS

Fish Spotter Data

April-March SPOTTER data were used for final biomass estimates. On balance, April-March annual periods appeared better because of differences in the precision of data and biomass estimates for the most recent season and because the assessment model fit the April-March SPOTTER data more closely. Precision in the most recent season is particularly important in setting fishery quotas.

CV's for SPOTTER index values in the most recent season were substantially lower using April-March annual periods (43% versus 53%; Table 1 and Figure 3). CV's averaged 36% for both SPOTTER series indicating similar precision overall. CV's for the 1963-1978 seasons were almost identical but there were discrepancies beginning with the 1979 season. With the notable exception of 1992, CV's for the April-March series were generally lower after 1979.

The difference in CV's for 1992 SPOTTER data occurred because proportion positive (fraction of blocks in which anchovy were sighted) in 1992 was 0.12 (standard error 0.12, CV 100%) using April-March data and 0.25 (standard error 0.10, CV 40%) using July-June data. Proportion positive for 1992 is the lowest value in the April-March series. It appears that variance calculations are sensitive to data and modeling procedures (Lo et al. 1992) in seasons with low proportion positive values. Fortunately, index values with high CV's receive less weight in the model and have trivial effects on biomass estimates (see below).

Trends in SPOTTER data appear more reasonable when July-June annual periods are used to aggregate data because two extreme values were reduced. Trends were similar overall (Table 1; Figure 3) but a peak at 1979 in the original April-March series was reduced and shifted back to 1978 in the July-June series. In addition, a peak at 1975 in the April-March series was reduced. The July-June SPOTTER index value for the most recent season was about 22% larger than the April-March value.

Spawning biomass estimates from April-March and July-June

SPOTTER data were similar. Spawning biomass estimates for the 1992 season were almost identical despite differences in the precision of SPOTTER data. The spawning biomass estimate for the most recent season from July-June SPOTTER data was about 12% higher than the estimate from the April-March SPOTTER data. CV's for the most recent spawner biomass estimates were 38% with April-May SPOTTER data and 41% with July-June SPOTTER data. Thus, the most recent spawning biomass estimate was slightly more precise when April-May SPOTTER data were used.

Larger standardized residuals were obtained from July-June SPOTTER data and the standard deviation of residuals was larger, indicating that fit of the assessment model was better for April-March SPOTTER data. Residuals ranged from -3.4 to 3.6 (standard deviation 0.62) for July-June SPOTTER data and from -2.4 to 3.5 (standard deviation 0.52) for April-March SPOTTER data.

Algorithms and Convergence Criteria

The simplex/axial search algorithm with relaxed convergence criteria and modified Newton algorithms with stringent convergence criteria gave almost identical results. Best estimates of parameters and anchovy biomass levels differed by -0.4 to 0.5%. Standard deviations for parameter and biomass estimates from twenty bootstrap iterations differed by -4 to 3%. The simplex/axial search algorithm with relaxed convergence criteria was used for final runs because it was faster and potentially more robust.

Final runs

As in previous assessments, two potential outliers in the abundance index data (standardized residuals of 3.5 for 1979 SPOTTER and 3.8 for 1983 EPI) were not omitted to conform to preferences expressed by Council's Scientific and Statistical Committee (Jacobson and Lo 1993). Omission of the outliers would have changed biomass estimates by +27% on average. Residual plots for abundance indices showed serial correlation.

We omitted EPI data during one run and omitted SPOTTER data during another to assess the sensitivity of anchovy biomass estimates to differences in abundance index data. See Jacobson et al. (1994a) for a more complete sensitivity analysis. Results (without bias correction) are summarized below.

<u>1994 Season Spawning Biomass (mt)</u>	
SPOTTER only	434,000
SPOTTER & EPI	380,000
EPI only	316,000

The sensitivity analysis indicates that biomass estimates for the 1994 season were sensitive to differences between SPOTTER and EPI data. SPOTTER and EPI data indicate increased anchovy biomass in the 1994 season (Figure 1) but SPOTTER data indicate that the increase was larger. The estimate using both (380,000 without bias correction) is nearly equal to the average of estimates with SPOTTER data only and EPI data only. Results from all three runs indicate that spawning biomass during the 1994 season exceeded the 300,000 mt cutoff used in the formula for optimum yield.

Bias corrections ranged from -17% (1963 season) TO +21% (1993 season). The spawning biomass estimate for the 1994 season (used to set quotas) was not biased appreciably (-2%), presumably because recruitment and biomass were near average levels.

We compared the new estimates of spawning biomass for anchovy to estimates from the assessment for last year but found little evidence for retrospective bias (Jacobson et al. 1994a) for recent years. There were differences for 1973-1975 seasons but these were due to changes in SPOTTER index values (Jacobson et al. 1994b).

Status of the Stock

The final estimate of spawning biomass for the central subpopulation of northern anchovy during the middle of February, 1995, based on all data and corrected for bias, was 388,000 mt (CV 38%, Table 3 and Figure 4).

Anchovy biomass declined after the 1985 season (Figure 4) due primarily to low recruitment (Table 3; Jacobson et al. 1994a). Fishing may have contributed to the decline but does not appear to have been critical because fishing mortality rates never exceeded 17% per year (Table 3). The apparent recent increase in anchovy spawning biomass was due to a relatively high estimated recruitment in the 1993 season. The 1993 year class began spawning as one year olds during the 1994 season.

The apparent increase in anchovy biomass during the 1993-1994 seasons is encouraging but additional data and at least another year will be required to determine if the increase is

real and substantial. The spawning biomass estimate for the 1994 season is imprecise (CV 38%) which implies a 95% confidence interval of about 109,000-667,000 mt. A 250% increase (154,000 to 388,000 mt) in biomass is suspiciously large but anchovy stocks are dynamic and substantial changes in estimated biomass have occurred previously (Figure 4). Thus, the true biomass of anchovy could be substantially smaller or larger.

Increased catches in Mexico during the 1994 or 1995 seasons would be evidence for increased biomass. When anchovy spawning biomass was at about 409,000 mt during 1986 season (Figure 4), there was a substantial fishery (116,000 mt) in Mexico (Table 1) but Mexican landings are currently low because anchovy are reportedly unavailable.

Increased biomass from a strong 1993 year class is consistent with SPOTTER and EPI data because the increase in SPOTTER data during 1993-1994 was larger than the increase in EPI data (Table 1). This pattern would be expected with a strong incoming year class because one year old fish "show up" in SPOTTER data to a greater extent than in EPI data. Age specific contributions to each SPOTTER and EPI data are represented in the assessment models by selectivity parameters (see below). One year old fish have relatively low selectivity values for EPI data because their fecundity and egg production are relatively low.

<u>Age</u>	<u>Age Specific Selectivities</u>	
	<u>SPOTTER</u> ²	<u>EPI</u> ³
0	0.0	0.0
1	1.0	0.21
2	1.0	0.54
3	1.0	0.84
4	1.0	1.0

²Fixed at assumed values; not estimated in model.

³From age specific fecundity estimates in Methot (1989); see Jacobson et al. (1994a) for additional information.

ACKNOWLEDGMENTS

Walterio Garcia (Centro Regional Investigacion de Pesquera) provided data for the Mexican fishery. Marcie Yaremko (California Department of Fish and Game) and Sam Herrick (Southwest Fisheries Science Center) provided data and information about American fisheries. Richard Charter, Geoff Moser and staff at the Southwest Fisheries Science Center provided fish spotter and CalCOFI data.

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Table 1. Abundance, landings (thousand mt) and temperature data (degrees C.) for northern anchovy during the 1963-1994 seasons. Units for SPOTTER are short tons per block, units for HEP and EPI are eggs / 0.05 sq. m / day. Units for EPM are thousand mt. "CV" is for coefficient of variation. Landings and for the 1993 season are preliminary. SPOTTER data were calculated using July-June and April-March annual periods for comparison.

Season	July-June SPOTTER	July-June SPOTTER-CV	April-March SPOTTER	April-March SPOTTER-CV	HEP	HEP-CV	EPI	EPI-CV	SONAR	EPM	EPM-CV	Mexican Landings	US Landings	Total Landings	Scripps Pier Temperature
1963	29.3	26%	19.4	26%	4.1	65%						0.000	1.795	1.795	15.0
1964	125.7	29%	147.1	29%	4.0	29%						0.000	2.324	2.324	13.3
1965	96.7	31%	115.5	30%	5.3	34%						0.000	18.958	18.958	13.8
1966	152.4	28%	162.2	28%								0.000	42.725	42.725	14.0
1967	44.3	31%	94.7	29%								0.000	13.470	13.470	14.5
1968	108.8	30%	63.5	32%	3.8	28%			0.44			0.000	33.224	33.224	14.3
1969	222.9	29%	264.7	28%					0.28			0.000	83.391	83.391	13.6
1970	117.9	32%	141.6	30%					0.23			0.000	81.854	81.854	13.1
1971	187.7	28%	187.0	28%	1.7	48%			0.82			0.000	55.624	55.624	12.8
1972	173.9	31%	149.4	30%					1.67			0.000	76.059	76.059	15.0
1973	989.9	27%	1021.8	27%					0.95			0.000	116.666	116.666	13.1
1974	596.6	27%	600.6	27%	19.7	53%			3.09			28.088	113.782	141.870	13.2
1975	571.8	27%	821.5	27%					1.98			35.287	135.573	170.860	13.9
1976	380.8	29%	490.7	28%					0.39			108.962	104.095	213.057	16.0
1977	430.1	28%	425.8	28%	2.3	192%			0.29			127.229	76.236	203.465	15.7
1978	843.7	32%	589.8	33%	5.4	48%			0.60	870	26%	195.675	55.966	251.641	13.9
1979	670.4	35%	1118.7	31%	2.7	47%	2.16	27%	0.57	635	22%	157.543	40.091	197.634	15.0
1980	552.1	36%	718.2	34%	4.4	48%	2.96	14%	0.25	415	26%	287.547	65.906	353.453	14.6
1981	381.7	34%	359.5	34%	3.3	41%	1.90	17%	0.53	652	21%	255.086	53.212	308.298	14.1
1982	85.9	47%	380.8	37%	3.9	30%	2.24	34%	0.57	309	17%	156.725	11.003	167.728	15.9
1983	34.9	55%	112.4	45%	2.9	37%	5.75	11%	1.02	521	19%	66.260	7.507	73.767	15.0
1984	358.7	43%	410.4	40%	2.6	26%	6.89	48%				123.359	4.762	128.121	13.8
1985	311.4	39%	330.6	38%			7.13	32%				85.801	6.321	92.122	15.2
1986	106.0	39%	136.1	38%			4.97	16%				116.334	4.783	121.117	15.0
1987	139.3	41%	101.9	40%			6.26	33%				98.498	5.794	104.292	14.0
1988	337.9	41%	497.2	37%			1.47	29%				86.361	5.795	92.156	13.0
1989	144.8	40%	174.1	37%			2.31	35%				55.647	8.228	63.875	14.4
1990	99.8	45%	80.1	46%			1.82	23%				0.796	10.328	11.124	14.9
1991	139.6	51%	171.0	43%			0.86	32%				1.896	6.353	8.249	15.3
1992	57.1	52%	31.4	106%			2.01	36%				0.673	4.068	4.741	15.4
1993	136.7	41%	104.7	39%			1.18	25%				0.268	3.541	3.809	15.2
1994	373.8	53%	307.6	43%			2.07	25%				0.923	2.473	3.396	15.4

Table 2 (landings)

Table 3. Total biomass, spawning biomass, recruitment biomass, and fishing mortality rate estimates for northern anchovy during the 1963 to 1994 fishing seasons. All biomass estimates were corrected for bias. Recruitment estimates are for age zero northern anchovy at the beginning of the fishing season (1 July). Total and spawning biomass estimates are for northern anchovy age 1 and older during the peak spawning period (15 February) of each fishing season.

