AN ECONOMIC OVERVIEW OF THE CALIFORNIA WETFISH INDUSTRY COMPLEX

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An Economic Overview of the California Wetfish Industry Complex

Steven C. Hackett
School of Business and Economics
Humboldt State University

Assisted by Matthew Krachey
Humboldt State University

Abstract

A key focus of this economic report is to address value added from the harvesting and processing of wetfish in California. Real (inflation-adjusted) value added by fishermen in the wetfish industry complex fluctuates due to both market and environmental conditions, and ranged from a low of $10.5 million in 1992 to a high of $35.8 million in 2000. Two-thirds of real fisherman value added was generated from the market squid fishery. Real value added by wetfish fishermen in 2000 represented 29 percent of the total for all landed fish in California. Real value added by processors (many of whom also perform their own distribution and export functions) in 2000 is estimated to range between $37.5 and $90.2 million, with the median estimate being $62.5 million. Based on our median estimate, real processor value added is about twice that of fishermen, a relationship consistent with a recent analysis of the West Coast fishing industry complex by Radtke and Davis (2000) for the Pacific States Marine Fisheries Commission.

Export markets are playing an increasingly important role in this industry. Based on our 2001 interviews with processors, most of the fish in this industry is currently processed into a frozen product (cleaned or whole) and exported as bait, feed, seafood, or for further processing. Despite declines in some traditional product forms such as canned fish and fish meal and oil, the real value of all product exports has increased in recent years. In particular, the real value of California exports of wetfish increased by 317 percent between 1989 and 2000, rising to almost $90 million in 2000. In contrast, real fisherman value added increased by 88.4 percent in the same time period. In the period between 1989 and 2000, market squid generally represented between two-thirds and three-fourths of the value of total California exports in this industry (with the exception of El Niño years such as 1998). Between 1990 and 2000 the Pacific sardine fishery experienced a remarkable recovery, due to rapid growth in spawning biomass and subsequent increases in harvest quotas. In particular, the share of total real California wetfish export value contributed by Pacific sardines rose from approximately 5 percent in 1990 to almost 25 percent in 2000.

Section 1: Introduction

This report provides an economic overview of the harvesting, receiving, processing, and distribution activities that derive from the commercial harvest of important coastal pelagic fish species in California. These fish species are northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel (*Scomber japonicus*), Pacific sardine (*Sardinops sagax*), market squid (*Loligo opalescens*), various tunas (bluefin (*Thunnus orientalis*), skipjack (*Katsuwonus pelamis*), and yellowfin (*Thunnus albacares*)) and Pacific bonito (*Sarda chiliensis*). Some of these fish, such as bluefin tuna and bonito, as well as jack mackerel, also support a recreational fishery that is discussed elsewhere (see for example McWilliams and Goldman 1994). The term "wetfish," which is used here to refer to the commercial anchovy, mackerel, sardine, squid, and coastal tuna catch, is an expression that has its origins in how these fish were processed in canneries. Unlike other fish such as tuna that is first cooked then canned, wetfish were first packed in a can "wet" and then cooked (Klingbeil 1992). Even though very little of these fish landed and processed in the present day industry are canned, "wetfish" is still used to describe the industry complex.

The overview of commercial fishing and processing in this report includes economic information on market structure characteristics, product prices and quantities, value added, and other trends in the wetfish industry complex between 1981 and 2000. Relevant historical information is also provided for fishermen and receiver/processors. As Scherer and Ross (1990) observe, market structure characteristics include the number and size distribution of market participants, the extent to which products are homogeneous or differentiated, and the extent of vertical integration, among other factors. Both concentration ratios and Herfindahl-Hirschman (HH) indices are used to measure market structure. Concentration ratios measure the percentage of total market sales (purchases) by the largest four (C4) or largest eight (C8) sellers (buyers) in a given industry. HH indices measure the sum of squared market shares. Markets with HH indices between 1000 and 1800 are considered moderately concentrated, and index values exceeding 1800 indicate a concentrated market. See the appendix to this report for additional details on measuring market structure.

An economic overview of commercial fishing is provided in section 2 of this report. Section 2 is divided into sections for each of the key species or species groups addressed in this study. As will be discussed in greater detail in section 2, the overall trend has been one of growth in landings and inflation-adjusted revenues generated by California fishermen from the early 1980s to 2000. The commercial catch is primarily sold to receiver/processors at various ports rather than direct to wholesalers or consumers. In some cases a receiver may serve as an independent intermediary to transport and sell fish to processors. The accompanying socio-economic profile by Pomeroy et al provides a more detailed description of the key California wetfish ports and the methods employed there in handling fish.

An economic overview of the receiving/processing industry is provided in section 3 of this report. One aspect of this overview covers current product types. For example, the freezing and storing of whole fish for future sale as bait or animal feed (or for additional processing into seafood products) is an important function performed by large California processors. Other important functions include the processing of fresh and frozen seafood products, and the processing of pet food. Processors also produce smaller quantities of canned, smoked, and other more extensively processed seafood products in California.

These seafood, bait, animal feed, and other products then move downstream into the wholesale distribution and export market channels. An overview of the wholesale distribution and export stage of production is provided in section 4 of this report. As will be shown in section 4, inflation-adjusted revenues from California wetfish exports have increased sharply during the 1990s into 2000. Many large processors are vertically integrated into the downstream wholesale distribution and export market functions, while others contract with independent brokers or wholesaler-distributors. Wetfish products reach their end use as seafood products in retail stores, restaurants, and food service operations, as pet food in retail stores, as animal feed in commercial aquaculture, poultry, and other operations, and as bait for commercial and recreational fishermen. While historically a large quantity of these fish were processed as meal, oil, and protein products in the reduction fishery, very little reduction has occurred in California in recent years.

The data used in this report come from both primary and secondary sources. Data on vessel landings are derived from existing fish ticket data gathered by the California Department of Fish and Game and archived by the Pacific States Marine Fisheries Commission in their PacFIN database. Each ticket contains information on quantity and revenue for each species of fish landed and sold. Fish tickets also identify the receiver/processors who buy the fish. Data on processed wetfish product types, quantities, revenues, and prices were generated by the authors from surveys and key-informant interviews of receiver/processor industry participants by Pomeroy and Hunter. Examples of survey questionnaires are included in the appendix to this report. Data on export product types, quantities, revenues, and prices are reported annually by the National Marine Fisheries Service.

We use these PacFIN and interview data to estimate value added by commercial fishing (section 2) and receiver/processors (section 3), as well as for both combined (section 5). At any given market-mediated stage of production, value added is measured as total revenue generated from sales of the product of that stage of production minus the value added at the previous stages of production (if any). Thus value added at the harvester stage of production in a capture fishery is simply total revenue to the fishermen. In contrast, value added at the processing stage of production (including any integrated wholesale distribution functions) is total revenue from sales of processed fish products minus the value of the fish received from the fishermen. Value added represents income that flows to those who supply the capital, labor, entrepreneurship, and intermediate good and service inputs that are assembled together in production. Value added also includes tax income provided to federal, state, and local government.

Note that value added does not necessarily include all of the possible positive and negative economic impacts of commercial fishing. For example, the income to employees of a processing facility is included in value added, but the additional community income generated by workers spending their paychecks at local grocery stores is not. Estimating economic impact requires location-specific income-expenditure multipliers that are not publicly available, or the use of more general multipliers that are inaccurate. Nevertheless by including an estimate of the value added by processors we provide a much more complete economic picture of the commercial fisheries than is provided by ex-vessel revenue alone.

Nominal (current dollar) figures are adjusted for inflation using the producer price index for intermediate foods and feeds from the Bureau of Labor Statistics, which uses 1982 as the base year. Subsequent "real" figures are expressed in constant 1982 dollars that eliminate the effects of inflation over time.

Section 2: The Economics of Wetfish Capture Fisheries

The economic information provided in this section of the report covers value added, market trends, and market structure for each species of fish, as well as summary information for the combined fisheries. The accompanying report by Pomeroy describes the gear and techniques employed in the wetfish and related fisheries. Her report also covers the relevant fishery regulations. Before we begin, a number of overall statements can be made about the market structure of the capture fisheries. Our research indicates that there is relatively little vertical integration of the harvesting and the processing stages of production in this industry, implying that most exchanges of fish between vessel and receiver/processor are mediated by price in a market or contractual context. While in some cases the market structure is relatively concentrated, competitive pressures may also derive from relatively easy entry as vessels with valid permits shift from one fishery to the next based on relative prices and the availability of fish.

Section 2.a: Combined Ex-Vessel Value Added

The trend in real (inflation-adjusted) revenue at the harvester stage of production (real ex-vessel value added) features substantial year-to-year fluctuations, as can be seen in Table 1 and the accompanying Figure 1. With the exception of 1998, an El Niño year with very poor squid landings, the overall trend in the 1990s into 2000 has been one of increasing landings and real growth in value added. The market squid fishery plays a dominant role in the overall data. For example, in 1999 and 2000 squid accounted for more than one-half of total landings and more than two thirds of total real ex-vessel value added. Sardines are once again becoming an important component of the California wetfish fishery complex. Sardines accounted for a bit over one-third of the overall landings in 1999, and about one-eighth of the real ex-vessel value added. Thus taken together, squid and sardines represented 90 percent of overall landings and 91 percent of real ex-vessel value added.

A breakdown of landings, market structure, and value-added by species is given below. Note that fish tickets, the source of ex-vessel data used here, report quantity and revenue of landings by specie for a particular vessel. Thus the price per pound information reported below represents average revenue, and is derived by summing revenue and quantity by species by year for all vessel landings in California, and then dividing total revenue by total quantity.

Table 1: Landings, Ex-Vessel Revenue, and Average Price Per Pound for All Wetfish Landings in California, 1981-2000*

Year	Total Quantity (lbs)	Total Nominal Revenue ($)	Total Real Revenue ($)**
1981	263,434,660	26,232,430	25,076,807.14
1982	237,092,461	22,466,396	22,451,428.38
1983	127,683,926	14,845,981	14,330,097.49
1984	125,749,932	13,232,173	12,517,625.23
1985	131,703,494	15,268,250	15,701,345.45
1986	174,755,193	18,269,725	18,996,334.81
1987	183,339,680	19,260,972	19,414,671.48
1988	225,370,190	24,600,158	22,459,060.86
1989	236,596,532	21,749,012	19,104,614.89
1990	182,250,336	15,524,419	13,694,995.81
1991	186,137,076	15,075,440	13,567,217.64
1992	123,045,962	11,587,615	10,462,070.57
1993	172,004,226	17,455,110	15,496,139.68
1994	191,627,788	23,327,417	20,325,951.50
1995	284,622,430	32,656,750	28,446,646.34
1996	302,052,079	33,406,768	26,085,451.33
1997	310,382,749	32,989,818	26,311,166.82
1998	163,490,605	12,897,683	11,100,351.14
1999	370,663,455	42,199,631	37,997,716.82
2000	460,543,223	40,030,029	35,834,426.81

* Source: PacFIN database, Pacific States Marine Fisheries Commission.
** Note: Real revenues were derived by deflating nominal revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 2.b: Northern Anchovy

History of the Northern Anchovy Fishery of California

As Jacobson (1992) reports, landings of northern anchovy in California have featured dramatic fluctuations over the last 80 years. Anchovy landings remained below 5 million pounds from 1916 (earliest reliable landings data) until the 1940s and 1950s following the collapse of the Pacific sardine. Anchovy landings spiked to nearly 20 million pounds in the late 1940s, fell back to less than 5 million pounds for several years, and then spiked to almost 90 million pounds in the early to mid-1950s. Following another decline to approximately 5 million pounds in the early 1960s, landings ranged from 100 to more than 300 million pounds between the late 1960s and the late 1970s (with the exception of a brief falloff in 1978).

Recent Trends in the California Northern Anchovy Fishery

The reduction fishery has historically targeted northern anchovy, and this fishery has been in a long-term decline since the mid-1970s (California Department of Fish and Game 2000). Jacobson

(1992, 1993) and Bergen and Jacobson (in press) argue that the California anchovy fishery is constrained by market rather than biological limitations. Specifically, the decline in anchovy landings since 1982 is attributed to declines in fish meal and oil prices, which reduced the prices offered by reduction processors in the anchovy reduction fishery. Since vessels that fish for anchovy have an opportunity cost (the returns from fishing for other wetfish as well as squid and tuna), when anchovy prices fall below fishermen's opportunity costs, effort gets redirected to other fisheries.

Thus due to market conditions, very little anchovy has been landed for the reduction fishery since the early 1980s. For example, the California Department of Fish and Game (2000) reports that no anchovy were reduced from 1992 to 1995, and only 7.8 million pounds of anchovy were reduced from 1996 to 1998. The Fish and Game report quotes reduction processors as saying in 1999 that reduction is at best a break-even exercise, and as a result few orders are placed and few vessels participate in the anchovy reduction fishery. The bait and feed markets have absorbed most of the landed anchovy in recent years, with smaller quantities going to seafood. Thomson (1990) reports that the prices offered by California fish meal processors during the mid- to late 1980s were only about 33 percent of that offered for menhaden, which supports the dominant U.S. reduction fishery on the Atlantic and Gulf coasts. Thomson states that the reasons for this price disparity are not clear.

As the data in Table 2 indicate, anchovy landings declined by 88 percent between 1982 and 1983, a severe El Niño time period, and did not exceed 10 million pounds again until 1997. While landings are still only a fraction of those as recently as the early 1980s, they have increased in the late-1990s, and particularly in 2000.

Analysis of landings data indicate that the top four vessels generated between 50 and 70 percent of total landings in California since the mid-1980s, and the HH indices have ranged between 800 and 1800 (see the appendix for explanatory notes on market structure terms). These data indicate a moderately concentrated industry structure. Prior to the mid-1980s the fishery was less concentrated. For example, in 1981 and 1982 the top four vessels only landed between 25 and 35 percent of the anchovy in California.

Value Added in the California Northern Anchovy Fishery

As mentioned earlier, total revenue can be interpreted as the value added by fishermen to the products created from the fish that they catch. Table 2 and the accompanying Figure 2 provide real (inflation-adjusted) total ex-vessel revenue from anchovy landings between 1981 and 2000. The northern anchovy fishery generated less than a million dollars in real ex-vessel value added in the period between 1983 and 1999. Landings increased sharply in 2000, however, pushing real value added to nearly $1.25 million.

Table 2: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Northern Anchovy in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	94,079,660	2,672,001	2,554,290.77	0.0284	0.0272
1982	80,380,700	1,886,537	1,885,280.15	0.0235	0.0235
1983	9,714,048	406,308	392,189.19	0.0418	0.0404
1984	6,287,906	395,265	373,920.38	0.0629	0.0595
1985	3,459,446	205,646	211,479.30	0.0594	0.0611
1986	3,334,592	209,801	218,145.05	0.0629	0.0654
1987	3,051,834	249,738	251,730.87	0.0818	0.0825
1988	3,252,466	365,938	334,088.25	0.1125	0.1027
1989	5,292,478	479,227	420,959.23	0.0905	0.0795
1990	7,052,112	562,619	496,319.05	0.0798	0.0704
1991	8,202,058	544,044	489,615.12	0.0663	0.0597
1992	2,175,846	164,626	148,635.32	0.0757	0.0683
1993	4,311,752	441,813	392,228.75	0.1025	0.0910
1994	3,857,676	490,677	427,543.13	0.1272	0.1108
1995	4,142,056	288,961	251,708.19	0.0698	0.0608
1996	9,385,246	597,506	466,558.56	0.0637	0.0497
1997	12,192,026	741,444	591,341.75	0.0608	0.0485
1998	3,188,558	173,845	149,619.16	0.0545	0.0469
1999	11,384,244	877,625	790,237.86	0.0771	0.0694
2000	25,899,603	1,395,623	1,249,345.84	0.0539	0.0482

* Source: PacFIN database, Pacific States Marine Fisheries Commission.
** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 2.c: Jack and Pacific Mackerel

History of the California Mackerel Fisheries

Mason (1992) provides an authoritative history of the California mackerel fisheries. She states that the jack mackerel fishery was of minor importance before 1947. These fish were referred to as horse mackerel and held little appeal as a canned product. Much of the 400 thousand to 30 million pounds of annual catch in those years was taken in schools mixed with Pacific sardine and the more desirable Pacific mackerel. The jack mackerel fishery developed as a consequence of the collapse of the sardine fishery. Annual landings from 1947 to the late 1980s experienced sharp periodic fluctuations, ranging from 40 to 300 billion pounds, with the largest peak years being in the late 1940s through the early 1950s when the fishery was first exploited. Mason states that many of the fluctuations in jack mackerel landings were related to changing market demand and the relative abundance and market value of other coastal pelagic fish. Peak landings followed

the collapse of the sardine fishery in the late 1940s and declining catches of Pacific mackerel in the mid-1960s.

Konno and Wolf (1992) report that Pacific mackerel (also known as chub or blue mackerel) supported a major cannery fishery in California during the 1930s and 1940s. The cannery fishery was still important into the 1980s, with pet food becoming an important element of the picture (Miller and Vojkovich 1992). Prior to this time Pacific mackerel were caught incidentally in the directed sardine fishery. Pacific mackerel landings peaked in the mid-1930s at approximately 150 million pounds, second only to Pacific sardines in California. Landings fluctuated but generally declined, and eventually collapsed during the late 1960s. A moratorium was placed on the fishery in 1970. In 1972 a quota system based on spawning biomass was established, and sufficient biomass existed by 1977 to activate the fishery. Pacific mackerel was the top-ranked finfish by pounds landed in California from 1984 through 1991.

Recent Trends in the California Mackerel Fisheries

The jack mackerel fishery experienced declining landings in California during the 1980s, which then stabilized at considerably reduced levels in the 1990s, as shown in Table 4. Pacific mackerel landings generally held between 33 and 63 million pounds in the 1980s, while in the 1990s there were several years in which Pacific mackerel landings fell below 20 million pounds, as shown in Table 5. Since there have been a great deal more Pacific mackerel landed during this time period, the trend for landings of all mackerel in Table 3 tends to follow the pattern for Pacific mackerel.

In recent years Pacific mackerel landings have been influenced by availability and by relative prices. For example, high prices for sardines, market squid, and various tunas will shift effort away from the directed mackerel fishery. According to the California Department of Fish and Game (2000), both availability and relative prices explain why the 1998-99 season closed with 23 percent of the quota (and standing orders from processors) left unfilled. Along these same lines Mason and Bishop (in press) report that the recovery of the Pacific mackerel population in the late 1970s shifted effort away from jack mackerel. Specifically, they argue that the wetfish fleet prefers Pacific mackerel because jack mackerel occur farther from port and tend to aggregate over rocky bottom where there is increased chance of damage to the encircling nets. Declining jack mackerel landings in California during the 1990s can also be attributed to the recovery of the Pacific sardine and increased demand for squid worldwide, both of which have raised the opportunity cost of fishing jack mackerel.

In terms of industry structure, while there has been a general trend of increasing concentration among mackerel fishermen in California (a larger share of total landings generated by the top vessels), the industry remains relatively unconcentrated. The associated HH indices for these fisheries have remained below 1000. While in the early 1980s the top four vessels landed less than 25 percent of all California Pacific and jack mackerel, by the late-1990s and 2000 the top four vessels landed between 30 and 45 percent of all Pacific and jack mackerel.

Value Added in the California Mackerel Fisheries

In terms of ex-vessel value added in the jack mackerel fishery, the declining landings of jack mackerel, combined with stagnant or declining prices, both contributed to steadily declining ex-vessel value added in this fishery. Value added in the jack mackerel fishery declined from around $3 million in the early 1980s to less than $250 thousand in 2000, as shown in Table 4 and the accompanying Figure 4.

Nominal prices generally declined in the Pacific mackerel fishery, falling from about 9 cents per pound in the early 1980s to between 5 and 6 cents per pound in the late 1990s into 2000. Combined with declining landings, Table 5 and Figure 5 show that ex-vessel value added in the Pacific mackerel fishery fell from nearly $6 million in the early 1980s to about $1 million in the late 1990s.

In terms of the combined mackerel fishery, real ex-vessel value added declined from $8.5 to $9 million in the early 1980s to less than $3 million in 2000, as shown in Table 3 and the accompanying Figure 3. Meloy et al. (2000) reported that California mackerel fishing was slow despite higher quotas, and that many vessels fished squid rather than mackerel. As a result, California fishermen left a considerable amount of the mackerel quota unfilled in 1998 and 1999.

Table 3: Landings, Ex-Vessel Revenue, and Average Price Per Pound for All Mackerel in California, 1981-2000*

Year	Quantity (Pounds)**	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)***	Nominal Price Per Pound ($)	Real Price Per Pound ($)***
1981	95,131,237	8,840,030	8,450,598.26	0.0929	0.0888
1982	103,113,980	9,416,332	9,410,058.63	0.0913	0.0913
1983	99,566,862	8,545,900	8,248,938.22	0.0858	0.0828
1984	106,151,178	8,609,405	8,144,490.34	0.0811	0.0767
1985	91,907,134	7,298,408	7,505,432.86	0.0794	0.0817
1986	111,635,536	8,290,922	8,620,662.33	0.0743	0.0772
1987	116,354,812	7,617,830	7,678,619.07	0.0655	0.0660
1988	119,718,014	8,743,035	7,982,076.99	0.0730	0.0667
1989	128,076,120	8,672,332	7,617,889.17	0.0677	0.0595
1990	94,810,210	5,723,724	5,049,230.90	0.0604	0.0533
1991	74,019,373	5,528,051	4,974,997.15	0.0747	0.0672
1992	43,715,681	4,137,957	3,736,023.17	0.0947	0.0855
1993	29,777,852	1,721,947	1,528,694.53	0.0578	0.0513
1994	27,842,204	1,721,848	1,500,303.22	0.0618	0.0539
1995	22,669,246	1,353,637	1,179,126.31	0.0597	0.0520
1996	25,770,926	1,495,141	1,167,470.85	0.0580	0.0453
1997	42,985,012	2,860,503	2,281,406.09	0.0665	0.0531
1998	48,560,422	2,801,651	2,411,232.30	0.0577	0.0497
1999	21,628,252	1,254,300	1,129,406.47	0.0580	0.0522
2000	51,085,206	3,171,611	2,839,190.10	0.0621	0.0556

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

** Note: The quantities given above exceed the sum of all jack and Pacific mackerel landings in any given year because of "unidentified mackerel" landings in the PacFIN database that are included in the figures for "all mackerel."

** *Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 4: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Jack Mackerel in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	31,933,740	2,968,858	2,838,070	0.0930	0.0889
1982	35,767,600	3,292,268	3,290,075	0.0920	0.0920
1983	19,554,402	1,596,845	1,541,356	0.0817	0.0788
1984	19,439,578	1,308,021	1,237,387	0.0673	0.0637
1985	14,043,474	1,196,442	1,230,380	0.0852	0.0876
1986	9,554,816	754,411	784,415	0.0790	0.0821
1987	16,958,232	1,141,690	1,150,801	0.0673	0.0679
1988	10,574,074	749,706	684,455	0.0709	0.0647
1989	23,666,480	1,674,141	1,470,587	0.0707	0.0621
1990	7,087,636	436,538	385,096	0.0616	0.0543
1991	3,730,952	245,904	221,303	0.0659	0.0593
1992	2,796,252	237,224	214,182	0.0848	0.0766
1993	3,747,912	267,941	237,870	0.0715	0.0635
1994	5,997,174	370,563	322,884	0.0618	0.0538
1995	3,830,540	282,019	245,661	0.0736	0.0641
1996	4,853,510	296,282	231,350	0.0610	0.0477
1997	2,728,110	245,653	195,922	0.0900	0.0718
1998	2,391,742	332,022	285,754	0.1388	0.1195
1999	2,240,306	187,144	168,510	0.0835	0.0752
2000	2,797,343	254,277	227,626	0.0909	0.0814

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 5: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Pacific Mackerel in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	62,931,700	5,842,183	5,584,816.06	0.0928	0.0887
1982	33,339,380	2,961,391	2,959,418.05	0.0888	0.0888
1983	34,517,520	2,805,941	2,708,437.26	0.0813	0.0785
1984	51,637,900	4,507,376	4,263,974.14	0.0873	0.0826
1985	37,624,440	3,118,648	3,207,110.81	0.0829	0.0852
1986	47,027,480	3,444,825	3,581,830.00	0.0733	0.0762
1987	56,862,480	3,807,031	3,837,410.50	0.0670	0.0675
1988	65,277,720	5,016,585	4,579,961.96	0.0768	0.0702
1989	46,084,240	3,312,337	2,909,599.88	0.0719	0.0631
1990	67,903,920	4,120,058	3,634,543.56	0.0607	0.0535
1991	69,574,300	5,226,133	4,703,284.54	0.0751	0.0676
1992	40,917,720	3,900,330	3,521,477.69	0.0953	0.0861
1993	26,016,320	1,453,461	1,290,340.46	0.0559	0.0496
1994	21,839,220	1,351,024	1,177,191.98	0.0619	0.0539
1995	18,838,706	1,071,618	933,465.16	0.0569	0.0496
1996	20,917,400	1,198,855	936,117.91	0.0573	0.0448
1997	40,253,240	2,613,914	2,084,738.00	0.0649	0.0518
1998	46,168,680	2,469,629	2,125,478.59	0.0535	0.0460
1999	19,387,078	1,066,956	960,716.74	0.0550	0.0496
2000	48,287,863	2,917,334	2,611,564.23	0.0604	0.0541

* Source: PacFIN database, Pacific States Marine Fisheries Commission.
** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 2.d: Pacific Sardines

History of the California Pacific Sardine Fishery

World War I provided the impetus for developing a large-scale sardine fishery in California. Factors include the curtailment of sardine imports into the U.S. in 1917 and 1918, and the overall scarcity of meat due to wartime demand (Culley, 1971). Pacific sardine landings in California steadily increased to a peak of 1.4 billion pounds in 1936, and averaged approximately 1.2 billion pounds in the period between 1934 and 1946. Maximum sustained yield for the subpopulation of Pacific sardines exploited by California fishermen was estimated to be approximately 500 million pounds. During this time the Pacific sardine fishery in California was the largest in the western hemisphere. Management of the fishery at this time was designed to limit the reduction fishery and to promote markets for canned sardine, but overall landings were not regulated (Wolf and Smith, 1992). The fishery collapsed in the late 1940s.

Wolf and Smith argue that both overfishing and natural changes in the ocean environment contributed to the collapse of the fishery. By 1968, commercial landings of sardines in California were only 142,000 pounds (Murphy, 1966). Between 1967 and 1973 sardine landings were restricted to incidental catch, and a moratorium was imposed by the State of California in 1974 that set a 500,000 pound (250 short ton) incidental take quota and eliminated the use of sardines for dead bait (Wolf and Smith). Sardine landings were below 100,000 pounds in the 1970s up to 1981.

Recent Trends in the California Pacific Sardine Fishery

The sardine moratorium was lifted in 1986, and a modest quota of 2 million pounds (1,000 short tons) was granted. This quota was increased to 16.3 million pounds (8,150 short tons) in 1991. Sardine landings increased steadily during the 1980s and 1990s, as shown in Table 6. By 1999 the California sardine quota increased to 260 million pounds (130,000 short tons), and biologists announced that the sardine resource was officially "recovered", with estimated spawning biomass exceeding two billion pounds. The Fishery Management Plan for Coastal Pelagic Species sets a sardine harvest guideline that ranges between five and 15 percent of estimated biomass, depending on environmental factors including three-year average sea surface temperature. While fishermen landed only about 132 million pounds of the 260 pound quota in 1999, sardines have been one of the top three commercial species landed in California based on weight between 1992-2000 (National Marine Fisheries Service 2001).