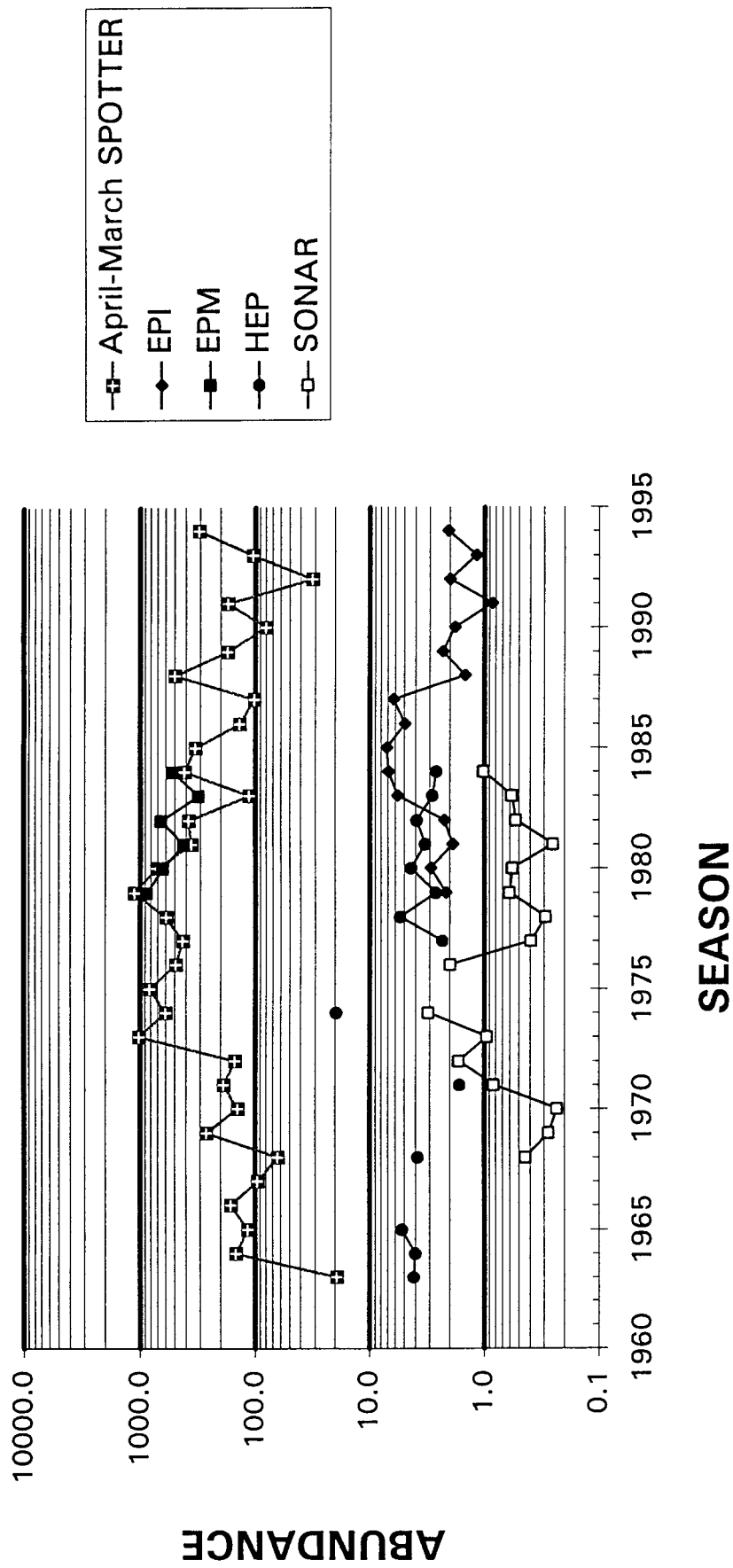
Fishing Season	Total Biomass (1,000 mt)	CV (%)	Spawning Biomass (1,000 mt)	CV (%)	Recruitment Biomass (1,000 mt)	CV (%)	Fishing Mortality (yr ⁻¹)
1963	637	39%	612	39%	166	47%	0.00
1964	379	30%	356	33%	207	48%	0.00
1965	261	28%	236	27%	464	50%	0.03
1966	275	31%	230	29%	248	48%	0.08
1967	214	30%	206	30%	241	45%	0.03
1968	187	29%	173	29%	830	48%	0.05
1969	331	33%	198	29%	258	47%	0.14
1970	221	30%	172	31%	868	54%	0.10
1971	360	38%	138	28%	680	57%	0.06
1972	391	37%	383	37%	4,348	47%	0.03
1973	1,598	36%	474	28%	1,495	76%	0.05
1974	1,246	35%	932	31%	2,652	75%	0.06
1975	1,326	35%	1,069	31%	990	59%	0.09
1976	902	31%	901	31%	496	56%	0.16
1977	521	32%	520	32%	654	55%	0.19
1978	395	32%	337	30%	1,770	37%	0.16
1979	673	24%	654	24%	961	40%	0.15
1980	513	20%	490	19%	631	40%	0.35
1981	356	22%	320	20%	2,050	25%	0.19
1982	714	19%	711	19%	222	42%	0.17
1983	397	20%	395	20%	1,935	35%	0.04
1984	822	22%	555	18%	1,115	60%	0.09
1985	723	32%	715	32%	304	41%	0.09
1986	412	30%	409	30%	217	42%	0.17
1987	241	29%	227	28%	1,285	39%	0.12
1988	441	29%	167	29%	186	38%	0.15
1989	245	30%	239	29%	136	35%	0.15
1990	153	29%	152	29%	270	36%	0.03
1991	172	27%	171	27%	174	37%	0.02
1992	145	28%	145	28%	235	40%	0.01
1993	156	31%	154	31%	938	51%	0.00
1994	392	38%	388	38%	561	13%	0.00

Figure 1. Indices of abundance for northern anchovy plotted in log scale to facilitate comparison. The SPOTTER index shown was calculated using April-March annual periods.

Figure 2. Anchovy landings for US and Mexican fisheries by fishing season.

Figure 3. Spotter index values and coefficients of variation (CV) by fishing season calculated using April-March and July-June annual periods.

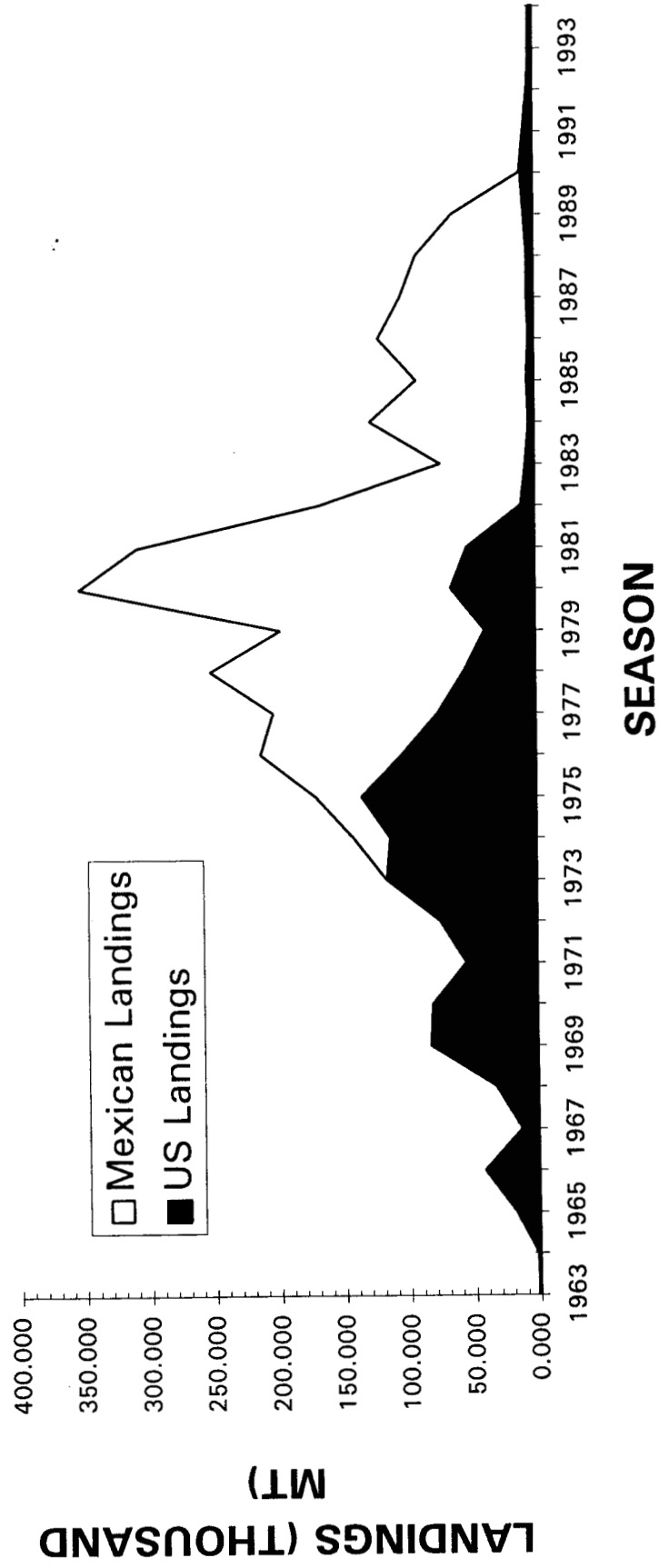
Figure 4. Spawning and total biomass (ages 1+) biomass estimates for anchovy (thousand mt) in the middle of February during the 1963-1994 seasons.

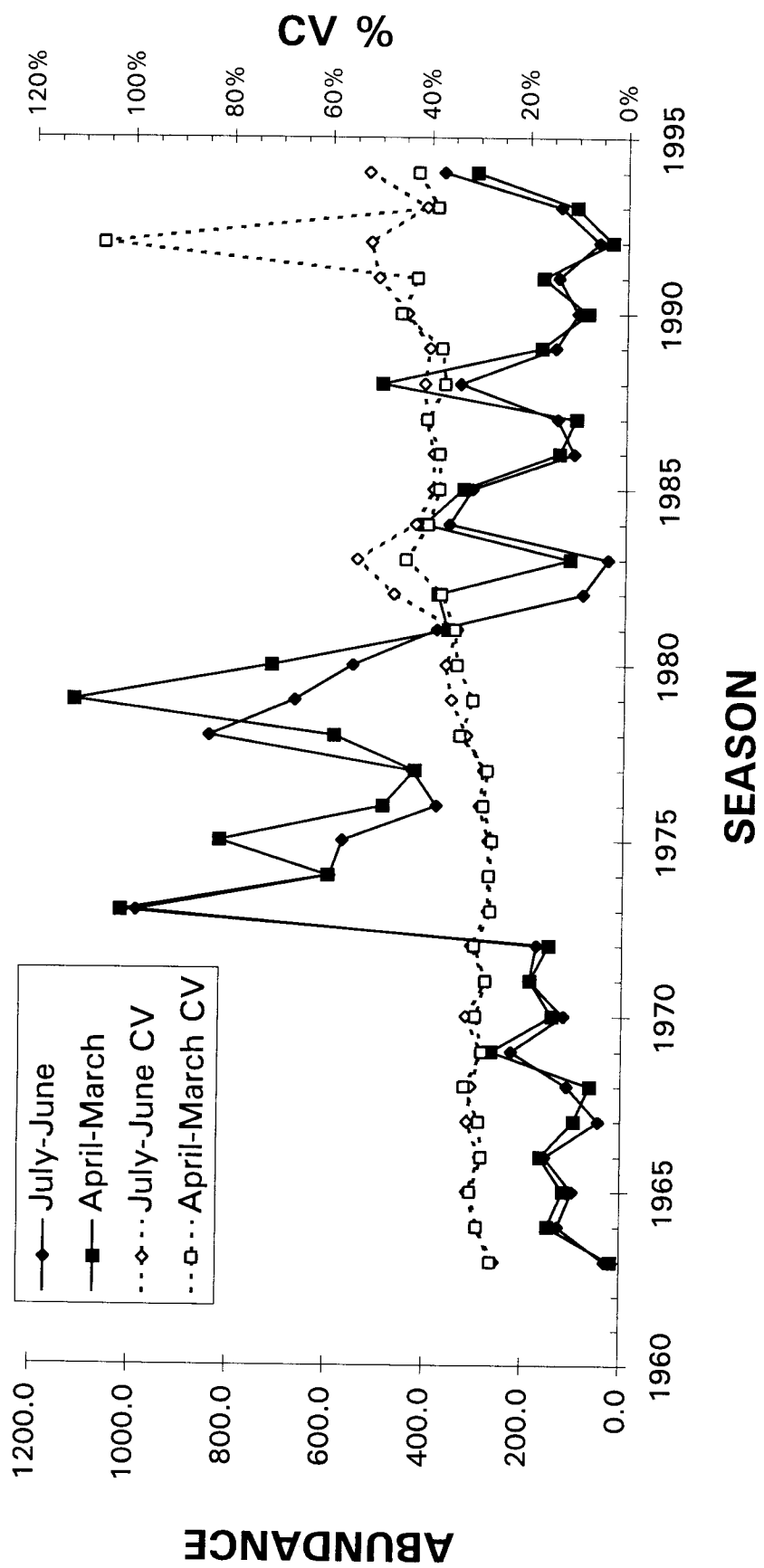


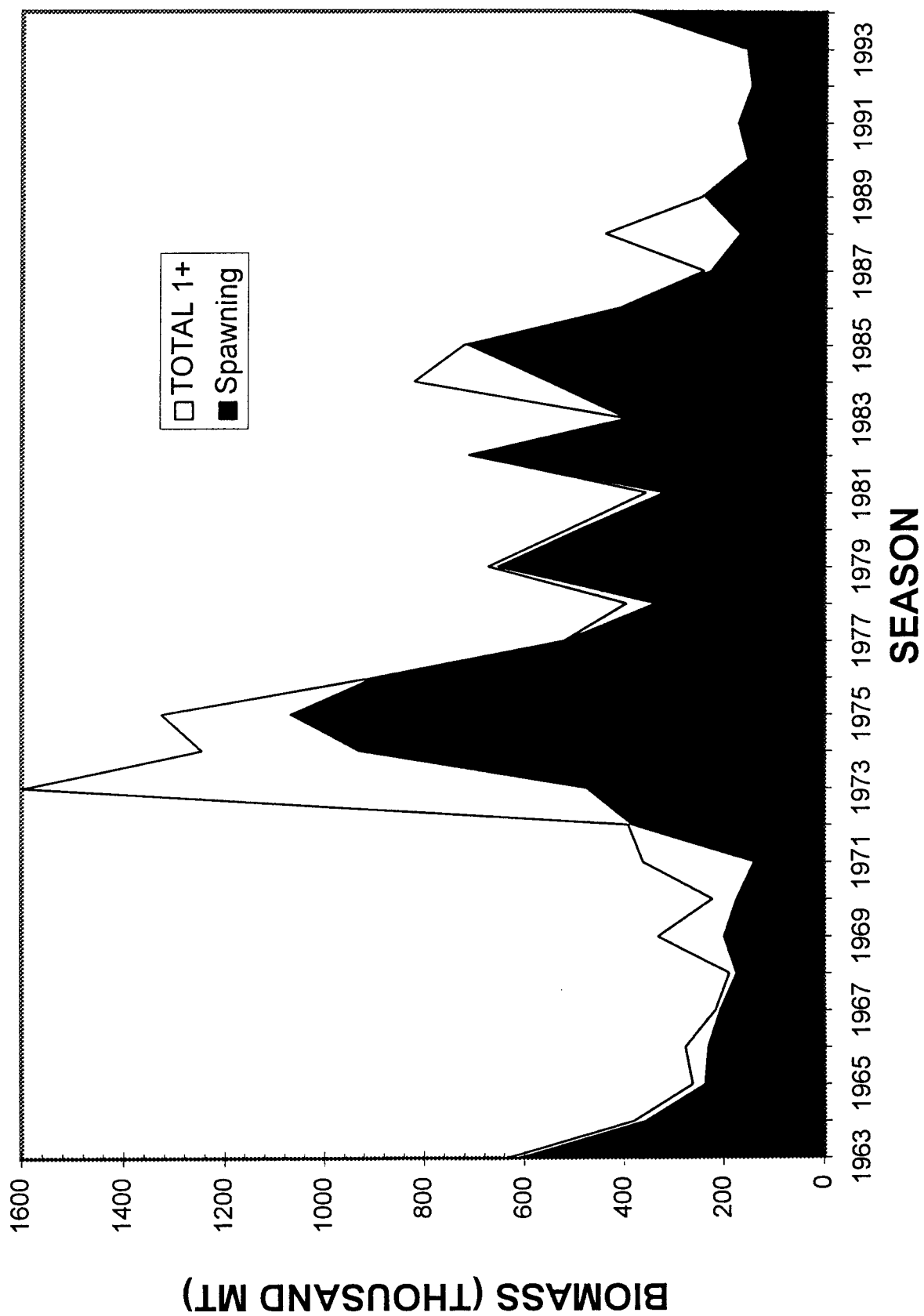
ADDENDUM.XLS

Examples to illustrate and check calculations in Table 3 of Jacobson et al. (1995. SWFSC Admin. Rept. LJ-95-11). Figures in **bold** (recruitment biomass, spawning biomass, and fishing mortality rates are from Table 3. Figures in *italics* (growth and natural mortality rates) are from Jacobson et al. 1994 (Fish. Bull. 92: 711-724). All biomass figures are in 1,000 mt. Fishing seasons are from July 1 to June 30 of the next calendar year. Spawning is assumed to occur on February 15. A total of 1,495K mt of recruits (age 0) and 2,402K mt of fish age 1+ on July 1, 1973 resulted in a 1+ biomass of 2,030K mt on July 1, 1974 which was reduced to 1,342K mt by February 15, 1975. Note that 1,342K mt agrees (except for rounding error) with 1,326K mt reported in Table 3. A spawning biomass of 474K mt on February 15, 1974, produced 1,246K mt of recruits age 0 on July 1 of 1974.

Instantaneous Natural Mortality (M)	0.8		
Instantaneous Growth (G)	0.198		
M-G	0.602		
Fishing Mortality 1973 Season	0.05		
Fishing Mortality 1974 Season	0.06		
Fraction Season 1-Jul to 15-Feb	0.625		
Fraction Season 15-Feb to 30-Jun	0.375		
Season	1973	1974	1974
Calendar Year	1973	1974	1975
Date	1-Jul	1-Jul	15-Feb
Recruits (Age 0)	1,495	1,246	824
Ages 1+	2,402	2,030	1,342
Ages 1+ (Spawning)		474	1,069
Ages 0+		3,276	2,166







APPENDIX 1 - STATUS OF THE COASTAL PELAGIC SPECIES FISHERY

Introduction

The purpose of this appendix is to describe the status of the coastal pelagic species fishery off California and Baja California, Mexico. Information about recreational participation and landings, commercial landings, commercial revenues and prices, information about processors and exports are provided. Thomson et al. (1994) and Ainley et al. (1993) give additional information about the fishery.

The coastal pelagic species fishery harvests mainly market squid (*Loligo opalescens*), Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*, northern subpopulation), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*, central subpopulation). Bonito (*Sarda chiliensis*), tunas, and other species are also taken.

The fishery operates mainly off southern California in the U.S. and northern Baja California in Mexico but occasionally as far north as Washington state and British Columbia, Canada. Commercial landings of the principal species (squid, mackerels, sardine and anchovy) in California have varied dramatically over time (Table 1).

Individual components of the CPS fishery include US and Mexican commercial fisheries, party and charter boats used for recreational fishing, and anglers who target coastal pelagic species or use them as bait. Coastal pelagic species are taken directly and as bycatch in fisheries that use many types of gear. Purse seines and other roundhaul nets are the primary gear used in directed fishing. Catches (mostly incidental) are also taken with midwater trawls, pelagic trawls, longlines, gill nets, dip nets, trammel nets, trolls, pots, hook and line, and jigs.

Total US commercial landings of coastal pelagic species increased from 1993 to 1994, due to a record harvest of market squid although landings of sardine, mackerel and anchovy declined. Sardine landings declined due to a smaller quota in the 1994 season; there were no apparent problems with availability or declines in overall fishing effort. Live and dead bait harvests of CPS declined in 1994, due to poor availability of northern anchovy to bait haulers. There was a decrease in recreational harvests of CPS, primarily mackerel, by California party and charter boat anglers in 1994. Mexican landings of coastal pelagic species decreased in 1994 due primarily to a sharp decline in sardine.

Summary

California commercial landings of coastal pelagic species totaled 81,446 mt in 1994, an 11% increase from 1993 (Table 1). The total harvest of northern anchovy in the U.S. and Mexico during 1994 was 4,723 mt, down slightly from 4,764 mt in 1993 and much lower than during the 1970's and early 1980's (Table 2). Relatively little northern anchovy (875 mt) was harvested in Mexico. About 1,924 mt was taken commercially in the U.S. for non-reduction uses and 1,923 mt was taken for live bait. No northern anchovy were taken for reduction to fish meal in the U.S. because the US reduction quota was zero (Table 3). The proportion of anchovy in the live bait catch has declined in recent years (Table 4). In 1994, northern anchovy were 56% of the live bait harvested in California. Although U.S. commercial landings decreased in 1994, exvessel prices for northern anchovy increased, so that exvessel revenues (\$501 thousand) increased also (Figure 1).

Total commercial landings of Pacific and jack mackerel in the U.S. totaled 12,398 mt in 1994, down from 14,077 mt in 1993, and much lower than in previous years (Table 1 and Figure 2). Quotas have been imposed by California in recent years because of declining biomass estimates (Table 5). Recreational catch of mackerel by anglers fishing from California commercial passenger fishing vessels declined somewhat in 1994 (Table 6). Exvessel prices for mackerel increased in 1994 but not enough to prevent exvessel revenues (\$1,718 thousand) from declining (Figure 2).

Total harvest of Pacific sardine in the U.S. during 1994 was 13,874 mt and lower than in 1993 (Table 7). Live bait accounted for 1,487 mt. Most of the commercial harvest was by the southern fishery. Although commercial landings declined, exvessel prices for sardine increased in 1994, so that exvessel revenues (\$1,880 thousand) increased also (Figure 3).

Squid landings reached a record high of 55,770 mt in 1994 (Table 1 and Figure 4) and were high in both northern and southern areas (Table 8). In addition, exvessel prices for squid increased so that revenues reached \$18,240 thousand, a new record (Figure 4).

Total landings of CPS in Mexico decreased to 35,070 mt in 1994 from 40,071 mt in 1993 (Table 9). Sardine landings decreased by about 33% while Pacific mackerel landings increased by about 50%. Mexican harvests of northern anchovy more than doubled in 1994, but were still low relative to historic levels.

Between 1993 and 1994, the number of round haul vessels that landed at least 50 mt of anchovy, mackerels and sardine, rose from 35 to 38 (Table 10). The number of round haul vessels that

landed less than 50 mt of anchovy, mackerels and sardine but at least 50 mt with squid decreased from 25 to 24. Squid was the most important species in terms of landings (Table 11) and revenues (Table 12) for both groups of boats.

The number of processors who bought at least 500 mt of anchovy, mackerel, and sardine declined during 1994 to eight plants (Table 13). The number of processors who bought at least 500 mt of anchovy, mackerel, sardine and squid decreased to eleven. Together, these 19 plants (down from 22 in 1993) processed 94% of total anchovy, mackerel and sardine landings and 96% of total squid landings in California.

Exports of coastal pelagic species declined in 1994 (Table 14). About 437 mt of mackerel products were exported during 1994 compared to 627 mt during 1993 (Table 14a). Mackerel exports were primarily (86%) to Australia. Pacific sardine exports declined to 1,458 mt in 1994 from 1,641 mt in 1993 (Table 14b). Sardine were exported mainly to Australia and Fiji. Exports of northern anchovy products declined from 83 mt in 1993 to 51 mt in 1994. Anchovy exports were mainly to Mexico (Table 14c).

Figures

Figure 1. Annual landings, exvessel revenues and exvessel prices for northern anchovy in California.

Figure 4. Annual landings, exvessel revenues and exvessel prices for mackerel (jack and Pacific mackerel combined) in California.

Figure 3. Annual landings, exvessel revenues and exvessel prices for Pacific sardine in California.

Figure 4. Annual landings, exvessel revenues and exvessel prices for market squid in California.

Figure 1a. California landings of northern anchovy (metric tons), 1955-94.

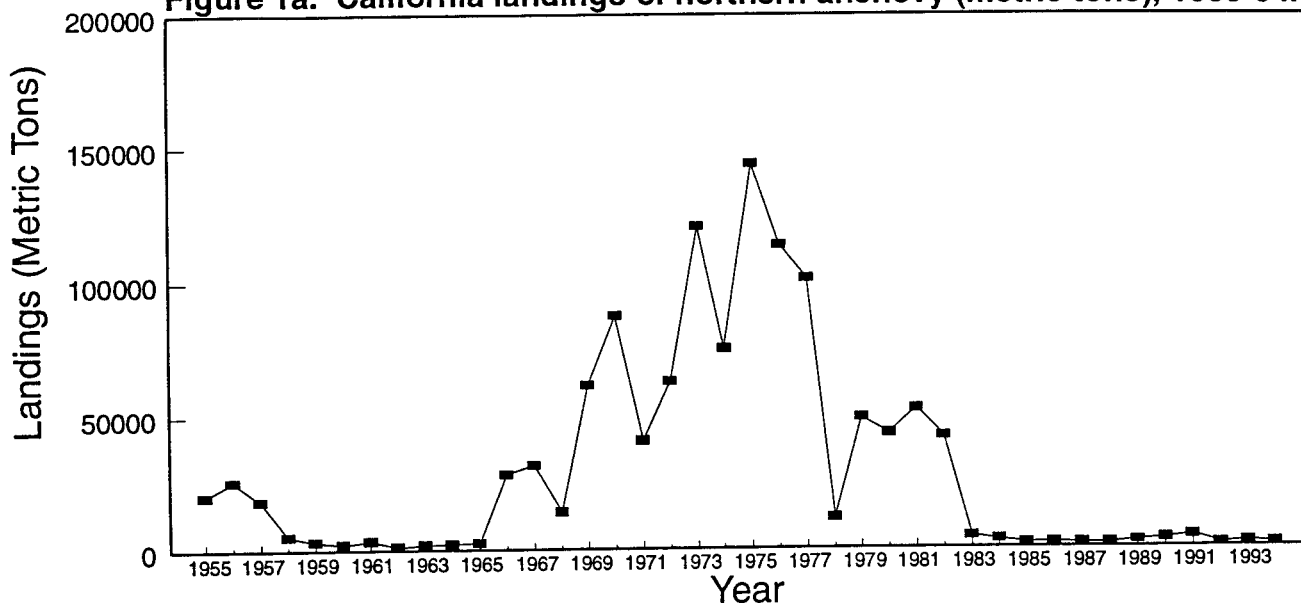


Figure 1b. Exvessel revenues from anchovy (\$1,000's), 1955-94.

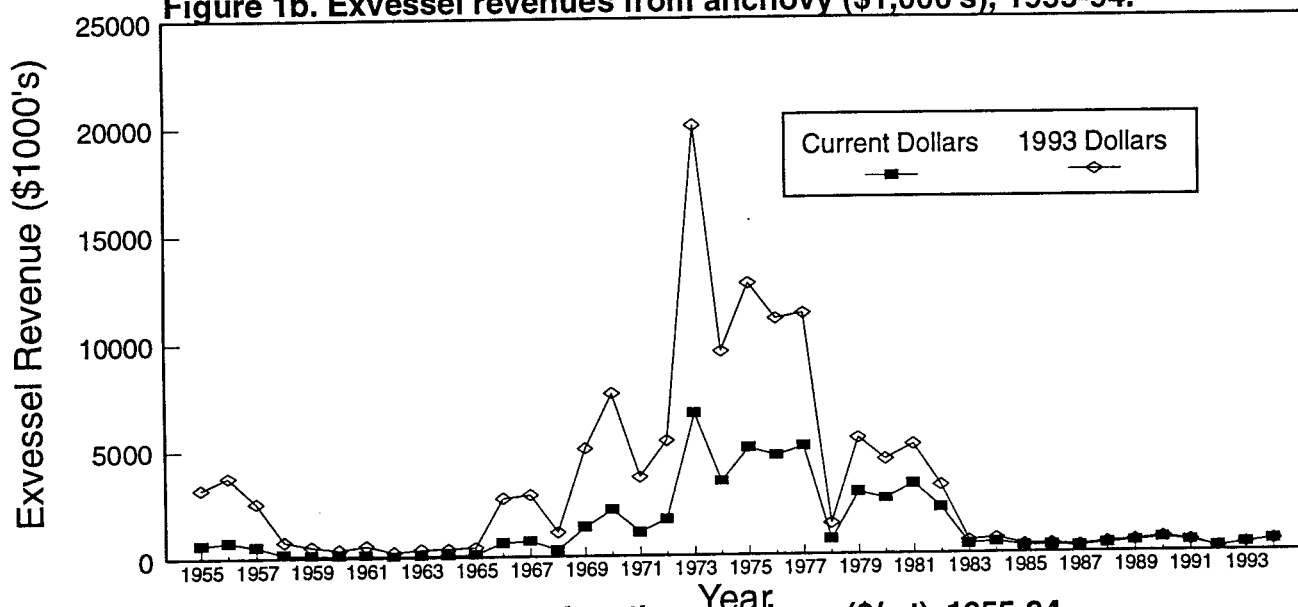


Figure 1c. Exvessel price of northern anchovy (\$/mt), 1955-94.