Kronman (1999) quotes industry sources as saying that ex-vessel prices in 1999 ranged between 3 and 5 cents per pound, with prices as high as 6 cents for premium sardines used for bait by Japanese long line fishermen and as feed for Australian bluefin tuna aquaculture operations. These same sources suggest that supplies of California sardine are influenced by the price of mackerel and squid. In particular, mackerel prices above 7 cents per pound, or squid prices above 15 cents per pound, may result in unfilled sardine quota as fishermen focus on these more valuable fisheries. Bard (2001) quotes industry sources as saying that foreign supplies of sardines from Ecuador and Peru contribute to relatively low ex-vessel prices in California, and thus help explain why California wetfish fishermen have been targeting the higher-value fisheries, leaving much of the sardine quota unfilled.

In terms of market structure, expansion of the California sardine fishery since the early 1980s has resulted in a growing number of vessels and thus a trend of decreasing market concentration. While as recently as the mid-1980s the top four vessels landed more than 75 percent of California sardines, that figure had fallen to less than 20 percent by 1999 and 2000. HH indices have remained below 500 throughout the 1990s and into 2000, indicating a relatively unconcentrated industry.

Value Added in the California Pacific Sardine Fishery

The resurgence of the California sardine fishery is illustrated in Table 6 and the accompanying Figure 6. While landings were increasing dramatically in the 1990s, average prices were generally lower than in the 1980s, typically ranging from just below 4 cents per pound to nearly 6 cents per pound. Nevertheless the increase in landings outstripped the decline in prices, and as a

result real ex-vessel value added sharply increased in the 1990s, rising from less than $200 thousand at the start of the decade to nearly $5 million at the end of the decade.

Table 6: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Pacific Sardines in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	31,334	2,908	2,779.89	0.0928	0.0887
1982	3,922	494	493.67	0.1260	0.1259
1983	1,384	175	168.92	0.1264	0.1221
1984	2,358	774	732.20	0.3282	0.3105
1985	12,876	1,415	1,455.14	0.1099	0.1130
1986	832,412	79,955	83,134.91	0.0961	0.0999
1987	935,133	60,270	60,750.94	0.0645	0.0650
1988	2,422,574	127,539	116,438.53	0.0526	0.0481
1989	1,645,553	184,571	162,129.57	0.1122	0.0985
1990	3,564,914	184,992	163,192.24	0.0519	0.0458
1991	16,711,022	892,166	802,909.25	0.0534	0.0480
1992	39,563,440	1,854,699	1,674,545.78	0.0469	0.0423
1993	33,828,380	1,544,349	1,371,028.19	0.0457	0.0405
1994	25,538,220	1,509,850	1,315,582.34	0.0591	0.0515
1995	88,617,140	3,549,953	3,092,293.55	0.0401	0.0349
1996	71,674,760	3,150,524	2,460,065.59	0.0440	0.0343
1997	93,894,700	4,386,289	3,498,303.07	0.0467	0.0373
1998	94,599,160	3,566,975	3,069,906.05	0.0377	0.0325
1999	132,584,960	5,278,509	4,752,915.73	0.0398	0.0358
2000	118,300,757	5,471,730	4,898,230.48	0.0463	0.0414

* Source: PacFIN database, Pacific States Marine Fisheries Commission.
** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 2.e: Market Squid

History of the California Market Squid Fishery

The fishery for California market squid was established by ethnic Chinese fishermen and centered in the Monterey Bay region in the nineteenth century. These fishermen used skiffs with a lighted torch in the bow to attract squid, which were then captured in an encircling purse seine (Pomeroy and FitzSimmons 2001). According to Dickerson and Leos (1992), ethnic Italian fishermen using lampara nets took control of the fishery in the early years of the 20th century. Prior to the Great Depression the fishery was driven by an export market for sun-dried squid in China. Development of a domestic market for canned and frozen squid began in the 1920s and

eventually came to support the fishery. Kato and Hardwick (1975) report that receiver/processors of frozen squid paid higher prices than canneries, and thus canners received the excess beyond the processing capacity of the freezer plants.

By the 1970s most of the frozen and canned squid was exported to Europe, with significant amounts of frozen squid also being used as bait in commercial and recreational fisheries. The fishery experienced large fluctuations in landings, with peak landings of 38 million pounds in 1946, diminished landings of 2.5 million pounds in 1960, peak landings of nearly 52 million in 1981, and diminished landings of 1.2 million pounds in 1984. While the squid fishery was traditionally centered on the Monterey Bay region, a southern California fishery began developing in the early 1960s that after the 1982-83 El Niño exceeded the landings of the Monterey bay wetfish fleet (Kato and Hardwick 1975, Pomeroy and FitzSimmons 2001).

Recent Trends in the California Market Squid Fishery

Market squid is one of the most valuable commercial fisheries in California. According to the National Marine Fisheries Service (2001), market squid was the top commercial marine species landed in California in 1997, 1999, and 2000 based on ex-vessel revenue, and was second in 1995 and 1996. Moreover, market squid was the top commercial species in California based on weight in 1993-2000 (with the exception of 1998).

As shown in Table 7, while landings of market squid fluctuated a great deal in the 1980s and 1990s, there was a broad trend of increasing landings. Vojkovich (1998) gives several reasons for the increased volume of squid landings in California, with perhaps the most important factor being a growing export market for California squid in China. Sonu (1993) argues that growth in the export market for squid in the early 1990s was fueled by the expanding global economy combined with a shortfall in squid supplies from the Falkland Islands, Japan, and New Zealand. A second reason given for the increased volume of squid landings in California given by Vojkovich is the increase in fishing effort in southern California.

Ocean conditions also have an important impact on the abundance of market squid. Vojkovich provides evidence that El Niño events have a negative impact on squid landings. One can see in Table 7, for example, that the California squid catch declined sharply during the strong El Niño years of 1982-83 and 1997-98. The years following El Niño events often feature a strong rebound in squid landings, such as in 1985 and again in 1999. Pomeroy and Fitzsimmons (1998) report that the number of vessels fishing squid off southern California doubled between 1994 and 1996, with the increase attributable to factors such as strong demand and prices, and limited entry and/or declines in other fisheries on the west coast of the United States.

The market structure of the squid fishery in California is relatively unconcentrated. In general the top four vessels landed less than 30 percent of the total since 1981. In 1999 and 2000 the top four vessels landed less than 15 percent of the total. Pomeroy and FitzSimmons (2001) report that most squid fishing is done by order from processors, and vessels that fish squid have established relationships with a single processor. Yaremko (in press) reports that in 1999 and 2000 squid processors generally limited the daily catch from vessels to 30 short tons to prevent supply from exceeding demand.

Value Added in the California Market Squid Fishery

There was also a great deal of fluctuation in average prices received by squid fishermen in the 1980s and 1990s, as shown in Table 7. As supply/demand theory would suggest, prices increased in years where supply sharply decreased, and vice versa. For example, Bard (2000) reported that record landings in late 1999 and 2000 stressed freezer storage capacities and depressed squid prices (which one can see in Table 7). Other major factors affecting squid prices are export demand, foreign supplies, and restraints on foreign trade. Bard attributes part of the decline in 2000 squid prices to the 45 percent tariff on squid imports imposed by China. Moreover, Bard reports that European consumers prefer relatively large squid when available, and so smaller California squid may have difficulty penetrating the European market when larger squid are abundant. Industry sources report that some California processors produce unique retail packaging and product forms that serve niche markets in Europe.

On a per-pound basis squid has been one of the more valuable species caught by round-haul gear in California, with vessel prices by the mid-1990s several times higher than for anchovy, mackerel, and sardines. Vojkovich (1998) reports that squid increased from the number three fishery (in terms of ex-vessel value) in California in 1993, to most valuable fishery in California in 1996.

Real ex-vessel value added by squid fishermen ranged from less than $300 thousand in 1984 (at the end of a particularly sharp El Niño event) to a high of nearly $30 million in 1999, as shown in Table 7 and the accompanying Figure 7. Both larger landings and (in the mid- and late 1990s) somewhat higher prices contributed to a general trend of higher ex-vessel value added in the 1990s. With the exception of 1998, where squid landings declined by almost 96 percent relative to 1997, real ex-vessel value added by squid fishermen ranged from $10 - 29.9 million in the period from 1993 to 2000.

Table 7: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Market Squid in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	51,829,720	5,078,052	4,854,347.49	0.0980	0.0937
1982	35,953,360	3,611,908	3,609,501.67	0.1005	0.1004
1983	4,020,354	756,851	730,551.16	0.1883	0.1817
1984	1,243,458	303,246	286,870.48	0.2439	0.2307
1985	22,654,920	3,971,811	4,084,474.42	0.1753	0.1803
1986	46,908,620	4,517,357	4,697,017.94	0.0963	0.1001
1987	44,056,900	3,954,933	3,986,492.73	0.0898	0.0905
1988	82,082,360	7,623,893	6,960,340.54	0.0929	0.0848
1989	90,134,660	7,525,570	6,610,558.52	0.0835	0.0733
1990	62,714,440	4,731,736	4,174,140.41	0.0754	0.0666
1991	82,426,960	6,073,319	5,465,713.81	0.0737	0.0663
1992	28,902,800	2,448,368	2,210,549.70	0.0847	0.0765
1993	94,422,600	10,269,533	9,116,993.12	0.1088	0.0966
1994	122,098,320	14,332,696	12,488,553.01	0.1174	0.1023
1995	155,076,520	22,299,941	19,425,035.71	0.1438	0.1253
1996	177,605,540	21,862,182	17,070,938.57	0.1231	0.0961
1997	149,515,340	19,961,571	15,920,434.14	0.1335	0.1065
1998	6,377,012	1,622,664	1,396,540.77	0.2545	0.2190
1999	201,762,200	33,277,105	29,963,627.22	0.1649	0.1485
2000	260,038,363	27,070,605	24,233,297.79	0.1041	0.0932

* Source: PacFIN database, Pacific States Marine Fisheries Commission.
** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 2.f: Coastal Tunas (Bluefin Skipjack, and Yellowfin) and Pacific Bonito

History of the California Coastal Tuna and Pacific Bonito Fisheries

Bayliff (1992a) reports that a sport fishery for bluefin tuna in California began in 1898, while the commercial fishery began in 1918. Bluefin landings in California have fluctuated a great deal. Peak landings between the late 1920s and the early 1970s ranged between 20 and 35 million pounds annually. In this same period annual landings occasionally fell to 2 million pounds or less. From the 1970s to current times there was a broad downward trend that is discernable in the annual fluctuations of bluefin tuna landings in California.

Wild (1992) states that the development of California fisheries for yellowfin and skipjack tunas resulted from sharply reduced sardine landings in 1903. While much of the early cannery fishery was supplied by albacore, a collapse of the albacore fishery in the mid to late-1920s shifted the cannery fishery to yellowfin and skipjack tuna. Peak landings of yellowfin in California occurred

in the late 1940s through the late 1970s, with landings ranging from 100 million to nearly 300 million pounds.

Wild describes the transition that took place in the California tuna fishery from the 1970s to the early 1990s, a summary of which is given here. At its peak the California tuna fishery employed 2000 fishermen and an additional 6000 workers at canneries, boat building, and repair facilities, primarily in Southern California. Wild reports that between 1982 and 1984 the major California tuna canneries focused their production outside of the continental United States. Industry sources indicate that the departure of tuna canneries from California was precipitated by a number of factors, perhaps the most significant of which was the pressure to remain competitive with growing imports of low-priced water-packed canned tuna, primarily from Thailand. Wild states that during the early 1980s the number of bait boats and purse seiners fishing the eastern Pacific declined by approximately one-half (from 184 vessels in the 1970s to 74 during the late 1980s). He goes on to report that by the late 1980s approximately 75 percent of the purse seiners registered in California were fishing the western Pacific and transshipping or unloading their catches to canneries in Asia, American Samoa, and various ports in Central and South America, as well as Puerto Rico.

Pacific bonito supports a large recreational fishery along with a commercial fishery, and Miller and Vojkovich (1992) report that the recreational fishery for bonito began with the expansion of the commercial passenger fishing vessel fleet after World War II. Commercial landings of bonito have experienced very large fluctuations, ranging between 120 thousand and more than 30 million pounds per year. As with the tuna fisheries in California, bonito landings generally declined in the 1980s and 1990s relative to harvest levels in the late 1960s and 1970s.

Recent Trends in the California Coastal Tuna and Bonito Fisheries

Table 8 shows recent trends in the combined "coastal tuna" fisheries. Landings in the overall fishery are far below historical levels, and feature considerable year-to-year fluctuations. The constituent elements of these trends are described below.

Commercial bluefin tuna landings dropped off considerably in the 1980s and 1990s relative to landings between the mid-1950s and the late 1970s. Bluefin landings also experienced substantial fluctuations during the 1980s and 1990s, as shown in Table 9. Bluefin is a highly valuable fish, as indicated by the high average prices per pound shown in Table 9. Industry sources indicate that in the late 1980s the San Pedro purse seine fleet caught very large bluefin tuna that were subsequently sold fresh into the Japanese seafood market and brought exceptionally high prices. While average nominal prices generally remained stable throughout the period, average prices received by fishermen were especially high in 1999, likely a response to low supplies of bluefin (1999 was a year in which landings had declined by nearly 93 percent from those of 1998).

Commercial landings of Pacific bonito fluctuate a great deal, but generally declined in the 1990s relative to the 1980s (and relative to commercial landings in the late-1960s and 1970s), as shown in Table 10. The great bulk of the bonito landings in California occur in the recreational fishery (Smiley et al. in press). 2000 was a particularly poor year for bonito landings. Yellowfin and skipjack tuna landings in California dropped considerably in the early 1980s in response to the sharp reduction in the California cannery market. As with the other tunas, yellowfin and skipjack landings fluctuated considerably in the 1980s and 1990s, as shown in Tables 11 and 12. While

skipjack landings rebounded somewhat in the mid-1990s, by the late 1990s into 2000 both skipjack and yellowfin landings had once again declined.