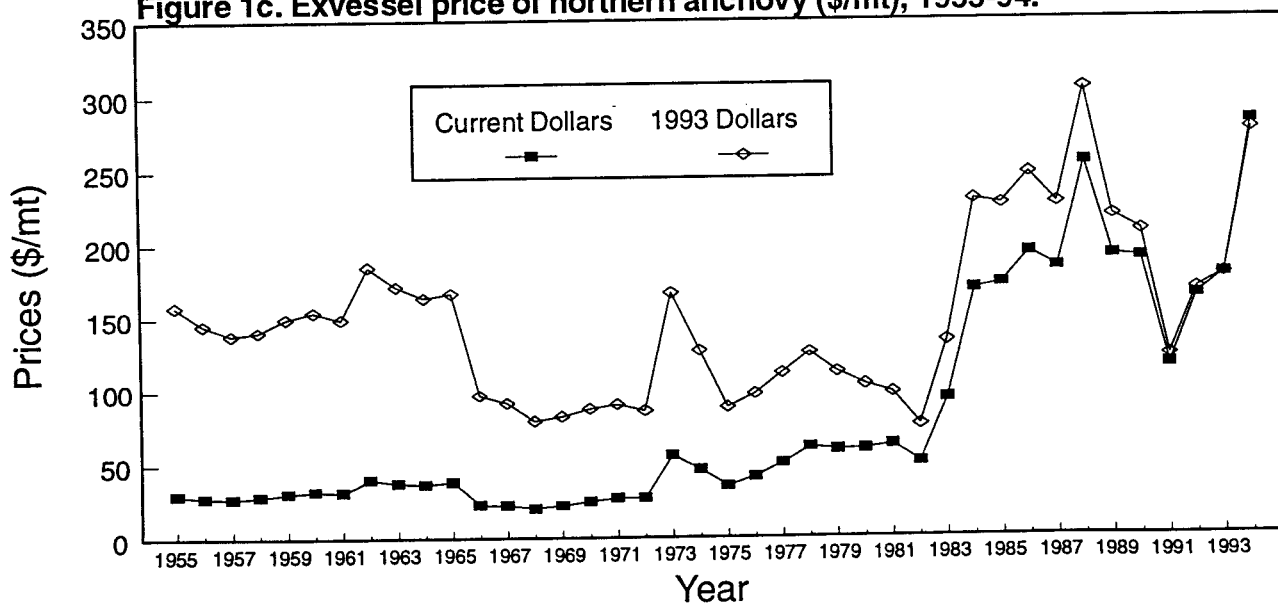


Figure 2a. California landings of Pacific and jack mackerel (mt), 1955-94

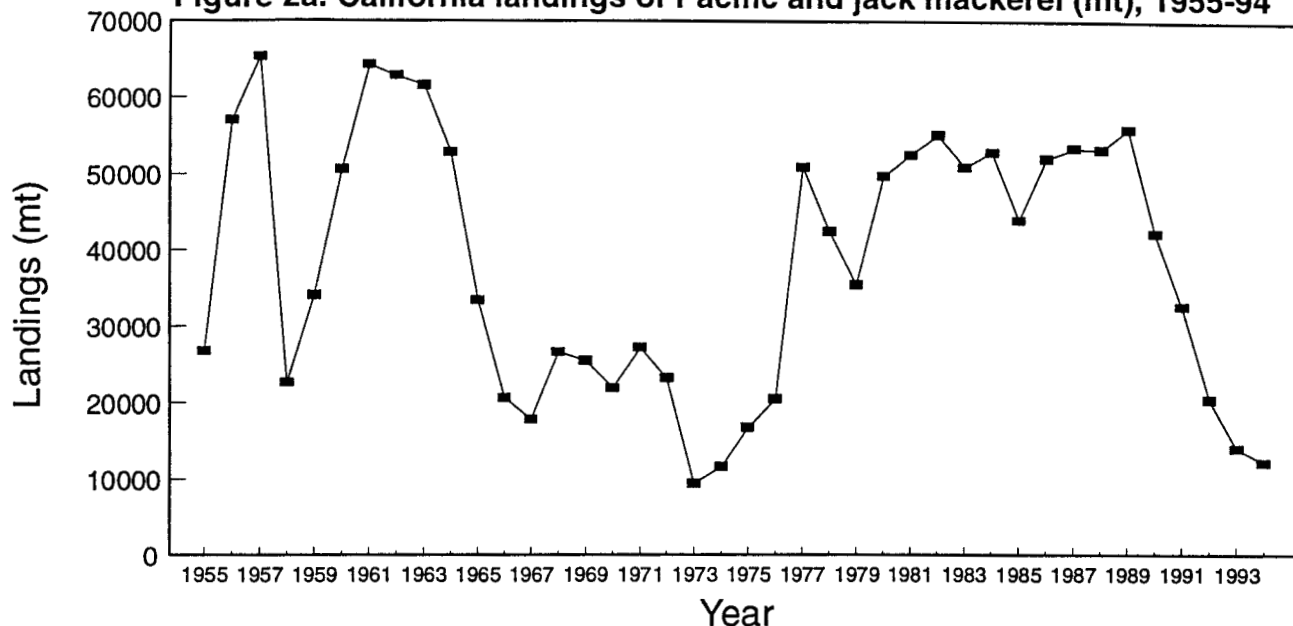


Figure 2b. Exvessel revenues from mackerel (\$1,000's), 1955-94.

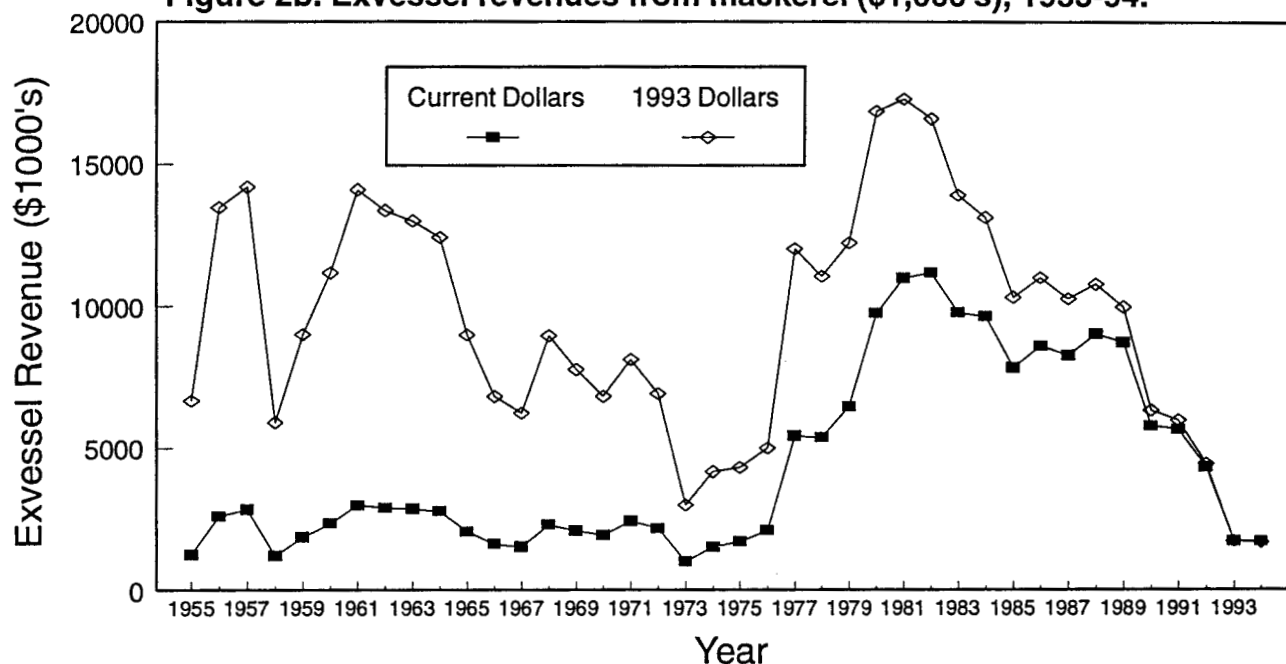


Figure 2c. Exvessel price of Pacific and jack mackerel (\$/mt), 1955-94.

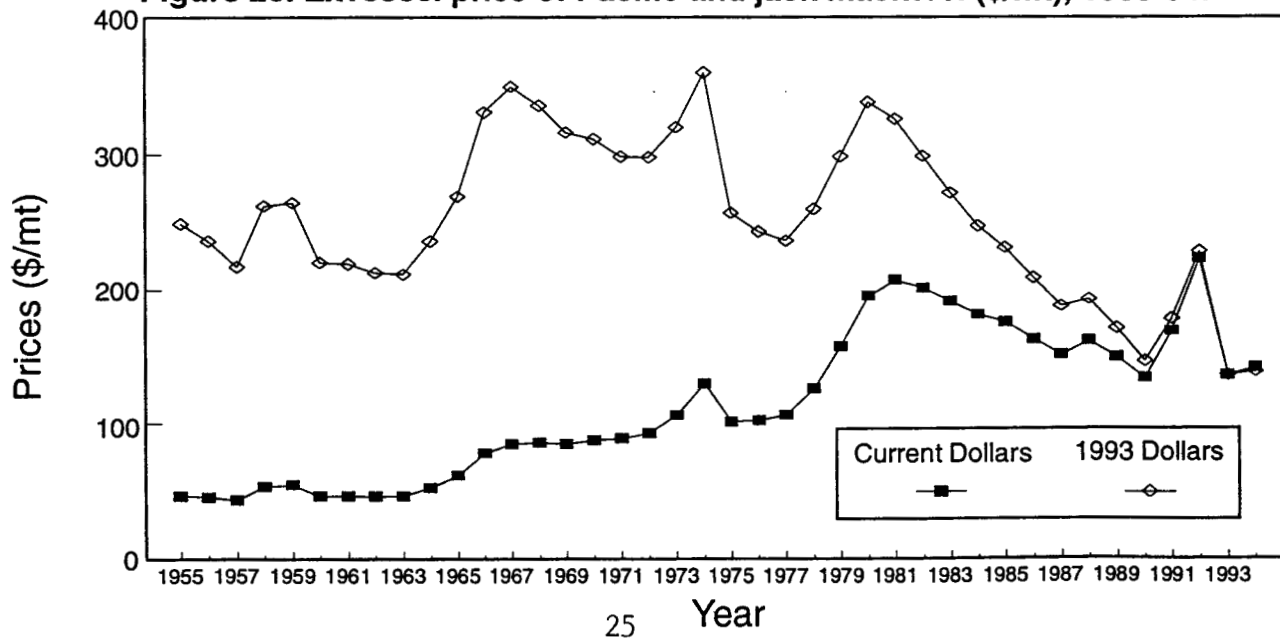


Figure 3a. California landings of Pacific Sardine (mt), 1955-94.

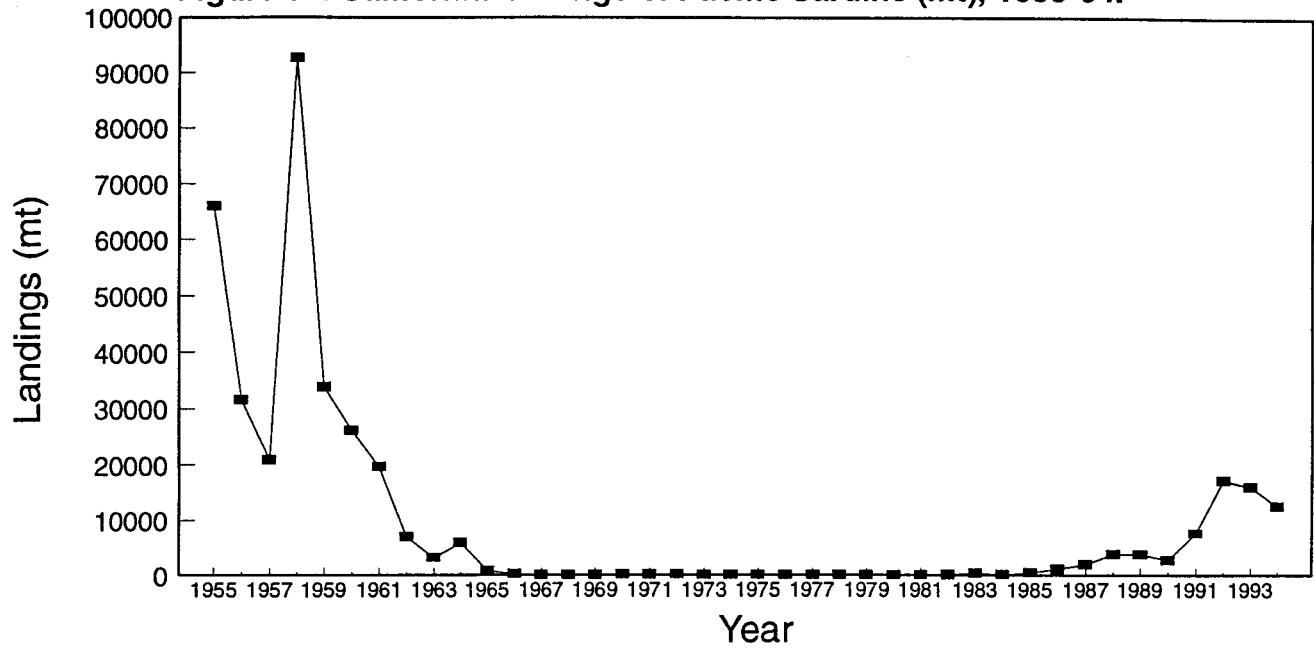


Figure 3b. Exvessel revenues from Pacific sardine (\$1,000's), 1955-94.

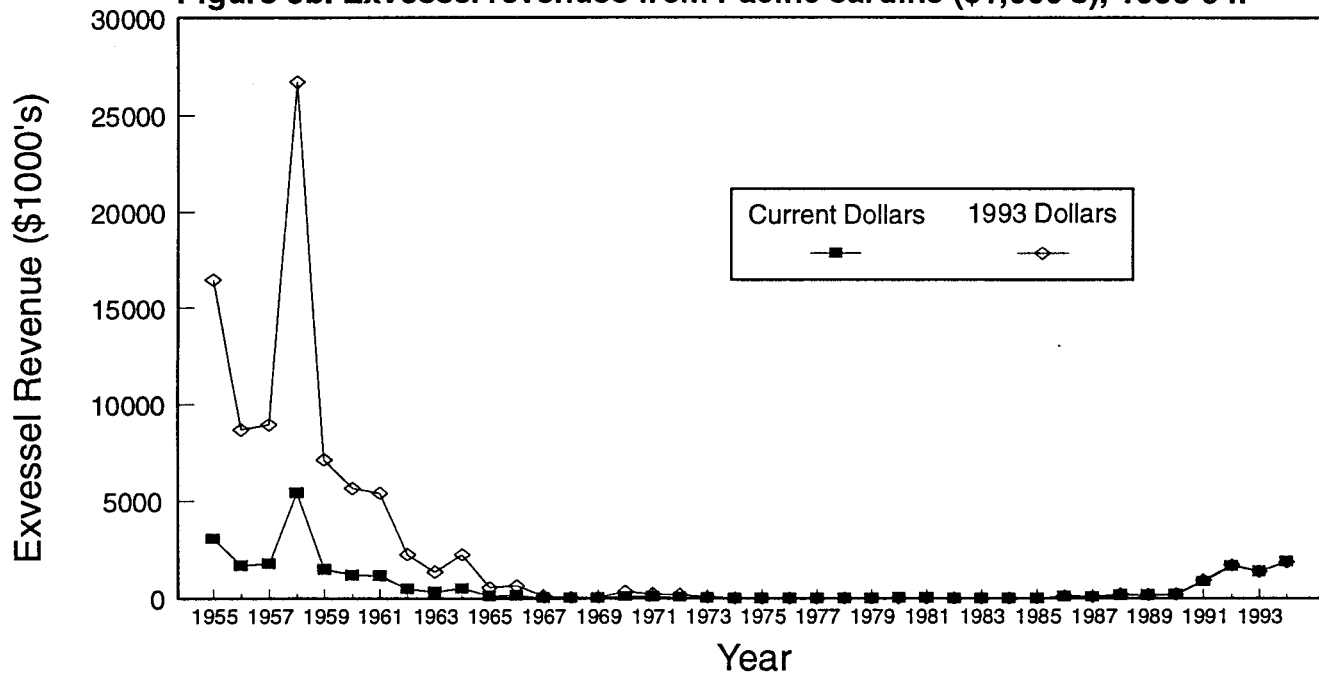


Figure 3c. Exvessel price of Pacific sardine (\$/mt), 1955-94.

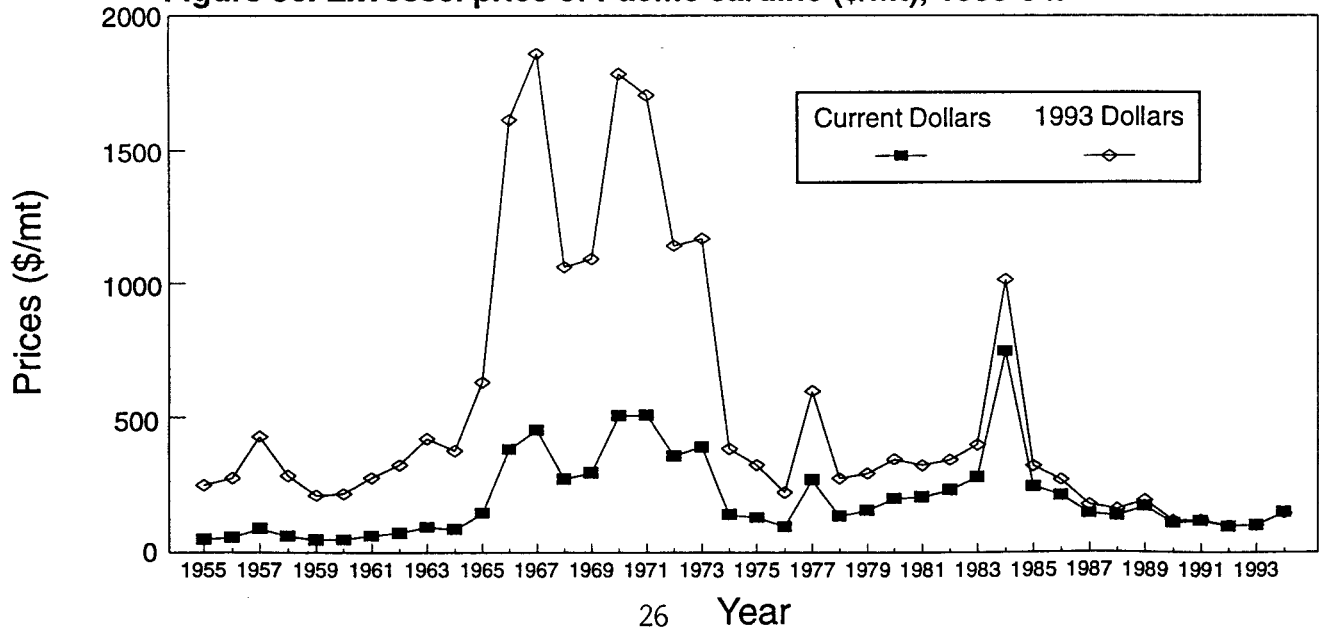


Figure 4a. California landings of market squid (mt), 1955-94.

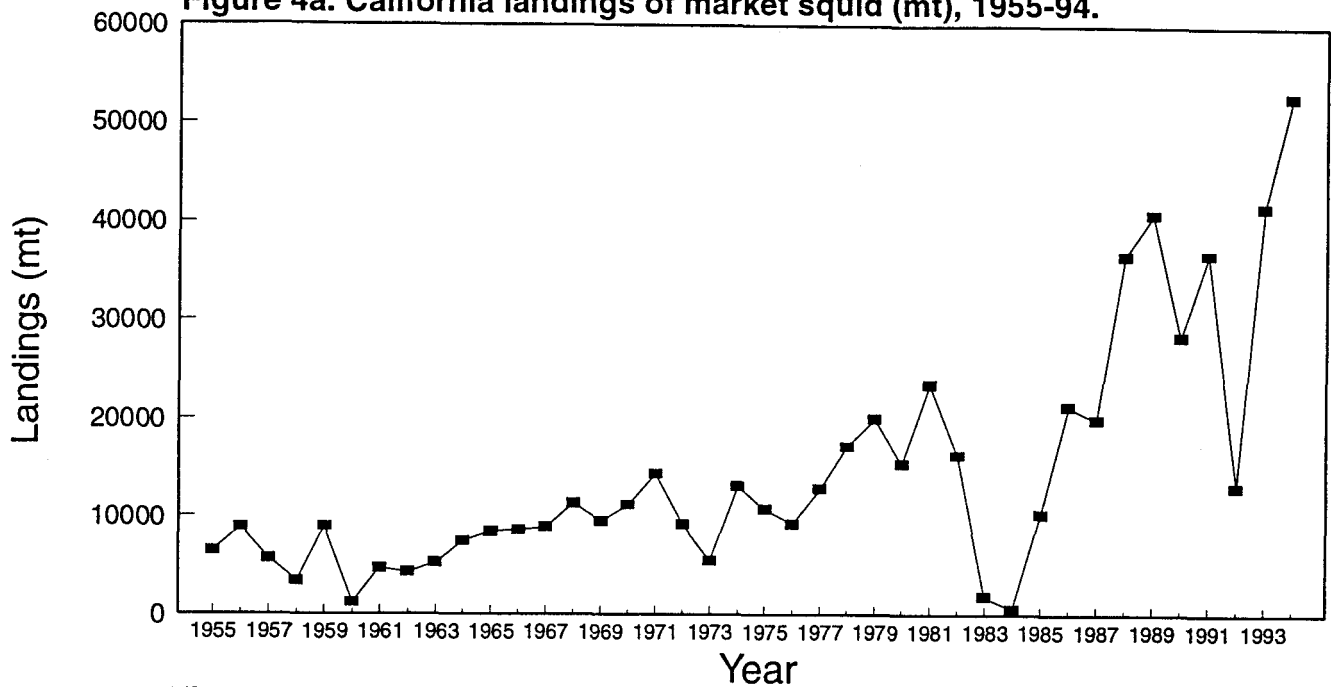


Figure 4b. Exvessel revenues from market squid (\$1,000's), 1955-94.

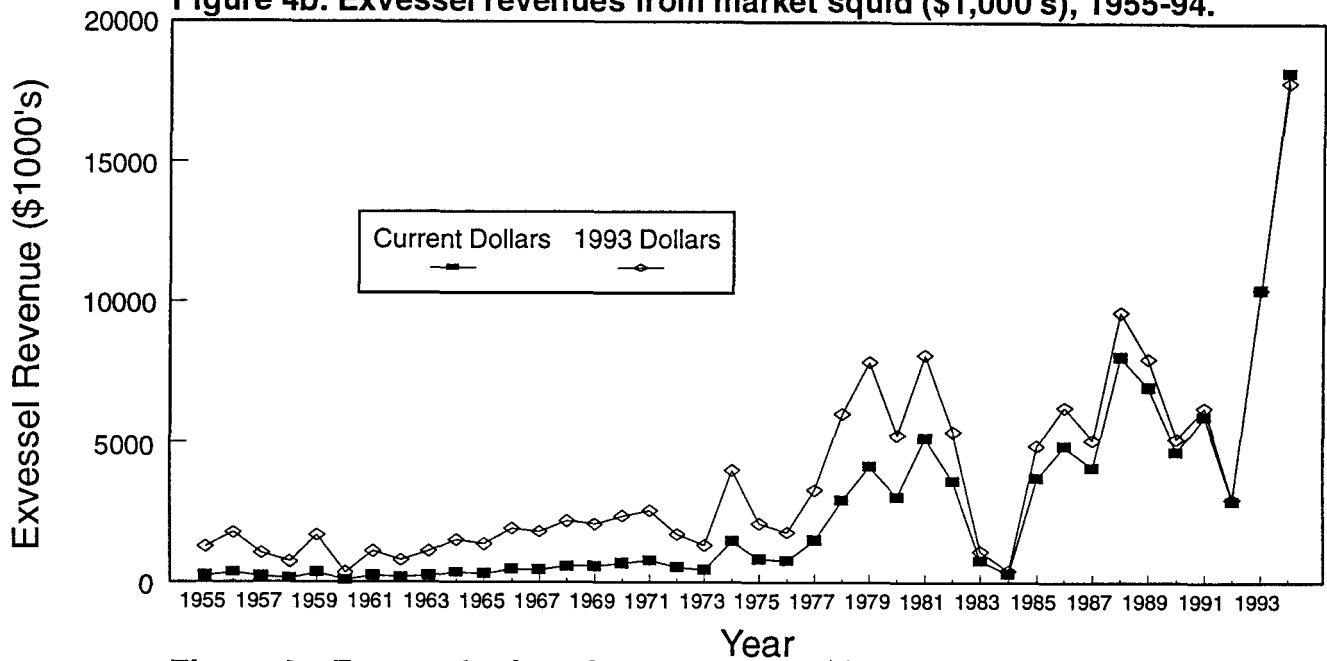


Figure 4c. Exvessel price of market squid (\$/mt), 1955-94.

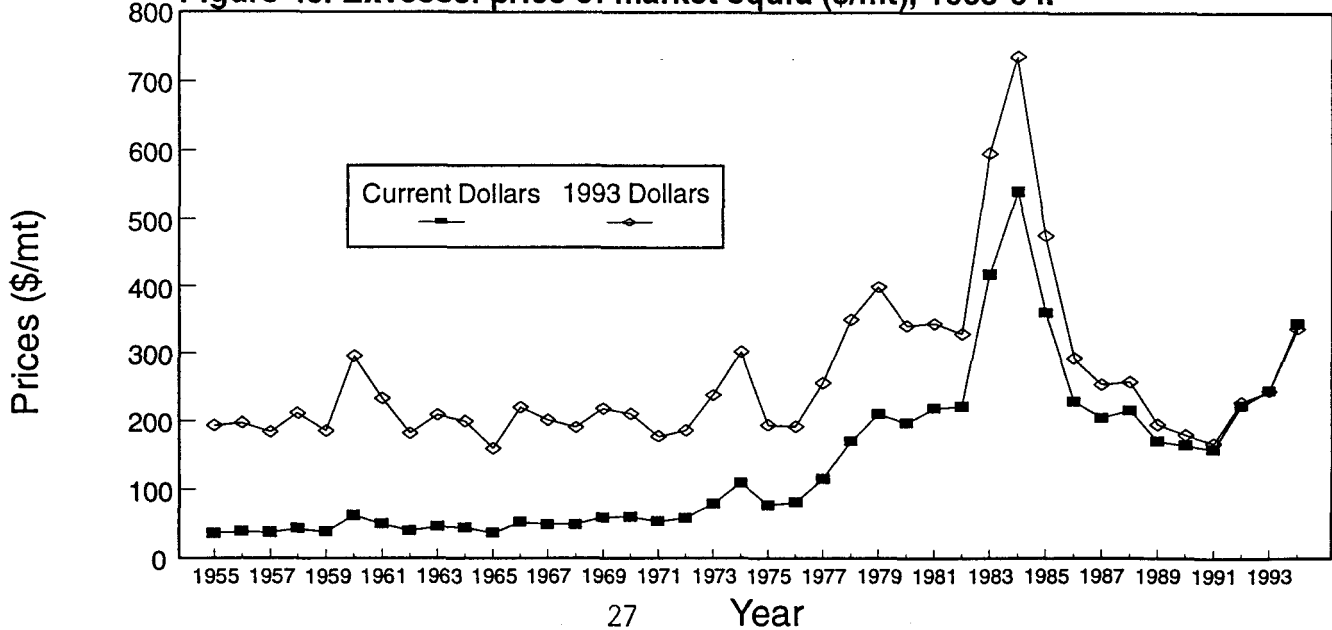


Table 1. Landings of northern anchovy, Pacific sardine, jack mackerel, Pacific mackerel and market squid in California (metric tons), 1916-1994.