The market structure of the overall coastal tuna fisheries in California fluctuates a great deal from year to year, but is generally moderately concentrated to concentrated. For example, in the four years between 1997 and 2000, the top four vessels landed between approximately 45 percent and 100 percent of all California bonito and bluefin, skipjack, and yellowfin tunas.

Value Added in the California Coastal Tuna and Bonito Fisheries

As one can see in Table 8 and the accompanying Figure 8, real ex-vessel value added for all tunas ranged between about $1.5 million and $5 million during the 1990s, with the fluctuations reflecting the variability in landings during this period. The constituent elements are described below.

Real ex-vessel value added for bluefin tuna fluctuated based on landings, and ranged from a low of less than $100 thousand in 1991 to a high of a bit over $4 million in 1986, as shown in Table 10 and in Figure 10. Real ex-vessel value added only exceeded $2 million twice (1986 and 1996), both of which represented years of extraordinarily large landings. Landings were exceptionally low in 1999, while price per pound was exceptionally high. Bonito is one of the less valuable tunas, and average prices per pound tended to be approximately one-half of those for bluefin, as one can see by comparing Tables 9 and 10. Real ex-vessel value added by bonito fishermen exceeded $2 million in several years in the 1980s, while in the 1990s was generally less than $500 thousand, as one can see in Table 10 and Figure 10.

Average prices received by fishermen for skipjack typically ranged between 30 and 40 cents per pound, though there were years in which prices were above or below that range. Real ex-vessel value added by skipjack fishermen fluctuated a great deal during this period, ranging from just over $100 thousand to more than $2 million, as shown in Table 11 and the accompanying Figure 11. Like bluefin, yellowfin is one of the more valuable tunas, and average price per pound usually ranged between 40 and 60 cents per pound, as shown in Table 12. Real ex-vessel value added by yellowfin fishermen is given in Table 12 and Figure 12, and typically ranged between $1 and $3 million during the 1990s, with 1999 being the worst year in this period.

Table 8: Landings*, Ex-Vessel Revenue, and Average Price Per Pound for All "Coastal" Tuna and Bonito in California, 1981-2000**

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)***	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	22,362,709	9,639,439	9,214,790.73	0.4310	0.4121
1982	17,640,499	7,551,125	7,546,094.27	0.4281	0.4278
1983	14,381,278	5,136,747	4,958,250.00	0.3572	0.3448
1984	12,065,032	3,923,483	3,711,611.82	0.3252	0.3076
1985	13,669,118	3,790,970	3,898,503.73	0.2773	0.2852
1986	12,044,033	5,171,690	5,377,374.58	0.4294	0.4465
1987	18,941,001	7,378,201	7,437,077.87	0.3895	0.3926
1988	17,894,776	7,739,753	7,066,116.56	0.4325	0.3949
1989	11,447,721	4,887,312	4,293,078.40	0.4269	0.3750
1990	14,108,660	4,321,348	3,812,113.21	0.3063	0.2702
1991	4,777,663	2,037,860	1,833,982.30	0.4265	0.3839
1992	8,688,195	2,981,965	2,692,316.61	0.3432	0.3099
1993	9,663,642	3,477,468	3,087,195.09	0.3599	0.3195
1994	12,291,368	5,272,346	4,593,969.79	0.4289	0.3738
1995	14,117,468	5,164,258	4,498,482.58	0.3658	0.3186
1996	17,615,607	6,301,415	4,920,417.75	0.3577	0.2793
1997	11,795,671	5,040,011	4,019,681.78	0.4273	0.3408
1998	10,765,453	4,732,548	4,073,052.86	0.4396	0.3783
1999	3,303,799	1,512,092	1,361,529.53	0.4577	0.4121
2000	5,217,238	2,918,307	2,612,435.24	0.5594	0.5008

* Note: Landings include small quantities of "not identified" tuna from fish tickets, and thus exceeds the sum of landings from Tables 9-13 below.
** Source: PacFIN database, Pacific States Marine Fisheries Commission.
*** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 9: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Bluefin Tuna in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	1,246,727	829,500	792,957.86	0.6653	0.6360
1982	2,588,072	1,355,501	1,354,597.93	0.5237	0.5234
1983	1,036,551	723,016	697,891.89	0.6975	0.6733
1984	1,233,239	762,154	720,997.08	0.6180	0.5846
1985	3,989,168	1,636,901	1,683,332.93	0.4103	0.4220
1986	8,598,304	3,971,962	4,129,931.89	0.4619	0.4803
1987	1,604,997	1,908,072	1,923,298.11	1.1888	1.1983
1988	1,648,228	1,992,790	1,819,345.71	1.2090	1.1038
1989	1,969,400	1,027,247	902,347.12	0.5216	0.4582
1990	1,547,919	849,178	749,109.46	0.5486	0.4839
1991	222,916	104,697	94,222.59	0.4697	0.4227
1992	1,871,565	868,111	783,788.43	0.4638	0.4188
1993	1,048,469	554,750	492,490.94	0.5291	0.4697
1994	1,743,357	1,305,389	1,137,428.70	0.7488	0.6524
1995	659,104	416,745	363,018.29	0.6323	0.5508
1996	8,204,784	3,033,147	2,368,412.55	0.3697	0.2887
1997	2,714,624	1,552,607	1,238,288.18	0.5719	0.4562
1998	2,934,200	1,611,582	1,387,003.08	0.5492	0.4727
1999	211,944	356,145	320,682.82	1.6804	1.5131
2000	681,263	558,042	499,552.85	0.8191	0.7333

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 10: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Pacific Bonito in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	10,658,104	2,876,510	2,749,790.49	0.2699	0.2580
1982	4,695,856	981,408	980,754.16	0.2090	0.2089
1983	5,903,092	1,021,790	986,283.78	0.1731	0.1671
1984	5,425,128	680,712	643,953.02	0.1255	0.1187
1985	5,963,908	569,361	585,511.35	0.0955	0.0982
1986	486,005	77,117	80,184.04	0.1587	0.1650
1987	10,311,704	2,191,545	2,209,033.18	0.2125	0.2142
1988	8,557,368	1,636,975	1,494,499.39	0.1913	0.1746
1989	2,287,814	424,238	372,656.17	0.1854	0.1629
1990	8,901,794	1,797,870	1,586,006.03	0.2020	0.1782
1991	548,114	104,407	93,961.60	0.1905	0.1714
1992	2,295,446	487,006	439,701.45	0.2122	0.1916
1993	829,446	141,027	125,199.67	0.1700	0.1509
1994	624,596	138,318	120,521.06	0.2215	0.1930
1995	128,376	26,237	22,854.53	0.2044	0.1780
1996	749,666	148,944	116,301.93	0.1987	0.1551
1997	633,783	159,080	126,874.92	0.2510	0.2002
1998	2,381,044	736,052	633,480.89	0.3091	0.2661
1999	189,727	27,730	24,968.86	0.1462	0.1316
2000	96,413	10,499	9,398.59	0.1089	0.0975

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 11: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Skipjack Tuna in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	4,381,604	2,255,235	2,155,884.65	0.5147	0.4920
1982	4,581,003	2,000,648	1,999,315.12	0.4367	0.4364
1983	2,892,805	1,122,859	1,083,840.73	0.3882	0.3747
1984	1,840,236	642,112	607,437.45	0.3489	0.3301
1985	358,555	112,307	115,492.67	0.3132	0.3221
1986	1,047,374	316,268	328,846.37	0.3020	0.3140
1987	2,603,129	937,617	945,099.03	0.3602	0.3631
1988	3,634,081	1,780,626	1,625,647.60	0.4900	0.4473
1989	2,040,792	812,263	713,502.38	0.3980	0.3496
1990	873,700	336,716	297,036.83	0.3854	0.3400
1991	1,171,150	411,361	370,206.39	0.3512	0.3161
1992	1,588,731	300,616	271,416.15	0.1892	0.1708
1993	5,456,040	1,747,496	1,551,376.19	0.3124	0.2773
1994	2,420,900	911,037	793,816.73	0.3616	0.3151
1995	9,135,980	2,784,240	2,425,296.17	0.3026	0.2636
1996	4,975,945	1,504,915	1,175,102.81	0.2983	0.2329
1997	4,627,198	1,767,907	1,410,001.60	0.3749	0.2990
1998	1,244,286	508,906	437,988.38	0.3591	0.3090
1999	1,359,396	303,299	273,098.82	0.2137	0.1925
2000	1,719,561	483,394	432,728.81	0.2811	0.2516

* Source: PacFIN database, Pacific States Marine Fisheries Commission.
** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 12: Landings, Ex-Vessel Revenue, and Average Price Per Pound for Yellowfin Tuna in California, 1981-2000*

Year	Quantity (Pounds)	Nominal Ex-Vessel Revenue ($)	Real Ex-Vessel Revenue ($)**	Nominal Price Per Pound ($)	Real Price Per Pound ($)**
1981	5,389,834	3,228,652	3,086,419.50	0.5990	0.5726
1982	5,470,181	3,043,672	3,041,644.24	0.5564	0.5560
1983	4,540,116	2,268,991	2,190,145.75	0.4998	0.4824
1984	3,538,068	1,804,279	1,706,846.51	0.5100	0.4824
1985	3,350,540	1,466,595	1,508,196.08	0.4377	0.4501
1986	1,891,427	788,998	820,377.44	0.4171	0.4337
1987	4,326,978	2,188,330	2,205,792.52	0.5057	0.5098
1988	4,052,121	2,323,680	2,121,436.40	0.5734	0.5235
1989	5,149,368	2,623,138	2,304,198.52	0.5094	0.4475
1990	2,784,589	1,336,595	1,179,088.44	0.4800	0.4234
1991	2,833,578	1,414,168	1,272,687.57	0.4991	0.4491
1992	2,929,056	1,322,450	1,193,995.94	0.4515	0.4076
1993	2,186,855	1,024,682	909,682.92	0.4686	0.4160
1994	7,403,148	2,912,834	2,538,048.79	0.3935	0.3428
1995	4,127,097	1,935,305	1,685,805.75	0.4689	0.4085
1996	3,616,022	1,614,077	1,260,341.23	0.4464	0.3485
1997	3,730,622	1,559,774	1,244,004.25	0.4181	0.3335
1998	4,032,652	1,871,702	1,610,874.56	0.4641	0.3995
1999	1,482,078	822,194	740,326.25	0.5548	0.4995
2000	2,529,005	1,286,988	1,152,097.02	0.5089	0.4556

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

** Note: Real revenues and prices were derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 3: The Economics of Wetfish Receiving and Processing in California

Section 3.a: Introduction

The receiving/processing stage of production is made up of firms that receive fish from vessels (or purchase fish from independent receivers) and process these fish into seafood, bait, feed, and other fish products. These firms can sometimes be subcategorized as primary and secondary processors. For example, primary processors might sell a cleaned or whole frozen fish product to secondary processors for further processing. Moreover, some primary processors may make use of contract secondary processing facilities outside the U.S. For example, a primary processor of squid in California might freeze whole squid into blocks and export these blocks to an overseas processing facility for cleaning into tentacles and tubes for re-export.

Processors may sell to secondary processors, wholesalers, distributors, and exporters, or they may perform some or all of these functions as vertically integrated enterprises. Processors may also access markets by contracting with independent brokers or wholesaler-distributors. As Radtke and Davis (2000) observe, the major processing firms in the U.S. West Coast take a multi-species and multi-market orientation. Since the availability of fish varies from year to year due to natural and management conditions, it becomes necessary for firms to process a variety of different species.

Our 2001 processor interviews indicate that most of the wetfish harvested in California is processed into bait, pet food, and feed products, and much of the processing of these fish consists of freezing them whole. Smaller quantities of wetfish are processed into seafood products. A large percentage of these wetfish products are exported. An important export market for feed is driven by Australian aquaculture facilities producing pen-raised bluefin tuna, and another is driven by Japanese and other fishermen around the world who support an important export market for bait.

Most squid and tuna are processed into seafood products for human consumption. A large percentage of squid is exported to China and to Europe. Exports to China have been a particularly important source of growth. Some processors export frozen whole squid to secondary processing facilities. Of the fish studied here, Americans are most accustomed to eating tuna, and consequently fresh, frozen, and canned tuna has a larger domestic market. For the most part wetfish products are commodities that face strong international competition for export markets. For example, California squid competes with squid from the New Zealand and Falkland Islands fisheries for the Chinese market, and industry sources indicate that California sardine competes with sardines from Mexico, Ecuador, Peru, and Morocco.

In recent years there has been a decline in the quantities of some wetfish products processed in California that traditionally served as mainstays of those fisheries. Two important examples are fish meal and oil, and canned fish. In past years California wetfish processors produced fish meal and oil from whole anchovy and sardines and from fish processing scrap. For example, a large reduction fishery existed in California for Pacific sardines from the late 1920s into the early 1940s, but the fishery collapsed in the late 1940s, and after several minor comebacks was curtailed in the 1960s. While California lifted its moratorium on the directed commercial sardine fishery in 1986, harvests were restricted to nonreduction uses (Thomson, 1990).

Jacobson (1992) notes that meal and oil production in California was in sharp decline by the early 1980s due to low prices for these commodities. Industry sources indicate that fish meal and oil have not been produced in California since 1999. Reasons given by industry participants include the rising costs of energy and fish, the northerly shift in abundance of anchovy and sardines, a decline in domestic canning (and subsequent loss of cannery waste), and the decline of the groundfish fishery (and subsequent loss of processing waste).

Tuna canning in California declined sharply beginning in the early 1980s, and Wild (1992) reports that much of this canning activity moved to Asia, American Samoa, Central and South America, and Puerto Rico. The remaining major California tuna canneries at Terminal Island experienced many changes in ownership, and the last major tuna cannery in California closed in 2001 (though minor quantities of niche market tuna canning still occur in California). Industry sources indicate that canned wetfish products were also an important part of the California wetfish industry complex until the closure of the last major wetfish processor (Pan Pacific) in the 1990s.