Year	Northern Anchovy	Pacific Sardine	Mackerel			Total Coastal Pelagics	Market Squid	GRAND TOTAL
			Jack	Pacific	Total			
1916	241	7,098	n.a.	n.a.	505	7,844	125	7,969
1917	240	47,221	n.a.	n.a.	1,518	48,979	199	49,178
1918	394	71,511	n.a.	n.a.	1,817	73,722	164	73,886
1919	730	69,798	n.a.	n.a.	1,204	71,732	1,678	73,410
1920	258	53,761	n.a.	n.a.	1,360	55,379	231	55,609
1921	883	26,913	n.a.	n.a.	1,322	29,118	196	29,314
1922	296	42,366	n.a.	n.a.	1,119	43,781	95	43,876
1923	139	71,741	n.a.	n.a.	1,612	73,492	535	74,027
1924	157	110,082	n.a.	n.a.	1,464	111,703	3,099	114,801
1925	42	143,017	n.a.	n.a.	1,590	144,649	858	145,507
1926	27	130,065	107	1,638	1,744	131,836	1,422	133,259
1927	167	155,255	210	2,145	2,355	157,777	2,728	160,505
1928	162	190,633	244	15,990	16,234	207,029	613	207,643
1929	174	295,642	317	26,297	26,614	322,430	2,114	324,543
1930	145	227,734	167	7,499	7,666	235,545	4,976	240,521
1931	140	165,269	255	6,466	6,721	172,130	789	172,918
1932	136	191,695	243	5,658	5,901	197,732	1,919	199,650
1933	144	284,132	459	31,577	32,035	316,311	374	316,685
1934	117	507,997	717	51,641	52,359	560,473	694	561,167
1935	81	497,033	4,529	66,419	70,948	568,062	370	568,432
1936	89	663,859	2,086	45,606	47,692	711,640	429	712,068
1937	103	486,025	2,967	27,641	30,608	516,736	228	516,963
1938	334	464,206	1,875	36,219	38,094	502,634	725	503,359
1939	974	526,533	1,706	36,700	38,406	565,913	527	566,440
1940	2,866	410,947	650	54,660	55,310	469,123	817	469,940
1941	1,862	572,657	938	35,456	36,395	610,914	649	611,563
1942	769	439,874	2,426	23,838	26,264	466,907	428	467,336
1943	713	441,019	5,760	34,117	39,887	481,619	4,157	485,766
1944	1,765	520,370	5,796	37,947	43,742	565,877	4,961	570,838
1945	733	383,318	4,097	24,366	28,463	412,514	6,906	419,421
1946	872	231,679	6,846	24,438	31,284	263,835	17,248	281,082
1947	8,591	115,900	58,536	21,082	79,619	204,110	6,597	210,707
1948	4,915	164,219	33,067	17,865	50,932	220,066	8,734	228,800
1949	1,507	287,299	23,247	22,576	45,823	334,629	3,111	337,740
1950	2,213	324,105	60,444	14,810	75,254	401,572	2,720	404,293
1951	3,155	149,188	40,750	15,204	55,954	208,297	5,617	213,914
1952	25,303	6,500	66,462	9,346	75,808	107,611	1,665	109,276
1953	38,935	4,295	25,288	3,403	28,691	71,921	4,045	75,966
1954	19,237	61,918	7,863	11,518	19,382	100,537	3,699	104,235
1955	20,272	66,047	16,218	10,574	26,792	113,111	6,474	119,585

Table 1 (cont.)

Year	Northern Anchovy	Pacific Sardine	Mackerel			Total Coastal Pelagics	Market Squid	GRAND TOTAL
			Jack	Pacific	Total			
1956	25,819	31,550	34,366	22,686	57,051	114,420	8,838	123,258
1957	18,392	20,803	37,200	28,143	65,343	104,525	5,647	110,185
1958	5,263	92,736	10,009	12,541	22,550	120,549	3,383	123,932
1959	3,254	33,733	17,013	17,056	34,069	71,056	8,915	79,971
1960	2,295	26,097	33,995	16,696	50,691	79,083	1,162	80,244
1961	3,498	19,581	44,274	20,008	64,282	87,361	4,666	92,027
1962	1,254	6,969	40,814	22,035	62,849	71,072	4,249	75,321
1963	2,073	3,235	43,292	18,254	61,546	66,854	5,244	72,098
1964	2,257	5,959	40,684	12,169	52,854	61,070	7,454	68,524
1965	2,601	873	30,240	3,198	33,438	36,912	8,446	45,357
1966	28,250	398	18,535	2,100	20,635	49,283	8,630	57,914
1967	31,575	68	17,319	529	17,848	49,491	8,891	58,381
1968	14,096	56	25,251	1,421	26,672	40,824	11,309	52,134
1969	61,362	48	24,459	1,070	25,529	86,939	9,426	96,365
1970	87,311	201	21,658	282	21,940	109,452	11,154	120,606
1971	40,690	135	27,162	71	27,233	68,058	14,296	82,355
1972	62,688	169	23,187	49	23,236	86,093	9,144	95,237
1973	120,327	69	9,351	26	9,377	129,773	5,471	135,244
1974	75,017	6	11,547	61	11,609	86,632	13,111	99,766
1975	143,799	2	16,683	130	16,813	160,614	10,715	171,329
1976	113,326	24	20,207	298	20,524	133,874	9,211	143,065
1977	101,131	5	45,508	5,420	50,928	152,064	12,811	164,876
1978	11,437	5	31,258	11,219	42,477	53,919	17,145	71,064
1979	48,881	16	16,602	18,928	35,530	84,427	19,982	104,409
1980	42,946	34	20,347	29,355	49,702	92,682	15,383	108,065
1981	52,308	28	14,218	38,298	52,516	104,852	23,510	128,362
1982	42,061	132	26,528	28,583	55,111	97,304	16,285	113,589
1983	4,300	352	18,391	32,552	50,943	55,595	1,815	57,410
1984	2,956	235	10,675	42,212	52,887	56,078	564	56,642
1985	1,626	592	9,361	34,609	43,970	46,188	10,275	56,463
1986	1,910	1,164	11,076	41,281	52,057	55,131	21,277	76,708
1987	1,447	2,095	11,843	41,631	53,475	57,017	19,984	77,000
1988	1,532	3,875	10,322	42,889	53,211	58,618	36,641	95,259
1989	2,450	3,908	19,795	36,129	55,924	62,282	40,893	103,175
1990	3,208	2,802	4,953	37,317	42,270	48,280	28,399	76,672

Table 1 (cont.)

Year	Northern Anchovy	Pacific Sardine	Mackerel			Total Coastal Pelagics	Market Squid	GRAND TOTAL
			Jack	Pacific	Total			
1991	4,252	7,750	1,695	30,957	32,652	44,654	36,768	81,422
1992	1,124	16,682	720	19,699	20,419	38,225	13,110	51,335
1993	1,959	16,143	1,685	12,392	14,077	32,179	41,642	73,677
1994 ²	1,924	11,354	2,648	9,750	12,398	25,676	55,770	81,446

¹ Data from fish tickets and adjusted using port sampling information to more accurately reflect species composition in mixed loads. All harvests except live bait (which are not recorded on fish tickets) are included.

² Preliminary

Sources: 1916-1968 data obtained from Heimann and Carlisle (1970).
 1969 data obtained from CDFG (1986).
 1970-1978 CPS data obtained from CDFG (1991).
 1978-1994 CPS data obtained from CDFG, unpublished.
 1970-1994 squid data obtained from B. Leos, CDFG, Monterey.

Table 2. Northern anchovy harvest in California, by disposition of catch, and landings in Mexico (metric tons), 1916-1994.

Year	California ¹				Total Mexico	GRAND TOTAL
	Reductn	NonRed ²	Subtotal	LvBait		
1916	---	---	241	0	0	241
1917	---	---	239	0	0	239
1918	---	---	394	0	0	394
1919	---	---	730	0	0	730
1920	---	---	259	0	0	259
1921	---	---	883	0	0	883
1922	---	---	296	0	0	296
1923	---	---	140	0	0	140
1924	---	---	158	0	0	158
1925	---	---	42	0	0	42
1926	---	---	27	0	0	27
1927	---	---	167	0	0	167
1928	---	---	162	0	0	162
1929	---	---	173	0	0	173
1930	---	---	145	0	0	145
1931	---	---	140	0	0	140
1932	---	---	136	0	0	136
1933	---	---	144	0	0	144
1934	---	---	117	0	0	117
1935	---	---	82	0	0	82
1936	---	---	89	0	0	89
1937	---	---	103	0	0	103
1938	---	---	334	0	0	334
1939	---	---	974	1,364	0	2,338
1940	---	---	2,866	1,820	0	4,686
1941	---	---	1,862	1,435	0	3,297
1942	---	---	768	234	0	1,002
1943	---	---	712	0	0	712
1944	---	---	1,765	0	0	1,765
1945	---	---	733	0	0	733
1946	---	---	872	2,493	0	3,365
1947	---	---	8,591	2,589	0	11,180
1948	---	---	4,915	3,379	0	8,294
1949	---	---	1,510	2,542	0	4,052
1950	---	---	2,213	3,469	0	5,682

Table 2 (cont.)

California ¹						Total Mexico	GRAND TOTAL
Year	Reductn	NonRed ²	Subtotal	LvBait	Total		
1951	---	---	3,154	4,665	7,819	0	7,819
1952	---	---	25,303	6,178	31,481	0	31,481
1953	---	---	38,935	5,798	44,733	0	44,733
1954	---	---	19,237	6,066	25,303	0	25,303
1955	---	---	20,272	5,557	25,829	0	25,829
1956	---	---	25,819	5,744	31,563	0	31,563
1957	---	---	18,392	3,729	22,121	0	22,121
1958	---	---	5,263	3,843	9,106	0	9,106
1959	---	---	3,254	4,297	7,551	0	7,551
1960	---	---	2,294	4,225	6,519	0	6,519
1961	---	---	3,498	5,364	8,862	0	8,862
1962	---	---	1,254	5,595	6,849	669	7,518
1963	---	---	2,073	4,030	6,103	944	7,047
1964	---	---	2,257	4,709	6,966	4,599	11,565
1965	155	2,446	2,601	5,645	8,246	9,171	17,417
1966	24,810	3,440	28,250	6,144	34,394	13,243	47,637
1967	29,346	2,229	31,575	4,898	36,473	20,104	56,577
1968	12,515	1,581	14,096	6,644	20,740	14,267	35,007
1969	59,153	2,209	61,362	4,891	66,253	3,871	70,124
1970	84,328	2,982	87,310	5,543	92,853	27,977	120,830
1971	39,601	1,089	40,690	5,794	46,484	20,079	66,563
1972	60,435	2,252	62,687	5,307	67,994	30,047	98,041
1973	118,432	1,895	120,327	5,639	125,966	15,424	141,390
1974	73,400	1,640	75,040	5,126	80,166	44,987	125,153
1975	141,586	2,214	143,800	5,577	149,377	56,877	206,254
1976	112,270	1,059	113,327	6,202	119,529	75,746	195,275
1977	99,674	1,457	101,131	6,410	107,541	142,575	250,116
1978	10,339	1,118	11,457	6,013	17,470	140,001	157,471
1979	47,408	5,836	53,244	5,364	58,608	204,585	263,193
1980	43,699	5,338	49,037	4,921	56,234	245,797	302,031
1981	51,290	246	51,536	4,698	56,234	258,700	314,934
1982	43,742	1,117	44,859	6,978	51,837	177,587	229,424
1983	2,854	1,446	4,300	4,187	8,487	79,389	87,876
1984	1,722	1,183	2,905	4,397	7,302	101,118	108,420
1985	825	1,184	2,009	3,775	5,784	121,081	126,865
1986	546	1,002	1,548	3,956	5,504	96,417	101,921
1987	149	1,154	1,303	3,572	4,875	124,475	129,350
1988	234	1,298	1,532	4,189	5,721	79,230	84,951
1989	109	2,341	2,450	4,594	7,044	80,823	87,867
1990	63	3,145	3,208	4,842	8,050	99	8,149

Table 2 (cont.)

California ¹						Total	GRAND
Year	Reductn	NonRed ²	Subtotal	LvBait	Total	Mexico	TOTAL
1991	1,037	3,215	4,252	5,039	9,291	831	10,122
1992	0	1,124	1,124	2,572	3,696	2,324	6,020
1993	0	1,959	1,959	2,521	4,480	284	4,764
1994 ³	0	1,924	1,924	1,923	3,847	876	4,723

¹Separate statistics on reduction and non-reduction harvests in California are available beginning in 1965, when a separate reduction quota was first established.

²Includes anchovy used as fresh, frozen and processed products for human consumption and as dead bait.

Sources: 1962-1974 Mexican landings obtained from Chavez (1977).
 1975-1994 Mexican landings obtained from pers. comm. with
 L. Jacobson, NMFS, La Jolla.
 1916-1964 California reduction harvests and 1939-1964
 live bait catches obtained from PFMC (1983), Tables
 3.2-1 and 3.2-2.
 1965-1994 California reduction, non-reduction and live
 bait catches obtained from CDFG, unpublished.

³Preliminary

Table 3. U.S. northern anchovy harvests for live bait, non-reduction and reduction and reduction quota (metric tons), 1966/67-1993/94 seasons.¹

Season	Live Bait	Non Reduction	Reduction			U.S. Reduction Quota
			South	North	Total	
1966/67	n.a.	n.a.	26,843	7,277	34,120	68,040
1967/68	n.a.	n.a.	773	5,127	5,899	68,040
1968/69	n.a.	n.a.	22,965	2,482	25,447	68,040
1969/70	n.a.	n.a.	73,894	1,833	75,726	127,007
1970/71	n.a.	n.a.	72,662	596	73,258	68,040
1971/72	n.a.	n.a.	47,221	1,192	48,468	68,040
1972/73	n.a.	n.a.	66,377	2,134	68,510	99,791
1973/74	n.a.	n.a.	99,072	10,324	109,396	104,327
1974/75	n.a.	n.a.	99,717	6,050	105,767	104,327
1975/76	n.a.	n.a.	123,033	4,800	127,829	104,327
1976/77	n.a.	n.a.	92,020	4,542	96,562	104,327
1977/78	n.a.	n.a.	62,113	6,543	68,656	104,327
1978/79	4,506	1,495	47,805	1,065	48,870	52,919
1979/80	3,015	1,182	30,285	2,146	32,431	105,325
1980/81	4,457	1,263	56,392	4,297	60,689	150,957
1981/82	4,626	829	40,959	4,493	45,452	370,226
1982/83	3,570	1,689	4,468	1,152	5,620	212,918
1983/84	4,071	1,064	64	1,601	1,665	104,781
1984/85	3,940	913	71	0	71	11,200
1985/86	4,192	939	0	1,420	1,420	140,000
1986/87	3,198	980	0	38	38	140,000
1987/88	4,328	1,467	0	111	111	140,000
1988/89	4,100	1,475	0	234	234	140,000
1989/90	5,139	3,114	142	29	171	5,000 ²
1990/91	4,826	3,138	181	855	1,037	116,200
1991/92	4,124	1,962	0	0	0	0
1992/93	2,060	1,461	0	0	0	0
1993/94	1,905	1,633	0	0	0	0
1994/95 ³	1,363	1,108	0	0	0	0

¹The U.S. reduction quota is divided between southern and northern permit areas. The dividing line was Point Conception until 1973/74, when it was moved 50 miles northward to Point Buchon. From 1966/1967 to 1977/78, the quota was set by the California Fish and Game Commission. Since 1978/79 the quota has been set by the Pacific Fishery Management Council. The season extends from July 1 of each year to June 30 of the following year.