Section 3.b: Market Structure

The structure of the receiving/processing industry is assessed by considering both the market for seafood, feed, and bait products, in which processors serve as sellers, and the market for landed fish, in which receiver/processors serve as buyers. The market for processed wetfish products is increasingly global in scope, and California processors compete with processors from other coastal states in the U.S. and from around the world. With the exception of some "value-added" products, most processed wetfish products are viewed as commodities that are largely homogeneous within species, grade, and geographical origin. Thus the market in which California processors participate as sellers is essentially competitive in structure and global in scope, and will not be analyzed in detail in this report.

The circumstances are somewhat different in the market in which California receiver/processors participate as buyers. Processors are to some degree geographically differentiated, and many fishermen have long-term relationships with specific processors that may be casual or formally contractual in nature. Acquiring the necessary capital and expertise, along with developing relationships with fishermen on the one hand and product markets on the other, together represent nontrivial costs for potential entrants. As will be described in greater detail below, the wetfish markets have usually ranged between being moderately concentrated and concentrated on the buyer side.

Taken together, the factors described above suggest that California receiver/processors can be characterized as oligopsonists (few buyers, relatively high concentration, and costly entry) in the market for fish. It is important to note, however, that a more concentrated market structure (such as oligopsony) does not necessarily imply that firms can exercise market power, and the question of market power is beyond the scope of this report. These findings are in accord with those of Radtke and Davis (2000) in their study of all U.S. West Coast processors. They report that the 15 largest processing companies or parent groups processed 65 percent of the fish by volume and 46 percent of the total fish by value in 1997.

The concentration ratios and HH indices reported in the tables below are for receiver/processors operating as buyers in the California market for landed fish. Since fish tickets may include some receivers who are not processors, actual market concentration in the processing industry is understated in the tables below.

Section 3.b.1: The Market Structure of Receiver/Processors as Buyers of Landed Northern Anchovy

Historical Northern Anchovy Products and Markets

Jacobson (1992) reports that northern anchovy were originally exploited for a reduction fishery and processed into meal, oil, and soluble protein products. These products were used as animal feed in the poultry and aquaculture industries, among others. Concerns about the size and scope of the reduction fishery resulted in the California Department of Fish and Game developing rules requiring processors to can 40 to 60 percent of the anchovy processed in their operations. Jacobson states that there was low consumer demand for canned anchovy. Beginning in 1965 the California Fish and Game Commission managed the anchovy fishery by way of a reduction quota. Thomson (1990) reports that anchovy meal production peaked at 55.2 million pounds in 1975. By the 1980s the reduction fishery for anchovy had declined sharply due to low fish meal prices. Klingbeil (1992) observes that in the 1980s and early 1990s the dominant processed anchovy products were live bait for the recreational fishing industry and frozen seafood exported to Europe.

Recent Trends in Processed Northern Anchovy

Our processor survey indicates that most of the processing of California anchovy results in a whole frozen product destined for use as bait or feed. More generally, Bergen and Jacobson (in press) report that anchovy landed by the non-reduction (other than live bait) fishery are used as dead frozen bait, fresh fish for human consumption, canned fish for human consumption, animal feed, and anchovy paste. The live, fresh, and frozen bait market (both domestic and export), and the export aquaculture feed market, are the primary engines driving the California anchovy industry.

As one can see in Table 13, since the mid-1990s there have been 20 or more receiver/processors who participate in the northern anchovy fishery. This number is deceptive, however, since the receiver/processors who participate in the northern anchovy fishery in California operate in a concentrated industry in which 85 to 90 percent or more of the anchovy is processed by the largest eight firms, and 70 to 80 percent is processed by the largest four firms. HH indices show that the anchovy processing sector is a concentrated industry.

Table 13: Buyer Concentration Ratios and HH Indices for California Northern Anchovy Receiver/Processors*

Year	C4	C8	Number of Receiver/ Processors	HH Index
1981	0.97	1.0	21	3329.80
1982	0.97	0.99	31	3566.58
1983	0.78	0.92	26	3711.98
1984	0.87	0.95	28	3591.05
1985	0.90	0.97	26	3357.62
1986	0.83	0.96	21	2379.39
1987	0.79	0.95	23	2033.02
1988	0.84	0.98	19	2227.23
1989	0.73	0.92	25	1703.92
1990	0.68	0.91	21	1417.52
1991	0.64	0.87	22	1292.86
1992	0.79	0.95	15	2841.41
1993	0.78	0.92	16	3368.83
1994	0.77	0.95	18	2650.85
1995	0.81	0.97	23	2275.59
1996	0.84	0.96	23	2359.87
1997	0.78	0.95	20	2232.71
1998	0.70	0.89	23	2136.56
1999	0.71	0.87	22	1839.40
2000	0.83	0.95	24	2405.71

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

Section 3.b.2: The Market Structure of Receiver/Processors as Buyers of Landed Mackerel

Historical Mackerel Products and Markets

Mason (1992) reports that prior to 1947 most of the jack mackerel landed in California were sold as a fresh fish product ("horse mackerel") in fish markets. Marketing improved in 1948 when the U.S. Food and Drug Administration authorized the name "jack mackerel" for use on seafood product labels. The collapse of the pacific sardine fishery caused processors to substitute jack mackerel for sardine as a canned product. Klingbeil (1992) observes that both jack and Pacific mackerel catches were primarily driven by a cannery fishery in the 1980s and into the early 1990s. Information provided by Miller and Vojkovich (1992) and various industry sources indicate that mackerel canneries produced canned product for both human and pet consumption until the closure of the last California wetfish cannery in the 1990s.

Konno and Wolf (1992) report that Pacific mackerel were sought after for a cannery fishery beginning in the late 1920s, with peak landings occurring in the mid-1930s. Prior to this, Pacific mackerel were caught incidentally in the directed sardine fishery and sold as a fresh fish product. Into the 1980s Pacific mackerel was canned as a seafood product and as pet food, with smaller

amounts sold as a fresh fish product or as live or dead bait. Konno and Wolf report that declining ex-vessel prices paid for Pacific mackerel during the 1980s reflects declining domestic demand for canned mackerel

Recent Trends in Processed Mackerel

Our 2001 survey indicates that most California mackerel is currently processed as a frozen product, either whole or as a cleaned "headed and gutted" item. More generally, Konno, Wolf, and Bergen (in press) state that most Pacific mackerel is used for human consumption, canned, or used for pet food, with a small but increasing amount sold as fresh fish. Minor amounts of mackerel are used by anglers for live and dead bait. As one can see in Table 14, receiver/processors who participate in the California mackerel fishery as buyers operate in a concentrated industry in which nearly all the mackerel is processed by the largest eight firms, and more than two-thirds is processed by the largest four firms.

Table 14: Buyer Concentration Ratios and HH Indices for California Mackerel Receiver/Processors*

Year	C4	C8	Number of Receiver/ Processors	HH Index
1981	0.88	0.99	51	2647.47
1982	0.85	0.98	62	3125.20
1983	0.81	0.95	66	2591.94
1984	0.84	0.94	66	2739.44
1985	0.81	0.97	77	2727.39
1986	0.82	0.98	71	3073.88
1987	0.75	0.91	63	1546.15
1988	0.88	0.96	68	3003.19
1989	0.82	0.97	63	2371.17
1990	0.81	0.95	69	2703.13
1991	0.84	0.99	53	2430.62
1992	0.71	0.97	57	1598.31
1993	0.79	0.95	55	1941.73
1994	0.88	0.98	55	2342.66
1995	0.77	0.96	63	1800.89
1996	0.76	0.97	57	1819.83
1997	0.55	0.84	52	1139.25
1998	0.64	0.92	51	1350.03
1999	0.68	0.97	41	1470.93
2000	0.77	0.99	75	1768.24

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

Section 3.b.3: The Market Structure of Receiver/Processors as Buyers of Landed Pacific Sardines

Historical Pacific Sardine Products and Markets

Culley (1971) provides a detailed history of sardine processing in California, and the material that follows borrows heavily from that work. Large-scale commercial sardine fishing in California supported a cannery fishery that grew quickly in response to the curtailment of imported sardines and the increased demand for meat during World War I. A number of tuna canneries converted to sardines, and another 28 sardine canneries were built between 1917 and 1920. The cannery fishery for sardines dominated in the early years, in part because California Fish and Game regulations reflected the widespread view that the "mass reduction of food resources for preparation of meal for animal food or for oil not for human consumption was considered an abuse of a resource" (Culley, 1971, p. 166). Sardine reduction was limited to a percentage of canning production, ostensibly based on the quantity of cleaning waste and poor-quality fish that would otherwise not be used.

In 1925 regulations changed to allow canneries to reduce sardine in quantities equal to 25 percent of the canning capacity of the particular facility. In 1929 the reduction quota for canneries was the residual ("overage") left over after a ton of sardines was converted into 960 pounds. After several years the minimum to be canned from a ton of sardines was reduced to only 648 pounds, thus increasing the reduction quota. Culley states that the "canning part of their business was increasingly becoming the cover whereby they could obtain permission to reduce sardines (Ibid, p. 167). Also in 1929 reduction operations that were independent of canneries were allowed to operate. By the mid-1930s there were nine floating reduction plants operating in California. During the peak years of the mid-1930s approximately two-thirds to three-fourths of all sardines in California were reduced into fish meal and oil.

In the late 1940s and 1950s sardine landings collapsed (with a slight rebound in 1949-50, and again in 1958). The percentage of sardines landed in California during this time that were processed into canned seafood products increased from 60-70 percent in the late-1940s and early 1950s to at least 80 percent from 1951 through the early 1960s. Sardine landings declined even further in the 1960s, which resulted in the curtailment of first the reduction fishery and then the cannery fishery. Those few sardines that were caught in the 1960s supported a bait fishery. The recovery of sardines following the moratorium in the mid-1970s allowed for rising quotas and a fishery driven by demand for sardines as bait and feed (Wolf and Smith, 1992). Klingbeil (1992) observes that sardine processors had not been able to re-establish a market for canned sardine products in the 1980s through the early 1990s, though since his report a sardine cannery in the Monterey Bay region was built in the mid-1990s.

Recent Trends in Processed Pacific Sardines

Our 2001 survey indicates that most Pacific sardines in California are currently processed as a frozen whole product. More generally, the California Department of Fish and Game (2000), along with Wolf, Smith, and Bergen (in press) reports that sardines are currently being processed into seafood products (fresh or canned), pet food, bait, and as feed for aquaculture operations such as pen-raised bluefin tuna in Australia. They go on to report that approximately 61 percent of California's sardine landings were exported in 1999, with the dominant product (85 percent of the total) being frozen blocks of sardines. Australia was the major importer of California sardines,

which are primarily used as aquaculture feed. Additional discussion of sardine exports is provided in Section 4 of this report.

As one can see in Table 15, the rebuilding of the sardine fishery in California is revealed not only in landings, but also in the number of receiver/processors buying fish. While the number of processing industry participants has increased, and the HH index has declined to "moderately concentrated" levels in recent years, the largest eight sardine receiver/processors buy between 80 and 90 percent of the fish, and the largest four sardine receiver/processors buy between half and two-thirds of the fish.

Table 15: Buyer Concentration Ratios and HH Indices for California Pacific Sardine Receiver/Processors*

Year	C4	C8	Number of Receiver/ Processors	HH Index
1981	1.00	1.00	5	6013.11
1982	1.00	1.00	2	8587.19
1983	1.00	1.00	3	9450.84
1984	0.79	1.00	9	1795.49
1985	0.93	1.00	9	3583.07
1986	0.95	1.00	17	3177.39
1987	0.85	0.99	23	2747.10
1988	0.95	1.00	15	6711.88
1989	0.95	1.00	15	3854.12
1990	0.90	0.99	20	3525.14
1991	0.85	0.97	26	2612.04
1992	0.78	0.98	28	1685.09
1993	0.71	0.93	24	1579.87
1994	0.68	0.95	34	1450.60
1995	0.72	0.94	30	1852.02
1996	0.75	0.96	27	1595.73
1997	0.61	0.85	32	1160.71
1998	0.63	0.92	34	1373.47
1999	0.55	0.84	32	1049.56
2000	0.62	0.91	29	1273.50

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

Section 3.b.4: The Market Structure of Receiver/Processors as Buyers of Landed Market Squid

Historical Market Squid Products and Markets

Dickerson and Leos (1992) report that the Chinese export seafood market for sun-dried squid was the engine that drove the founding and early years of the California market squid fishery in Monterey Bay. This market was displaced by a domestic seafood market for canned and frozen squid in the 1920s and 1930s. Kato and Hardwick (1975) report that processors of frozen squid products historically paid between 1.5 and 4 times the prices paid by squid canners. As a result, "squid [were] sold to freezer plants because of the higher price, and canner receive[d] the excess beyond processing capacity of the freezer plants" (p. 110). Kato and Hardwick go on to report that at the time of their study the bulk of California squid was processed into canned or frozen seafood products and exported to Europe, and to a lesser degree to markets in Central and South America and to Asia (particularly the Philippines). Lesser quantities were sold domestically as a frozen seafood product or as a frozen bait product.

Recent Trends in Processed Market Squid

According to our survey (corroborated by Vojkovich 1998 and Yaremko in press), most California squid is processed whole as a fresh or frozen product, mostly destined for seafood markets but with some becoming bait or feed. Smaller quantities receive additional domestic processing (tubes, tentacles, rings, breaded, or canned seafood products). A large percentage of California squid products are exported to Asia and Europe, as discussed in greater detail in Section 4 of this report.

As one can see in Table 16, since the mid-1990s there have been between 42 and 58 receiver/processors participating in the California market squid fishery. These numbers are a bit deceiving, however, since the HH indices show the squid processing industry to be moderately concentrated to concentrated (though the recent trend is toward a somewhat less concentrated industry). Moreover, the largest eight squid receiver/processors in California buy at least 80 percent of the commercial market squid landings in California, and the largest four buy more than 50 percent.