²U.S. reduction quota of 5,000 mt provided on the basis of an emergency rule approved by the Department of Commerce.

³Preliminary through December 31, 1994.

Source: CDFG.

Table 4. Live bait harvest in California, by species and year (metric tons), 1974-1994.¹

Year	Northern Anchovy	Pacific Sardine	Pacific Mackerel	Jack Mackerel	Market Squid	Other ²	Total
1974	3,544	0	n.a.	n.a.	0	26	3,570
1975	3,285	0	n.a.	n.a.	0	32	3,317
1976	4,287	0	n.a.	n.a.	6	46	4,339
1977	4,118	0	3	6	0	5	4,132
1978	5,202	107	3	0	4	2	5,318
1979	2,328	0	9	7	0	0	2,329
1980	4,352	12	8	0	0	8	4,372
1981	4,783	6	2	0	0	1	4,792
1982	3,823	38	17	0	0	1	3,879
1983	3,882	193	3	3	0	3	4,084
1984	4,060	53	0	0	1	0	4,114
1985	4,223	11	1	1	7	4	4,247
1986	3,612	17	0	0	16	0	3,629
1987	3,574	216	3	0	24	151	3,968
1988	4,189	50	15	13	424	4	4,695
1989	4,594	100	2	0	178	3	4,877
1990	4,842	543	---	---	32	11	5,428
1991	4,862	272	10	0	143	---	5,464
1992	2,572	1,807	2	---	8	3	4,392
1993	2,521	1,648	6	2	96	4	4,277
1994 ³	1,923	1,487	15	---	2	8	3,435

¹Based on logbooks returned to CDFG by live bait haulers. May underestimate actual live bait catch because of unreturned logs.

²"Other" consists largely of barracuda, queenfish, bonito and croaker. During 1974-1976, "Other" also included Pacific and jack mackerel; the mackerels were not reported separately in the logbooks for those years.

³Preliminary

--- denotes trace amount.

Source: California Department of Fish and Game

Table 5. Pacific mackerel landings and quota (metric tons) in California, 1977/78-1993/94 seasons.¹

Season	Landings			Quota
	Jul 1-Dec 30	Jan 1-Jun 30	Total	
1977/78	2,943	4,844	7,787	8,437
1978/79	6,375	11,874	18,249	16,329
1979/80	7,054	12,955	20,009	22,680
1980/81	16,400	11,510	27,910	18,144
1981/82	26,788	10,975	37,763	34,473
1982/83	17,608	13,019	30,627	26,309
1983/84	19,533	16,776	36,309	30,391
1984/85	25,436	13,804	39,240	50,803
1985/86	20,805	16,811	37,616	36,288
1986/87	24,470	19,829	44,299	None
1987/88	21,802	23,036	44,838	None
1988/89	19,853	22,116	41,969	None
1989/90	14,013	11,050	25,063	None
1990/91	26,267	13,710	39,977	None
1991/92	17,722	9,028	26,750	None
1992/93	10,671	7,641	18,312	34,020 ²
1993/94	4,877	5,910	10,787	23,133
1994/95 ³	4,133	3,986	8,119	14,697

¹During 1977/78 to 1979/80, the season extended from October 1 to September 30. Beginning in 1980/1981, the season extended from July 1 to June 30. Once a quota is reached, fishermen can continue to harvest Pacific mackerel incidentally with other species. Thus total landings sometimes exceed the quota.

²Although the season began with no quota restrictions, a quota was imposed after the mid-season biomass assessment.

³Preliminary through May 31, 1995.

Source: California Department of Fish and Game

Table 6. Landings of Pacific mackerel, jack mackerel and all other species (numbers of fish), and number of angler trips made aboard California commercial passenger fishing vessels,¹ 1936-1994.

Year	Pacific Mackerel	Jack Mackerel	Total Mackerel	All Else	GRAND TOTAL	# Angler Trips
1936	70,586	1,308	71,894	1,241,579	1,313,473	n.a.
1937	59,281	1,928	61,209	1,282,930	1,344,139	n.a.
1938	87,959	3,462	91,421	1,190,187	1,281,608	n.a.
1939	160,962	1,222	162,184	1,562,020	1,724,204	n.a.
1940	119,320	10,109	129,429	1,743,409	1,872,838	n.a.
1947	148,041	4,505	152,546	1,917,886	2,070,432	n.a.
1948	203,012	2,351	205,363	1,904,656	2,110,019	n.a.
1949	95,158	2,932	98,090	2,241,704	2,339,794	n.a.
1950	66,969	557	67,526	2,122,887	2,190,413	n.a.
1951	47,188	202	47,390	2,303,254	2,350,644	n.a.
1952	76,568	4,395	80,963	2,225,170	2,306,133	n.a.
1953	61,467	196,280	257,747	2,022,411	2,280,158	n.a.
1954	315,037	19,407	334,444	2,940,093	3,274,537	n.a.
1955	151,018	39,473	190,491	2,923,392	3,113,883	n.a.
1956	121,136	23,493	144,629	3,118,366	3,262,995	n.a.
1957	151,960	6,878	158,838	3,340,747	3,499,585	n.a.
1958	136,607	27,867	164,474	3,786,406	3,950,880	n.a.
1959	88,952	11,820	100,772	4,227,803	4,328,575	n.a.
1960	79,370	8,537	87,907	4,002,127	4,090,034	637,498
1961	113,988	28,891	142,879	3,310,754	3,453,633	593,916
1962	116,738	9,029	125,767	3,530,226	3,655,993	595,866
1963	146,560	9,342	155,902	4,122,600	4,278,502	643,155
1964	101,219	6,577	107,796	4,326,380	4,434,176	695,445
1965	151,896	25,619	177,515	4,457,043	4,634,558	688,103
1966	205,090	19,027	224,117	5,184,303	5,408,420	857,000
1967	108,366	16,236	124,602	4,319,562	4,444,164	780,102
1968	78,933	13,588	92,521	5,638,680	5,731,201	849,654
1969	120,036	11,272	131,308	5,594,267	5,725,575	802,811
1970	129,700	15,725	145,425	5,485,410	5,630,835	873,327
1971	224,223	10,611	234,834	4,369,318	4,604,152	728,126
1972	245,882	5,913	251,795	5,210,610	5,462,405	792,618
1973	199,104	15,789	214,893	5,708,585	5,923,478	880,100
1974	102,619	12,467	115,086	5,576,517	5,691,603	809,100
1975	129,944	5,677	135,621	5,218,430	5,354,051	748,052

Table 6 (cont.)

Year	Pacific Mackerel	Jack Mackerel	Total Mackerel	All Else	GRAND TOTAL	# Angler Trips
1976	51,441	5,504	56,945	5,092,548	5,149,493	735,674
1977	484,722	8,789	493,511	4,355,961	4,849,472	716,536
1978	940,204	5,237	945,441	4,310,910	5,256,351	732,460
1979	1,272,038	2,957	1,274,995	5,355,663	6,630,658	786,347
1980	1,315,971	4,166	1,320,137	5,087,647	6,407,784	761,958
1981	1,007,198	2,984	1,010,182	5,304,352	6,314,534	830,653
1982	914,238	4,404	918,642	4,452,003	5,370,645	773,473
1983	630,003	5,308	635,311	3,989,685	4,624,996	691,792
1984	604,324	13,261	617,585	3,554,808	4,172,393	701,737
1985	695,708	6,825	705,533	3,444,163	4,149,696	711,787
1986	605,716	4,390	610,106	3,465,015	4,075,121	660,294
1987	517,166	3,056	520,222	3,582,630	4,102,852	678,594
1988	406,169	21,251	427,420	3,775,867	4,203,287	689,422
1989	363,700	4,422	368,122	4,225,428	4,593,550	737,193
1990	472,006	8,059	480,065	4,282,958	4,763,023	765,431
1991	438,979	4,686	443,665	3,759,911	4,203,576	659,694
1992	327,747	1,806	329,553	3,761,236	4,090,789	635,356
1993	417,760	7,963	425,723	3,196,917	3,622,640	592,934
1994 ²	351,870	5,771	357,641	2,836,129	3,193,770	569,468

¹These data represent landings and fishing effort reported to the California Department of Fish and Game via CPFV logbooks, and may underestimate actual CPFV landings and effort because of unreturned logs. No published data are available for the World War II years (1941-1946), when CPFVs were largely inactive. Number of angler trips prior to 1960 was not available from published sources.

²Preliminary.

Source: 1936-1940 and 1947-1958 data obtained from Best (1963).
1959-1968 data obtained from Heimann and Carlisle (1970).
1969-1976 data obtained from Oliphant (1979).
1977-1986 data obtained from Oliphant et.al. (1990).
1987-1994 data obtained from CDFG, unpublished.

Table 7. US sardine harvest by disposition of catch (metric tons), 1986-1994

Year	Incid.	Directed ¹		Live Bait ²	Dead Bait ³			GRAND TOTAL
		North	South		North	Central	South	
1986	762	---	---	402	---	---	---	1,182
1987	1,711	---	---	384	---	---	---	2,311
1988	2,801	---	---	1,074	---	---	---	3,925
1989	2,609	233	838	1,071	---	---	---	4,008
1990	1,329	164	1,071	1,235	68	47	123	3,345
1991	1,175	976	5,215	6,191	0	64	386	8,093
1992	52	2,713	13,852	16,565	0	65	0	18,489
1993	63	670	14,531	15,201	0	65	814	17,791
1994 ⁴	380	1,958	9,396	11,354	0	65	588	13,874

¹During 1989-1990 the directed quota was allocated 20%-80% respectively between areas north and south of Point Buchon. During 1991-1994 the directed quota was allocated 33%-67% respectively between areas north and south of San Simeon Point.

²Based on logbook data.

³A separate dead bait quota was established in 1989. Beginning in 1990, the dead bait quota was allocated among three areas: north of Pescadero Point, between Pescadero Point and Point Buchon and south of Point Buchon.

⁴Preliminary
Source: California Department of Fish and Game

Table 8. California landings of market squid (metric tons), by area, 1970-1994.

Year	Southern California	Monterey	Other ¹	Statewide Total
1970	7,241	3,914	0	11,155
1971	6,745	7,551	0	14,296
1972	3,583	5,560	0	9,144
1973	4,908	562	0	5,470
1974	6,536	6,575	0	13,112
1975	8,451	2,263	0	10,715
1976	6,933	2,278	0	9,211
1977	10,784	2,027	0	12,810
1978	7,776	9,370	0	17,145
1979	7,114	12,867	1	19,982
1980	8,255	7,127	1	15,383
1981	10,686	12,822	2	23,510
1982	5,694	10,587	5	16,285
1983	862	492	462	1,815
1984	76	391	97	564
1985	6,386	3,812	77	10,275
1986	14,958	5,488	832	21,277
1987	14,861	4,780	343	19,984
1988	31,420	4,834	386	36,641
1989	33,743	7,146	4	40,893
1990	20,367	7,902	130	28,399
1991	29,212	6,703	1,473	37,388
1992	4,551	6,111	2,448	13,110
1993	35,655	6,026	1,018	42,709
1994 ²	39,904	13,625	2,241	55,770

¹North of Monterey.

²Preliminary.

Source: B. Leos, CDFG, Monterey.

Table 9. Mexican landings of northern anchovy, Pacific sardine and Pacific mackerel (mt) in Ensenada, Baja California, 1961-1994 as available.

Year	Northern Anchovy	Pacific Sardine	Pacific Mackerel	Total
1961	0	0	n.a.	n.a.
1962	669	4,580	n.a.	n.a.
1963	944	4,269	n.a.	n.a.
1964	4,599	4,907	n.a.	n.a.
1965	9,171	4,286	n.a.	n.a.
1966	13,243	2,575	n.a.	n.a.
1967	20,104	5,846	n.a.	n.a.
1968	14,267	5,135	n.a.	n.a.
1969	3,871	n.a.	n.a.	n.a.
1970	27,977	n.a.	n.a.	n.a.
1971	20,079	n.a.	n.a.	n.a.
1972	30,047	n.a.	n.a.	n.a.
1973	15,424	3,258	103	n.a.
1974	44,987	6,284	82	n.a.
1975	56,877	n.a.	n.a.	n.a.
1976	75,746	n.a.	n.a.	n.a.
1977	142,575	n.a.	n.a.	n.a.
1978	140,001	n.a.	n.a.	n.a.
1979	204,585	n.a.	n.a.	n.a.
1980	245,797	n.a.	n.a.	n.a.
1981	258,700	n.a.	n.a.	n.a.
1982	177,587	n.a.	n.a.	n.a.
1983	79,389	274	135	79,798
1984	101,118	0	128	101,246
1985	121,081	3,722	2,582	127,385
1986	96,417	243	4,883	101,543
1987	124,475	2,432	2,082	128,989
1988	79,230	2,035	4,484	85,749
1989	80,823	6,222	13,887	100,932
1990	99	11,375	35,767	47,241
1991	831	31,392	17,500	49,723
1992	2,324	34,568	24,345	61,237
1993	284	32,045	7,742	40,071
1994	875	20,877	13,318	35,070
1995 ¹	143	8,426	677	9,246

¹Preliminary through March.