Table 16: Buyer Concentration Ratios and HH Indices for California Market Squid Receiver/Processors*

Year	C4	C8	Number of Receiver/ Processors	HH Index
1981	0.52	0.73	49	1005.82
1982	0.58	0.82	46	1222.16
1983	0.53	0.76	55	972.59
1984	0.63	0.89	41	1361.32
1985	0.60	0.80	56	1295.98
1986	0.63	0.84	62	1340.47
1987	0.59	0.83	63	1130.00
1988	0.71	0.90	58	1525.15
1989	0.63	0.79	54	1430.87
1990	0.58	0.81	58	1264.30
1991	0.58	0.81	42	1334.80
1992	0.68	0.93	42	1425.19
1993	0.67	0.88	37	1358.81
1994	0.72	0.98	49	1441.38
1995	0.67	0.93	44	1324.17
1996	0.60	0.85	44	1114.10
1997	0.57	0.80	47	1003.65
1998	0.83	0.98	42	2250.93
1999	0.53	0.83	58	1004.97
2000	0.51	0.82	56	977.69

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

Section 3.b.5: The Market Structure of Receiver/Processors as Buyers of Landed Coastal Tunas and Pacific Bonito

Historical Coastal Tuna Products and Markets

Extremely large bluefin tuna are exported as a fresh seafood product to Japan, where they are sold at auction and command high prices. Miller and Vojkovich (1992) report that the commercial bonito catch was driven by a (limited) cannery fishery in the 1980s, with small amounts of fresh or frozen seafood products, and "value-added" cured or smoked bonito products. As for skipjack and yellowfin tunas, Bayliff (1992b) reports that for years, most of the tunas caught in the eastern Pacific were landed and canned in California (or Puerto Rico). As Bayliff reports, due "principally to high labor costs, all but one of the major tuna canneries in California were closed during the early 1980s" (p. 146). Industry sources argue that factors such as the Marine Mammal Protection Act, growing international competition, Mexico's assertion of a 200 mile Exclusive Economic Zone, and the "dolphin-safe" movement all played a role in displacing tuna canneries from California.

Bayliff reports that most of the vessels participating in the eastern tropical Pacific (ETP) skipjack and yellowfin fisheries operate out of Mexico, Venezuela, and Ecuador, and fish caught by these vessels are canned outside the United States. Industry sources indicate that U.S. vessels also participate in the ETP tuna fishery, but their catch is often times delivered offshore and trans-shipped to canneries and other processing facilities outside of the continental U.S.

Recent Trends in Processed Tuna

According to our 2001 survey, most California tuna is currently processed as fresh or frozen products, either sold whole or as cleaned "headed and gutted" items destined for seafood markets. Industry sources indicate that some of the frozen tuna is subsequently exported and canned outside of the United States. Recently the last major California tuna cannery was closed. According to the WorldCatch News Network (2001b), Thai Union Frozen Products, owner of Chicken of the Sea, shut down its California canning plant and moved cannery equipment to the company's plant in American Samoa on October 1 2001. The article quotes Dennis Mussell, chief executive of Chicken of the Sea International Ltd, as saying that the California cannery incurred comparatively high wage and tax costs relative to their cannery in American Samoa. As of this time there is no large-scale canning of coastal tunas in California.

As one can see in Table 17, receiver/processors who are participants in the California coastal tuna fishery operate in a highly concentrated industry in which the largest four receiver/processors buy more than 80 percent of all the tunas landed in the state.

Table 17: Buyer Concentration Ratios and HH Indices for California Coastal Tuna Receiver/Processors*

Year	C4	C8	Number of Receiver/ Processors	HH Index
1981	0.97	0.99	30	3094.86
1982	0.98	1.00	24	3587.78
1983	0.96	0.98	52	3854.40
1984	0.94	0.98	48	3555.09
1985	0.92	0.99	46	3704.58
1986	0.97	0.99	43	5810.50
1987	0.95	0.99	41	5797.48
1988	0.98	1.00	39	7634.44
1989	0.98	0.99	34	7756.06
1990	0.97	0.99	41	6737.40
1991	0.96	0.99	33	7215.45
1992	0.92	0.99	50	2527.15
1993	0.93	0.99	46	3878.62
1994	0.97	0.99	33	3037.11
1995	0.86	0.99	44	2072.13
1996	0.93	0.99	44	3244.37
1997	0.94	0.99	41	3126.12
1998	0.87	0.98	50	3343.56
1999	0.81	0.97	45	2248.79
2000	0.88	0.96	78	5817.63

* Source: PacFIN database, Pacific States Marine Fisheries Commission.

Section 3.c: Value Added by Processors

In order to estimate value added by receiver/processors, one must gather price, quantity, and product data from processors using survey and ethnographic research techniques, and subtract the cost of purchased fish from product sales revenue. These data do not currently exist. Consequently, primary data were generated on product types, quantities, prices, and revenues for this report using survey research techniques, including field interviews and a mail survey. California receiver/processors of wetfish (as indicated from fish ticket data) were surveyed via mail (see the appendix for the survey instrument), with both telephone and in some cases on-site follow-up contacts also being utilized. A low response rate to our mail survey prompted us to use a key-informant interview process. An important cross-section of major California processors were visited and interviewed face-to-face.

From these key-informant interviews we were able to develop price and quantity information for various seafood, feed, and bait products for 2000 (we generally found that older data were not available). We used this information to calculate value added by individual processors for each species of fish. See the appendix for an explanation of the value-added calculations.

No data are available that show the total annual production of various seafood, bait, feed, and other items by the processing industry in California. Consequently we estimate a range of industry-wide processor value added in California by species for 2000 based on the range of firm-level value added from our key-informant interviews. For 2000 our processor data encompasses 80 percent of the anchovy, 50 percent of the mackerel, 64 percent of the sardine, 61 percent of the squid, and 8 percent of the coastal tuna received and processed in California.

For each processor from our key-informant interviews we estimate average value added per pound by species. Since different processors produce different mixes of products, and have different experiences in the market, there will naturally be a range of average value added per pound across the processors in our survey. Consequently we calculate both the range and the median of average value added per pound, by species or species group, for the processors who participated in our interviews. We apply that range and median of average value added per pound to the total quantity of landed fish by species (or species group) for 2000 to get our estimate of the range and median of value added by processors. These figures are then adjusted for inflation and reported in Table 18.

As one can see in Table 18, based on our survey the estimated real value added by California receiver/processors of wetfish ranged from $37.5 million and $90.3 million in 2000, with the median estimate being $62.5 million. Approximately 50 percent or more of the real value added by processors was generated from squid, and approximately 25 percent was generated from sardines, as shown in Figure 13. Comparing real value added by fishermen in 2000 from Table 1 to the estimates in Table 18, one can see that receiver/processors added between approximately one to three times the real value added by fishermen, with the median estimate being that processors added twice the real value added by fishermen. It is important to note that most of the processors in our survey were vertically integrated downstream into distribution and export channel functions, and thus the information on real value added in Table 18 can be expected to include a sizeable amount of value added through distribution and export.

In their broader study of all U.S. West Coast fisheries, Radtke and Davis (2000) estimated ex-processor value using financial information about five components of product cost (raw product purchase, labor, taxes and fees, fixed plant and other costs, and profit). Recall that value added represents income that flows to those who supply the capital, labor, entrepreneurship, and intermediate goods and services inputs that are assembled together in production, as well as tax income to government. Thus the Radtke and Davis approach, which they applied to the processing of all U.S. West Coast landings in 1996, is comparable to the value-added analysis in this report. Radtke and Davis then applied this analysis to the processing of all U.S. West Coast landings in 1996.

It is important to note that Radtke and Davis' analysis found that value added by processing was about double the ex-vessel value of the landings, which provides some external validation for our median estimate of real processor value added as twice that of real harvester value added.

Table 18: Estimated Real Value Added by California Wetfish Processors in 2000*

Fish Species or Species Group	Total Real Processor Value Added		
	High Estimate	Median Estimate	Low Estimate
Northern Anchovy	4,356,467	3,256,337	1,854,802
Jack and Pacific Mackerel	5,945,016	4,815,463	2,350,568
Pacific Sardine	20,407,218	14,826,209	9,531,134
Market Squid	50,653,665	34,917,508	23,278,339
Coastal Tunas	8,931,229	4,699,135	467,041
Total	90,293,595	62,514,653	37,481,885

* Note: Real value added was derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 4: An Overview of the Economics of Distribution and Export

Section 4.a: Distribution

After fish are converted into seafood, bait, feed, and other products by processors, these products find their way downstream to consumers by way of several market channels. According to the *Seafood Handbook* (www.seafoodhandbook.com), these channels include brokers, wholesalers (sometimes known as distributors), and exporters (which can be brokers or wholesalers). Brokers are independent intermediaries who specialize in finding buyers and facilitating transactions, including export sales. Brokers rarely take title or physical possession of the product during the intermediation process (Hackett 1992). The *Seafood Handbook* reports that most seafood brokers trade in container load quantities, and serve as independent representatives for a variety of different processors. Brokers are compensated with a commission on sales.

According to the *Seafood Handbook*, seafood wholesalers usually purchase large quantities of seafood products from processors, and then distribute this product in smaller quantities to retailers, restaurants, and other outlets, including export sales. Wholesalers also perform quality control and marketing support functions. Some processors perform their own wholesaling functions. Wholesalers usually take title and physical possession of the product during the intermediation process (Hackett 1992).

Note that there is not adequate existing information to measure the market structure of distribution and export. Moreover, since the channel functions of distribution and export are in many cases vertically integrated with processing, it appears likely that a considerable percentage of value added by distribution and export is already captured in the value added computations for processors. As a result we do not report separate value added information for distribution and export.

Section 4.b: Export Sales

Seafood, bait, and feed exports out of California are tracked by U.S. Customs, and are available from the National Marine Fisheries Service's Southwest Region office (Sustainable Fisheries Division http://swr.ucsd.edu/fmd/sustaina.htm). Customs values exports at the “free alongside ship” value, which is the transaction price (including shipping and other charges) at the port of exportation. There are several issues that limit the comparability of the export data on the one hand, and our harvester and processor data on the other.

First, while it is likely that most of the seafood, bait, and feed products exported out of California were landed and processed in California, it is not possible to establish this fact conclusively. Thus it is possible that some seafood, bait, and feed products exported out of California were landed or processed elsewhere. For instance, Thomson (in press) observes that California exports may include fish landed in Mexico and subjected to additional handling or processing in California before being sold to a third country. She also observes that exports also include fish that were imported and not sold, then re-exported - sometimes in substantially the same condition as when imported.

A second issue with regard to the export data has to do with inadequately identified seafood, bait, and feed products. For example, both *Loligo opalescens* and *Loligo pealei* are used to produce

squid products exported out of California. The problem is that each year there are some export sales reported for a species group, such as *Loligo*, in which the actual species is not specified. Since *L. pealei* is not one of our target species in this study, simply reporting all of the "not specified" squid will result in an overestimate of market squid (*L. opalescens*) exports.

In order to generate a more reasonable estimate, we derive the percentage of total *specified opalescens* and *pealei* export quantities that is made up of *opalescens* exports, and assume that the same percentage prevails in the "not specified" squid exports. Note that in 1989 and 1990 the NMFS data do not provide any indication of particular squid species, and thus we report all of these "not specified" data as *opalescens*. As with squid, in the case of tuna there are multiple species that fall under tuna exports, including albacore, which is not one of our target species in this study. Consequently the "not specified" tuna product exports are assigned to each species, with the percentages equal to that of bluefin, bonito, skipjack, and yellowfin out of the total specified tuna exports.

As one can see in Table 19 export markets for wetfish have become increasingly important, surpassing $100 million in nominal value in 2000. This trend can easily be seen in Figure 14. In fact, real export revenues have increased by 317 percent between 1989 and 2000, while in contrast real ex-vessel revenue increased by 88.4 percent over the same period.

Exports of northern anchovy have generally diminished both in quantity and in revenue, as shown in Table 20. While California anchovy products were sold into export market that generally exceeded $500 thousand in 1989-1992, in more recent years the export market for anchovy has declined to less than $250 thousand. In 2000 only 0.5 percent of California anchovy landings were exported.

Exports of Pacific and jack mackerel have fluctuated a great deal since 1989, as can be seen in Table 21. In recent years California mackerel products have been sold into export markets that generated between $900 thousand and $4 million in revenues. In 2000 approximately 44 percent of the jack and Pacific mackerel landed in California was exported.

The export market for California sardine products has been growing apace with the resurgent fishery, as one can see in Table 22. Sardine products are also becoming a more and more important element of overall California wetfish exports. Comparing the data in Tables 19 and 22 one can see that in 2000, sardine products represented nearly one-third of all California wetfish exports by weight, and nearly one-quarter of these total exports by revenue. In contrast, in 1990 sardine products comprised less than five percent of total exports by quantity and revenue. In 2000 more than 78 percent of the sardines landed in California were exported. Australia is the major importer of California sardines for fish food in their aquaculture operations. Japan also imports sardines as seafood to offset recent declines in its own sardine resource (California Department of Fish and Game 2000).

As a consequence of the dominant role of export markets, protectionism is a potential threat to the California sardine industry, and the European Union has taken action to protect its sardine industry. According to the WorldCatch News Network (2001a), the European Union passed regulations in 2001 that prohibit use of the term "sardine" for anything other than the European

species of sardines (*Sardinia pilchardus*), a policy affecting export fisheries in Maine, Canada, California, and Peru. Peru has filed a complaint with the World Trade Organization and the U.S. Trade Representative has made oral arguments in support of Peru's complaint.

Yaremko (in press) argues that export markets have played a substantial role in the temporal growth and success of the California squid fishery. Market squid products are the dominant element of all exports of wetfish from California, as one can see by comparing Tables 19 and 23. In 1999 and 2000 squid products comprised nearly two-thirds of combined exports by quantity and more than two-thirds of combined exports by revenue. With the exception of the extremely poor catch in 1998, the general pattern has been one of increasing exports and export revenues. In 2000 nearly 71 percent of California squid landings were exported, with the primary export market being China. Due to lower labor costs, much of the squid is exported whole and receives further processing overseas.