Sources: 1962-1974 anchovy landings obtained from Chavez (1977).
1975-1991 anchovy landings obtained from pers. comm. with
L. Jacobson, NMFS, La Jolla.
1961-1974 sardine and mackerel landings obtained from
Osuna et.al. (1976).
1983-1990 sardine and mackerel landings and 1992-1993
landings of all three species obtained from pers.
comm. with INP, Ensenada, Baja California.
1991 sardine and mackerel landings obtained from INP
(1992).

Table 10. Number of California round haul vessels that landed at least 50 mt of CPS and/or market squid during the year, 1981-1994.

Year	Vessels Vessels With CPS≥50 mt	Vessels With 0≤CPS<50 mt & CPS+squid≥50 mt	Total
1981	56	21	77
1982	56	30	86
1983	53	3	56
1984	47	0	47
1985	45	16	61
1986	47	11	58
1987	49	13	62
1988	43	25	68
1989	45	17	62
1990	46	11	57
1991	49	16	65
1992	36	24	60
1993	35	25	60
1994	38	24	62

Source: Vessel summaries generated from California fish ticket data and Redefined PacFIN data base.

Table 11. Average landings per vessel (metric tons) by California round haul vessels landing at least 50 metric tons of CPS and/or market squid during the year, by species, 1981-1994.

Year	Northern Anchovy	Mackerel	Pacific Sardine	Market Squid	Pacific Herring	Bonito	Tuna	All Else	Total
Vessels for which CPS≥50 mt:									
1981	899.4	909.8	0.3	135.9	12.6	94.1	33.9	1.6	2,087.6
1982	751.2	984.7	---	77.5	15.1	43.0	29.5	2.4	1,903.4
1983	21.7	831.2	---	9.9	11.9	61.8	43.5	3.2	983.2
1984	43.8	1,006.3	---	3.3	5.5	55.4	94.9	9.4	1,218.6
1985	26.1	970.8	0.1	137.3	9.3	60.8	43.1	2.6	1,249.3
1986	19.7	1,109.8	7.0	354.0	8.8	4.3	82.5	2.0	1,587.2
1987	25.1	1,100.0	7.9	275.7	10.6	87.4	27.9	4.9	1,539.5
1988	30.4	1,284.5	26.1	576.5	10.2	89.9	33.4	4.4	2,054.2
1989	47.0	1,249.5	15.6	514.5	12.1	22.1	22.7	3.1	1,886.7
1990	64.6	901.9	35.1	432.9	18.6	85.1	30.6	3.2	1,570.3
1991	74.1	655.6	146.5	533.1	14.1	10.5	2.3	21.4	1,457.6
1992	23.5	543.6	493.4	114.6	3.4	24.6	40.2	8.3	1,251.6
1993	50.5	338.3	370.3	658.4	6.5	10.1	52.8	28.8	1,515.7
1994	41.0	266.9	272.3	737.3	0.0	4.8	73.3	3.0	1,398.7
Vessels for which 0≤CPS<50 mt, CPS+squid≥50 mt:									
1981	0.1	5.8	0.0	383.3	24.8	0.0	5.1	4.2	423.3
1982	0.5	8.9	0.0	274.8	36.6	0.0	0.8	8.2	329.8
1983	6.2	13.8	0.0	75.2	49.4	---	1.3	3.9	149.8
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	2.4	4.8	0.0	136.5	31.0	0.0	1.5	15.3	191.5
1986	5.5	4.7	0.3	270.9	24.7	0.0	---	10.9	317.0
1987	0.7	7.4	0.2	353.8	39.5	1.7	0.0	11.7	415.0
1988	0.5	2.9	0.1	348.8	28.3	0.0	2.0	10.5	393.1
1989	2.3	3.0	0.0	855.2	38.2	---	3.9	6.3	908.9
1990	0.0	10.6	0.1	653.9	16.4	0.5	2.0	7.4	690.9
1991	2.1	4.4	2.8	580.3	14.5	0.3	---	20.6	625.0
1992	3.0	3.5	3.3	367.7	35.1	0.0	---	7.2	419.8
1993	0.7	2.2	2.6	654.3	2.4	0.0	0.0	10.5	672.7
1994	0.0	1.2	2.1	720.0	0.0	3.5	0.5	2.3	729.7

--- denotes trace amount.

Source: Vessel summaries generated from California fish ticket data and Redefined PacFIN data base.

Table 12. Average ex-vessel revenues per vessel (\$1000s) (Base Year=1993) by California round haul vessels landing at least 50 mt of CPS and/or market squid during the year, by species, 1981-1994.

Year	Northern Anchovy	Mackerel	Pacific Sardine	Market Squid	Pacific Herring	Bonito	Tuna	All Else	Total
Vessels for which CPS≥50 mt:									
1981	89.5	296.8	0.1	50.7	8.2	87.1	73.8	2.7	609.0
1982	52.7	297.4	---	21.3	7.6	28.3	52.4	1.9	461.6
1983	5.3	229.0	0.0	5.6	19.1	33.1	70.0	1.4	363.5
1984	4.3	258.1	---	2.3	2.4	21.5	161.4	4.5	454.4
1985	9.7	227.7	---	53.4	8.1	16.9	55.7	3.7	375.2
1986	3.2	301.6	1.9	102.8	7.5	1.4	197.8	3.6	619.8
1987	5.9	330.6	1.4	73.1	8.1	59.1	114.1	8.0	600.4
1988	9.4	260.2	4.7	141.8	5.2	48.7	165.7	4.1	639.8
1989	9.8	237.4	7.4	104.2	4.7	10.2	95.8	10.0	479.5
1990	30.8	213.8	5.2	78.4	12.6	44.4	70.8	16.9	473.0
1991	12.2	121.1	18.5	99.0	9.4	1.2	2.3	12.4	276.2
1992	5.8	144.1	49.7	22.3	3.1	12.0	29.7	7.1	273.8
1993	11.7	42.7	36.1	151.6	1.7	6.3	38.6	7.3	296.0
1994	11.3	33.3	41.5	250.8	0.0	2.5	65.2	1.8	406.3
Vessels for which 0≤CPS<50 mt, CPS+squid≥50 mt:									
1981	---	1.4	0.0	158.2	30.7	0.0	15.3	4.9	210.5
1982	0.1	2.5	0.0	105.9	32.9	0.0	1.9	7.1	150.4
1983	1.4	2.7	0.0	46.2	80.6	---	2.3	28.4	161.7
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.7	1.1	0.0	80.0	37.3	0.0	2.4	23.3	144.7
1986	1.4	1.2	0.1	94.8	18.1	0.0	---	19.3	135.0
1987	0.1	2.2	---	99.7	28.0	1.2	0.0	38.7	170.0
1988	0.2	6.0	---	102.1	9.9	0.0	4.9	22.9	146.1
1989	0.4	0.5	0.0	218.4	11.6	---	7.7	10.2	248.9
1990	0.0	3.0	---	179.5	12.0	0.2	6.4	13.4	214.4
1991	0.4	1.5	0.3	119.7	22.3	0.2	---	12.2	156.7
1992	0.5	1.1	1.1	78.2	36.9	0.0	0.0	13.3	131.2
1993	0.2	0.6	0.2	160.5	2.4	0.0	0.0	10.5	174.4
1994	0.0	0.2	0.2	251.9	0.0	1.7	0.5	31.9	286.4

--- denotes trace mount.

Source: Vessel summaries generated from California fish ticket data and Redefined PacFIN data base.

Table 13. Number of California processing plants that receive at least 500 mt of CPS and/or squid, average annual receipts per plant of all species (mt), % of plant receipts consisting of CPS and squid, and % of total California landings of CPS and squid accounted for by these plants, 1981-1994.

Plants for which CPS≥500 mt					% Calif. landings	
Year	# plants	Average receipts all spp. (mt)	%CPS	%squid	CPS	Squid
1981	13	10,486.2	76%	7%	99%	38%
1982	15	8,912.6	72%	5%	99%	43%
1983	13	7,321.3	56%	1%	96%	47%
1984	15	6,374.9	56%	---	96%	41%
1985	11	6,474.8	61%	7%	95%	49%
1986	11	8,649.1	55%	14%	96%	62%
1987	15	6,800.9	53%	15%	96%	74%
1988	15	7,904.8	48%	25%	97%	78%
1989	14	7,057.2	61%	20%	98%	49%
1990	12	6,509.9	58%	24%	94%	66%
1991	10	7,681.0	55%	33%	96%	69%
1992	10	5,171.3	73%	10%	99%	39%
1993	10	5,793.1	47%	33%	85%	46%
1994	8	6,103.9	47%	44%	89%	46%

Plants for which 0≤CPS<500 mt, CPS+squid≥500 mt					% Calif. landings	
Year	# plants	Average receipts all spp. (mt)	%CPS	%squid	CPS	Squid
1981	13	10,486.2	76%	7%	99%	38%
1981	10	1,712.4	4%	76%	1%	55%
1982	8	1,522.6	4%	66%	---	49%
1983	0	n.a.	n.a.	n.a.	0%	0%
1984	0	n.a.	n.a.	n.a.	0%	0%
1985	4	962.1	31%	62%	3%	23%
1986	6	1,528.4	6%	70%	1%	29%
1987	6	1,139.5	16%	55%	2%	19%
1988	4	1,950.4	3%	84%	1%	17%
1989	8	3,458.5	1%	76%	1%	46%
1990	7	1,595.5	11%	81%	2%	32%
1991	6	2,171.0	5%	86%	2%	31%
1992	6	1,532.6	1%	78%	---	55%
1993	12	1,761.2	1%	95%	1%	48%
1994	11	2,452.2	5%	86%	5%	50%

Source: Plant summaries for 1986-1990 generated from California fish ticket data base; summaries for 1981-1985 and 1991-1994 generated from Redefined PacFIN data base.

--- denotes positive amount less than 0.5%.

Table 14a. Selected attributes of exports of mackerel products from California customs districts, 1989-1994. See footnotes on last page.

Attribute	1989	1990	1991	1992	1993	1994
Export Volume: ¹						
mt	1,660.0	2,873.7	6,154.5	6,746.0	627.0	437.3
\$1000s	\$3,383.5	\$1,567.8	\$4,323.2	\$3,305.1	\$488.6	\$348.0
Product Type: ²						
Fresh	1%	4%	15%	7%	11%	11%
Frozen	42%	91%	78%	89%	87%	85%
Prep/Pres	52%	5%	8%	3%	3%	4%
Cured/Smoked/ Salted	5%	0%	0%	0%	0%	0
Customs District: ³						
San Diego	---	---	0%	1%	0%	0
Los Angeles	68%	95%	95%	99%	91%	100%
San Francisco	32%	5%	6%	---	9%	0
# Importing Countries: 16		10	13	14	8	5
Major Importing Countries:						
	Japan (49%) Thailand (15%) So. Korea (15%) Chile (13%)	Fiji (84%)	Japan (27%) Fiji (23%) Phlpns (19%) So. Korea (17%)	So. Korea (68%) Fiji (17%)	Aust. (53%) Fiji (20%) Costa Rica (14%)	Aust. (86%)

Table 14b. Selected attributes of exports of sardine products from California customs districts, 1989-1994.

Attribute	1989	1990	1991	1992	1993	1994
Export Volume: ¹						
mt	24.8	787.2	1,667.0	1,180.6	1,641.0	1,457.7
\$1000s	\$100.8	\$603.4	\$1,105.0	\$ 863.4	\$1,320.0	1,177.5
Product Type: ²						
Fresh	0%	1%	12%	4%	1%	5%
Frozen	100%	94%	79%	53%	54%	60%
Prep/Pres	0%	6%	9%	43%	45%	35%
Customs District: ³						
San Diego	0%	2%	5%	---	2%	---
Los Angeles	96%	57%	62%	70%	62%	51%
San Francisco	4%	41%	33%	30%	36%	49%
# Importing Countries:	2	9	10	16	11	18
Major Importing Countries:	Portugal (73%)	Belgium (45%)	Fiji (40%)	W.Samoa (28%)	Fiji (25%)	Fiji (11%)
	Japan (27%)	Fiji (43%)	Belgium (36%)	Aust. (15%)	W.Samoa (23%)	Aust. (28%)
			Aust. (11%)	Phlpns (14%)	Aust. (21%)	Malay. (11%)
				Belgium (12%)	NewZlnd (17%)	Aust. (86%)
				Fiji (10%)		

Table 14c. Selected attributes of exports of anchovy products from California customs districts, 1989-1994.

Attribute	1989	1990	1991	1992	1993	1994
Export Volume: ¹						
mt	258.6	288.0	268.3	260.5	82.9	50.7
\$1000s	\$2,483.1	\$636.4	\$638.4	\$786.3	\$253.4	\$53.0
Product Type: ²						
Salted	12%	75%	78%	93%	6%	92%
Prep/Pres	0%	25%	22%	8%	94%	8%
Canned	88%	0%	0%	0%	0%	0
Customs District: ³						
San Diego	0%	0%	0%	2%	32%	0
Los Angeles	71%	39%	78%	79%	6%	13%
San Francisco	29%	61%	22%	19%	62%	87%
# Importing Countries:	12	3	5	8	3	3
Major Importing Countries:	Spain (44%)	Spain (93%)	Spain (48%)	Spain (35%)	Belgium (62%)	
Belgium (79%)		Portugal (17%)		Japan (31%)	Italy (22%)	Mexico (32%)
Aust. (13%)						
	Morocco (12%)		Italy (21%)	Portugal (22%)		
	So. Korea (10%)					

FOOTNOTES FOR TABLES 14a, 14b and 14c

¹Export volume in mt pertains to "net weight", that is, the weight of a product's consumable contents (including liquid) exclusive of the container (such as cans). Export volume in \$1000s has been adjusted for inflation and is expressed in 1993 dollars.

²Distribution of export volume (mt) by product type. "Prep/Pres" denotes "prepared/preserved".

³Distribution of export volume (mt) by customs district of origin.

⁴Major importing countries defined as countries that receive at least 10% of the volume (mt) exported from California during the year. Numbers in parentheses denote proportion of total export volume (mt) attributable to each country.

Source: National Marine Fisheries Service, Market News/Statistics, Long Beach.