Factors affecting export demand for California squid include global economic conditions, exchange rates, the abundance of substitute sources of squid (such as from New Zealand), and market-enhancing activities. For example, from the mid-1990s until its dissolution in 2001, the California Seafood Council promoted California seafood such as squid, sardines, mackerel in export markets. According to Council manager Diane Pleschner, the Council's primary export activities involved developing one-page product sheets for these species, with color photo on front and summary market information on the backside, translated into various Asian and European languages. These product sheets and export availability posters were distributed by the Council and various California processors at trade shows in Hong Kong, Korea and, in recent years, at the European Seafood Expo.

Exports of California tuna products are a relatively minor component of wetfish exports, and there has been a general downward trend in export quantities and total revenues since the mid-1990s, as shown in Table 24. In 2000 only about 11 percent of the coastal tunas landed in California were exported.

Table 19: California Wetfish Export Quantities and Revenues

Year	Pounds Exported	Nominal Export Revenue ($)	Real Export Revenue ($)*
1989	39,744,534.51	24,473,496.19	21,497,837.23
1990	37,882,803.53	18,834,733.55	16,615,217.42
1991	46,834,871.73	18,548,928.59	16,693,201.06
1992	53,534,111.55	24,662,101.95	22,266,588.17
1993	30,451,012.34	17,872,021.80	15,866,261.86
1994	67,536,727.86	36,662,470.45	31,945,225.48
1995	119,532,280.38	52,860,041.40	46,045,332.23
1996	145,661,444.01	64,880,411.22	50,661,435.10
1997	168,164,122.46	77,930,977.14	62,154,175.57
1998	71,676,206.58	23,397,257.56	20,136,777.65
1999	176,094,725.91	64,362,249.54	57,953,552.52
2000	300,646,252.36	100,154,875.10	89,657,505.39

Source: NMFS website http://swr.ucsd.edu/fmd/bill/califexp.htm
* Note: Real export revenues were derived by adjusting nominal export revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 20: California Export Quantities and Revenues for Northern Anchovy

Year	Pounds Exported	Nominal Export Revenues ($)	Real Export Revenues ($)*
1989	755,794.60	596,007.00	523,540.30
1990	677,648.40	621,845.00	548,565.76
1991	590,242.40	544,662.67	490,171.89
1992	573,188.00	766,551.00	692,093.30
1993	182,303.00	253,438.00	224,994.90
1994	111,595.00	54,040.00	47,086.84
1995	3,258.20	8,206.00	7,148.08
1996	15,813.60	42,662.00	33,312.34
1997	644,494.40	536,397.00	427,805.66
1998	34,740.20	57,200.00	49,229.00
1999	74,377.60	106,984.00	96,331.36
2000	132,924.00	239,075.00	214,017.22

Source: NMFS website http://swr.ucsd.edu/fmd/bill/califexp.htm
* Note: Real export revenues were derived by adjusting nominal export revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 21: California Export Quantities and Revenues for Pacific and Jack Mackerel

Year	Pounds Exported	Nominal Export Revenues ($)	Real Export Revenues ($)*
1989	4,127,442.00	1,227,754.00	1,078,475.08
1990	6,322,034.40	1,428,290.00	1,259,977.95
1991	13,718,181.40	3,725,455.53	3,352,742.33
1992	14,841,288.00	3,222,477.00	2,909,466.86
1993	1,379,395.60	429,343.00	381,158.25
1994	961,974.20	354,936.00	309,267.50
1995	844,868.20	433,315.00	377,452.09
1996	1,382,704.40	625,903.00	488,732.17
1997	7,833,421.20	3,003,170.00	2,395,190.75
1998	12,461,565.60	4,289,754.00	3,691,963.57
1999	4,267,859.20	1,006,909.00	906,648.76
2000	22,488,776.20	4,165,908.00	3,729,273.47

Source: NMFS website http://swr.ucsd.edu/fmd/bill/califexp.htm
* Note: Real export revenues were derived by adjusting nominal export revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 22: California Export Quantities and Revenues for Pacific Sardine

Year	Pounds Exported	Nominal Export Revenues ($)	Real Export Revenues ($)*
1989	920,084.00	564,726.00	496,062.66
1990	1,731,917.00	549,714.00	484,934.79
1991	3,551,523.80	841,824.21	757,603.91
1992	2,597,331.00	841,798.00	760,031.30
1993	3,610,252.80	1,320,040.00	1,171,893.17
1994	3,206,904.80	1,200,964.00	1,046,439.73
1995	27,576,236.60	6,649,851.00	5,792,553.14
1996	27,102,013.40	6,146,316.00	4,799,309.73
1997	24,148,935.80	5,378,993.00	4,290,038.28
1998	49,272,416.60	11,957,564.00	10,291,240.62
1999	79,395,496.40	17,130,686.00	15,424,944.25
2000	92,994,228.80	23,769,433.00	21,278,126.16

Source: NMFS website http://swr.ucsd.edu/fmd/bill/califexp.htm
* Note: Real export revenues were derived by adjusting nominal export revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 23: California Export Quantities and Revenues for Market Squid

Year	Pounds Exported	Nominal Export Revenues ($)	Real Export Revenues ($)*
1989	31,501,256.60	18,830,915.00	16,541,320.55
1990	25,195,172.20	12,281,569.00	10,834,288.61
1991	26,579,898.58	11,610,681.74	10,449,091.11
1992	26,623,987.02	14,563,743.63	13,149,117.71
1993	19,654,260.68	12,288,290.65	10,909,187.53
1994	53,358,114.67	27,897,817.44	24,308,292.86
1995	82,646,560.60	38,495,832.82	33,532,955.41
1996	110,124,201.18	51,222,569.16	39,996,800.49
1997	131,532,549.36	63,066,031.48	50,298,576.22
1998	5,275,523.71	3,596,926.27	3,095,683.51
1999	88,741,407.87	43,702,317.64	39,350,777.50
2000	184,455,859.28	71,389,390.23	63,906,970.41

Source: NMFS website http://swr.ucsd.edu/fmd/bill/califexp.htm
* Note: Real export revenues were derived by adjusting nominal export revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Table 24: California Export Quantities and Revenues for Coastal Tunas and Bonito

Year	Pounds Exported*	Nominal Export Revenues ($)**	Real Export Revenues ($)***
1989	2,439,957.31	3,254,094.19	2,858,438.65
1990	3,956,031.53	3,953,315.55	3,487,450.31
1991	2,395,025.55	1,826,304.45	1,643,591.83
1992	8,898,317.53	5,267,532.32	4,755,879.00
1993	5,624,800.26	3,580,910.14	3,179,028.02
1994	9,898,139.19	7,154,713.01	6,234,138.55
1995	8,461,356.78	7,272,836.59	6,335,223.51
1996	7,036,711.44	6,842,961.06	5,343,280.37
1997	4,004,721.70	5,946,385.65	4,742,564.66
1998	4,631,960.47	3,495,813.29	3,008,660.94
1999	3,615,584.84	2,415,352.89	2,174,850.66
2000	574,464.08	591,068.87	529,118.13

Source: NMFS website http://swr.ucsd.edu/fmd/bill/califexp.htm
* Note: Not all of these tunas were caught by the California round-haul fleet, and thus these export data overstate the value added at the export distribution stage for those tunas caught by the round-haul fleet.
** Note: An estimate of the value of high-grade bluefin tuna exported as a fresh seafood product to Japan is included in these revenue figures, but these estimates do not reflect actual auction prices paid.
*** Note: Real export revenues were derived by adjusting nominal export revenues using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 5: Industry-Wide Value Added in California

The information in Table 25 combines the information in Table 1 and Table 18 to provide summary information on estimated real value added from harvesting and processing (and a sizeable but unestimated amount of distribution and export) in California's wetfish industry complex. One can see that harvesting and processing was estimated to have added between $73.3 million and $125.1 million in real value in 2000, with a median estimate of $98.3 million. These figures do not include additional value added to these various seafood, bait, and feed products as they make their way through various retail market channels both inside California, the United States, and the world. Because a substantial amount of these products is exported, most of the value added by retail market channels will occur outside of the United States. We have generated a report that focuses on value added primarily to the California economy.

Table 25: Industry-Wide Real Value Added in California for 2000*

Fish Species or Species Group	Industry-Wide Real Value Added**		
	High Estimate	Median Estimate	Low Estimate
Northern Anchovy	5,605,813.00	4,505,683.32	3,104,148.25
Jack & Pacific Mackerel	8,784,206.52	7,654,653.40	5,189,758.13
Pacific Sardine	25,305,448.09	19,724,439.44	14,429,364.81
Market Squid	74,886,962.55	59,150,805.67	47,511,636.37
Coastal Tunas	11,543,664.37	7,311,570.41	3,079,476.45
All Species Total	126,126,094.53	98,347,152.23	73,314,384.02

* These numbers represent the sum of harvester and processor value added, combining information from Tables 1 and 18.

** Real value added is derived by deflating nominal values using the producer price index for intermediate foods and feeds (source: U.S. Department of Labor, Bureau of Labor Statistics, http://www.stls.frb.org/fred/data/ppi/ppiiff).

Section 6: Appendix

Section 6.a: Technical Notes

Market Structure: The number and size distribution of market participants, hereafter referred to as *market concentration*, is measured in several ways. Once the relevant market is identified, concentration ratios measure the percentage of total market sales made by the largest four (C4) or largest eight (C8) firms. Concentration ratios do not indicate variation in size within the largest four or eight firms, however, and an additional measure of market concentration that more fully reveals the size distribution of firms in the market is the Herfindahl-Hirschman (HH) index.

The HH index is the sum of squared market shares for all firms in the market. Thus under a pure monopoly the HH index value would be 100^2, or 10,000, while the HH index value for a market with four firms of equal size would be $25^2 + 25^2 + 25^2 + 25^2 = 2500$. Thus the fewer the firms the larger is the HH index and the more concentrated is the market. Markets in which the HH index is between 1000 and 1800 points are considered to be moderately concentrated by U.S. antitrust authorities, while those in which the HH index is in excess of 1800 points are considered to be concentrated (U.S. Department of Justice and the Federal Trade Commission 1997).

Concentration ratios and HH indices can overstate market concentration if the market selected for analysis is inappropriately narrow in scope. For example, California processors are confronted with extensive competition from other processors in the United States and around the world, and the relevant market for many of their products is global in scope.

Products are considered to be differentiated when, owing to differences in physical attributes, ancillary service, geographic location, information, and/or subjective image, one firm's products are clearly preferred by at least some buyers over rival products at a given price. Homogeneity prevails when, in the minds of buyers, products are perfect substitutes (Scherer and Ross 1990, p. 17). The three types of market structure that are likely to be encountered in the wetfish industry complex in California are (i) competition (many sellers, homogeneous product, low-cost entry), (ii) monopolistic competition (many sellers, differentiated products, low-cost entry), (iii) oligopoly (few sellers, relatively high concentration, and costly entry), and (iv) oligopsony (few buyers, relatively high concentration, and costly entry).

Value Added: Consider the following example of the calculations for processor value added. Value added from producing various anchovy products by a processor in a particular year is given by the following equation:

Value added to anchovy by processor X = $Q_{anch}[\Sigma_i (P_{product\ i} \times PCT_{product\ i}) - VP_{anch}]$, i = 1,2,..., n.

Note that Q_{anch} refers to the quantity of anchovy received from fishermen. Our interviews indicate that in general all of the purchased fish are used for some sort of commercially valuable product form. Since most of the fish are processed as fresh or frozen whole, with any waste items generally becoming bait products, the implied yield is 100 percent (note that Radtke and Davis assume a 97 to 99 percent yield for coastal pelagic fish in their analysis of West Coast fish processors). Since most of the fish in this report are sold as fresh or frozen whole, there is very little processing waste.

$P_{product\ i}$ refers to the price of the i^{th} anchovy product (out of "n" total products), and $PCT_{product\ i}$ refers to the percentage of total processed anchovy (by weight) that was made up of product i. Since the sum of $PCT_{product\ i}$ across all "n" products is equal to 1, then Σ_i ($P_{product\ i}$ x $PCT_{product\ i}$), i = 1, 2, ..., n, is a weighted average price of anchovy products based on the particular product mix produced by processor X. Thus (Q_{anch} x Σ_i ($P_{product\ i}$ x $PCT_{product\ i}$)), i = 1, 2, ..., n, measures gross revenue to the processor from sales of anchovy products. Subtracted from these gross revenues is (VP_{anch} x Q_{anch}), the total cost of purchased anchovy (harvester value added), equal to the average "vessel price" paid for anchovy by the processor multiplied by the quantity of purchased anchovy.

Section 6.b: Survey Questionnaire Forms Used

California receiver/processors of wetfish (as indicated from fish ticket data) were surveyed via mail, with both telephone and in some cases on-site follow-up contacts also being utilized. The survey questionnaire materials are included below. Note that a low response rate to our mail survey prompted us to use a key-informant interview process to gather most of data used to estimate value added by receiver/processors. Those interviews were conducted by Pomeroy and Hunter.

Cover letter, processor survey:

June 25, 2001

Processor

Dear _____:

We are conducting a socio-economic study, sponsored by the California Seafood Council (CSC), on California's wetfish industry. The purpose of the study is to document the traditions, the social, cultural and economic characteristics of the industry and its participants, and the value of the products produced by the industry. We hope you have received the letter from CSC Manager Diane Pleschner encouraging you to participate in the study. The results of our research will be included in a CSC report on the industry, which will be available to fishery regulators and other interested parties as well as industry participants. The final report will be reproduced both on CD and in print format.

We believe that considerable economic value is added to California seafood by those who process wetfish, squid, coastal tunas (bluefin, yellowfin, and skipjack) and bonito into marketable seafood, animal feed, fishmeal, bait and other products. Unfortunately, data on the value added by wetfish processors' production of these commodities are not readily available. Only you can provide the information to enable us to determine the value added to wetfish, squid and coastal tuna in California.

We would therefore like to ask you to participate in our study by completing the enclosed survey, and returning it to us in the enclosed self-addressed, stamped envelope. The survey includes instructions, followed by species-specific tables and a brief set of questions about your processing operation. For the tables, we would ask that for each product type you review your records and fill in the quantity of product produced, the price per unit, total revenues from sales of the product, and the product's destination (e.g., grocery stores, aquaculture, export). We are seeking information on wetfish, squid and tuna processing over the past five years (1996-2000), beginning with the most recent period and working back in time. Please provide as much of the requested information as possible. Partially completed tables will still be helpful to us. The survey also includes a brief set of questions to help us develop our socio-economic description of the industry. Although we are asking for detailed information, we have strived to design a brief and efficient survey, and to minimize the burden upon you.

We realize that we are asking for potentially sensitive and proprietary business information, and would like to assure you that we will take great care to insure that your responses remain anonymous and confidential. Only we and the other members of our research team will have access to individuals' data and identifying information (to facilitate data collection and analysis). We will not share information from individual firms with other researchers, industry participants, the California Seafood Council, resource managers or members of the public. In reporting our results, we will aggregate processor data and use it to estimate annual processor value-added by the overall industry in California, and by individual wetfish product. We also will use a "rule of three", whereby our results will only be reported when they represent at least three processors.

In addition, we will present our analysis of the socio-economic aspects of the industry in a manner that does not identify particular individuals or businesses.

Your participation in this study is voluntary, but we would greatly appreciate your taking part and making your best effort to provide the information requested. Your contribution is essential to our efforts to fully and completely account for the economic value added by the California wetfish industry. We will call you in early July to follow up on the survey, and to explore the possibility of speaking with you further to gain some of your insights into the industry. In the meantime, please call or e-mail us if you have any questions or concerns about the enclosed materials or the study in general.

Thank you for your consideration and participation. We look forward to talking with you soon.

Sincerely,

Steven Hackett, Associate Professor
School of Business and Economics
Humboldt State University
Arcata, CA 95521
(707) 826-3237
sh2@humboldt.edu

Caroline Pomeroy, Research Scientist
Institute of Marine Sciences
UC Santa Cruz
Santa Cruz, CA 95064
(831) 459-5614
cpomeroy@cats.ucsc.edu

Survey Instructions

Instructions: Please review your records for 1996 through 2000 and provide as much of the requested information as possible. Partially completed surveys will still be helpful to us. You may clarify or add to the information on the back of each page of the survey. Please return the completed survey to us in the enclosed, self-addressed stamped envelope at your earliest convenience.

EXPLANATION OF SPECIES PRODUCT QUESTIONNAIRES

Processing Production and Revenues: Please provide the following information on the wetfish, squid and coastal tuna (bluefin, yellowfin, skipjack and bonito) products your business produces:

1. ***Pounds of product produced***: If quantity is measured in units other than pounds, indicate the unit of measurement used, and how it converts to pounds.
2. ***Average or typical price per pound***: List the average or typical price per pound that you received from selling the wetfish, squid, or tuna product in the year listed at the top of the form. Use per-unit price if units other than pounds are used to measure quantity.
3. ***Total revenues***: List total sales revenue for each product in the year listed at the top of the form.

End Use: Here we are seeking information that you may have on the end uses of your products. To the best of your knowledge, please tell us the percentage of each product that goes to various end uses such as domestic food service (restaurants), grocery (supermarkets, fish markets), fishermen (bait), aquaculture and export. If a percentage of the product usually goes to an end use other than one we have specified (e.g., a domestic secondary processor), please provide this information under “Other”. If you don't know the ultimate end use, please indicate that in the last column.

Products: Each row lists a different product that you may have produced. If you produced a product from wetfish, squid or coastal tunas that is not included on the table, please specify that product in “Other” at the bottom of the table. If you did not receive or process a particular species in a given year, please check "n/a" at the top of the sheet.

PARTICIPATION, ANONYMITY AND CONFIDENTIALITY

Your participation in this survey is voluntary. However, the study's success and our report's thoroughness and accuracy depend critically upon your providing information as clearly, completely and accurately as possible. We realize you are very busy, and have sought to keep the survey as brief as possible.

We realize that we are asking for potentially sensitive and proprietary information. We are committed to respecting your needs for anonymity and confidentiality in handling this information. As you will see, we have coded each survey with a unique processor ID number that will enable us to keep track of the information we collect from each processor. **Only we and the other members of our research team will have access to individuals' data and identifying information (to facilitate data collection and analysis). It will not be shared with other researchers, industry participants, the California Seafood Council, resource managers or members of the public**. In reporting our results, we will use a "rule of three",

whereby our results will only be reported when they represent at least three processors. In addition, we will present our description of the socio-economic aspects of the industry in a manner that does not identify particular individuals or businesses.

Please contact us if you have any questions or concerns about the survey or the study.

Steven Hackett
Humboldt State University
(707) 826-3237
sh2@humboldt.edu

Caroline Pomeroy
UC Santa Cruz
(831) 459-5614
cpomeroy@cats.ucsc.edu

Thank you for your participation - we look forward to hearing from you!

California Wetfish Processor Questionnaire

Processor ID _____

1. In what year did your firm first become involved in:

A. the fishing industry? _____

B. the wetfish (i.e., sardine, mackerel, anchovy) industry? _____

C. the squid industry? _____

D. the tuna industry? _____

2. What role(s) does your company play in the wetfish industry? (Please check all that apply.)

	Anchovy	Mackerel	Sardine	Squid	Tuna	Other
Receiver						
Trader/Broker						
Secondary Processor						
Wholesaler/Distributor						
Retailer						
Exporter						
Importer						
Harvester						

3. What California seafood receiving/processing facilities does your company operate? Please indicate locations, and whether your company owns, leases or has some other arrangement for each.

Facility	Location	Leased	Owned	Other (specify)
Pumping/receiving station				
Ice plant				
Processing/packing plant				
Cold storage facility				
Other (please specify)				

4. Where is your company's California seafood production headquarters located (city, state or country)?

5. Approximately what percentage of your company's California revenues is derived from each of the following products and activities?

Activity	Percent revenue	Activity	Percent revenue
Wetfish		Other commodities	
Squid			
Tuna		Other activities (please specify)	
Other seafood			

6. Approximately what percentage of your company's California revenues is derived from

A. domestic sales of wetfish products? _____

B. export of wetfish products? _____

7. How many boats do you own that operate in the California wetfish, squid and tuna fisheries?

____ operate in wetfish, squid and tuna

____ operate in wetfish and squid only

____ operate in wetfish only

8. Have you imported any anchovy, mackerel, sardines, squid, or tuna for processing in California over the last five years? If so, please use the table below to report the quantity imported and the price you paid per pound for each species for the past 5 years:

		Anchovy	Mackerel	Sardine	Squid	Tuna
2000	Quantity					
	Price / lb.					
1999	Quantity					
	Price / lb.					
1998	Quantity					
	Price / lb.					
1997	Quantity					
	Price / lb.					
1996	Quantity					
	Price / lb.					

9. What have been the most important technological changes in wetfish receiving, processing and packing?

A. _____

B. _____

C. _____

10. What have been the three most important market changes in the wetfish industry?

A. _____

B. _____

C. _____

11. Have there been changes in the physical ocean environment that have affected your wetfish business? Please list them below.

A. _____

B. _____

C. _____

12. What have been the three most important regulatory changes affecting the wetfish industry?

A. _____

B. _____

C. _____

13. Do you have any comments about this survey or your experience in the wetfish industry that you would like to add?

Example of processor product survey:

PROCESSOR ID:_____ **SQUID**

YEAR: _____ **_____ N/A: DID NOT RECEIVE OR PROCESS SQUID THIS YEAR**

Squid products	Processing Production and Revenues			End Use To the best of your knowledge, what <u>percentage</u> of each product you make goes to the following end uses?				
	Pounds of product produced	Average or typical price per pound	Total rev-enues	Domes-tic food service	Domes-tic grocery	Domestic fishermen (bait)	Export	Other or don't know (please specify)
Fresh whole								
Fresh cleaned								
Frozen whole								
Frozen cleaned								
Frozen tubes								
Frozen rings								
Frozen tentacles								
Canned								
Dried								
Ink								
Bait								
Other:_____								

If you would like to clarify or add to the information you have provided above, please do so on the back of this page.

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Figure 1
Total Inflation Adjusted Ex-Vessel Value Added, All Wetfish, 1981-2000

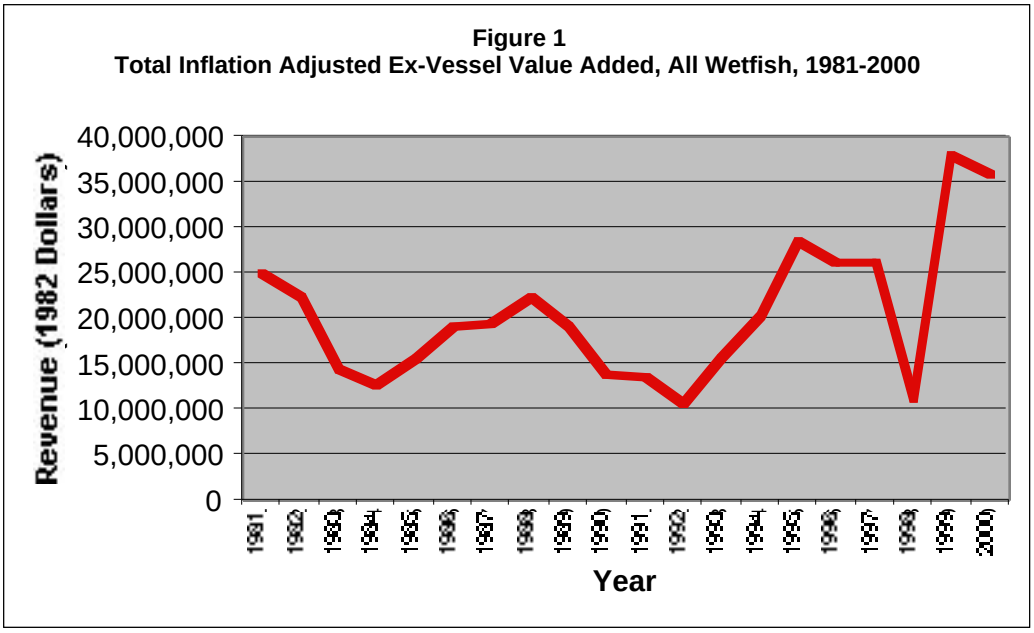

Figure 2
Inflation Adjusted Ex-Vessel Value Added for Northern Anchovy, 1981-2000

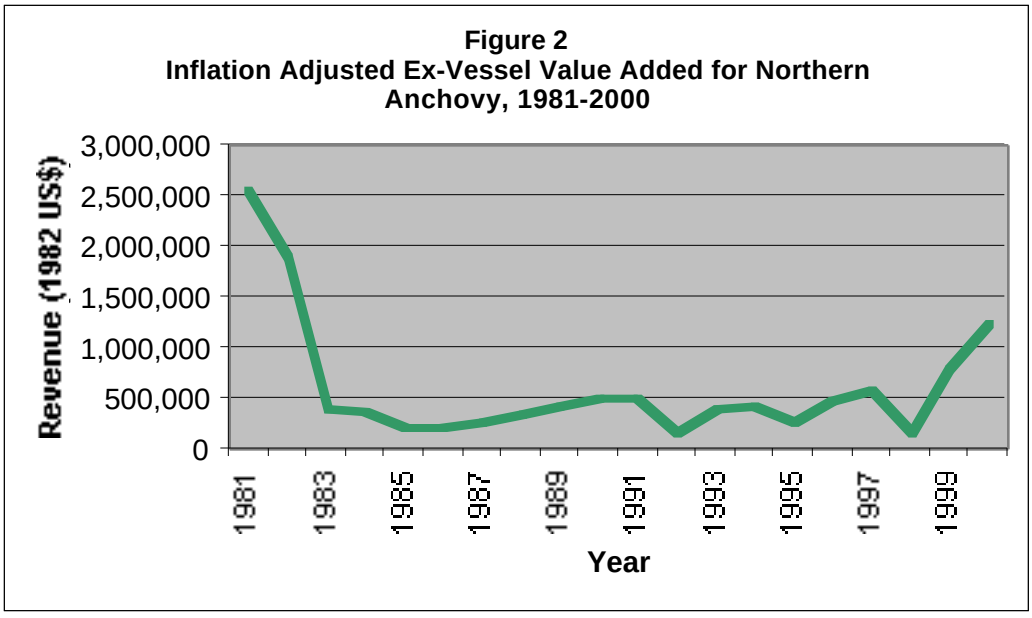

Figure 3
Inflation Adjusted Ex-Vessel Value Added for All Mackerel, 1981-2000

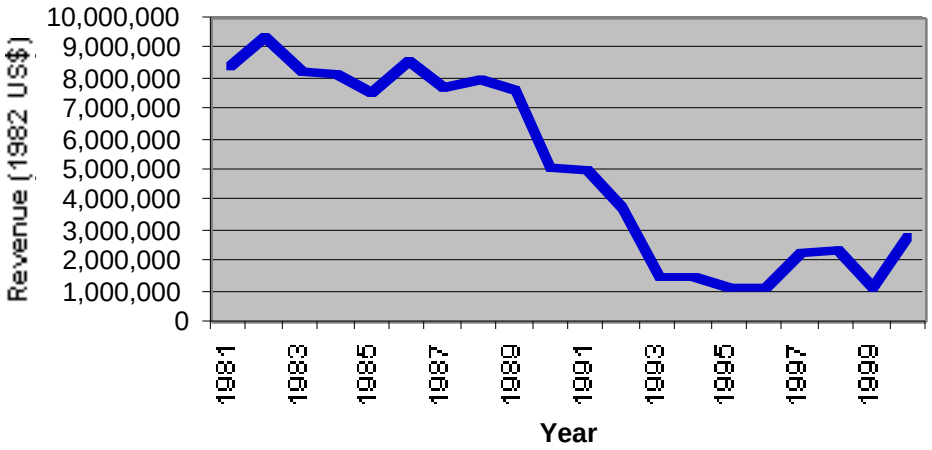

Figure 4
Inflation Adjusted Ex-Vessel Value Added for Jack Mackerel, 1981-2000

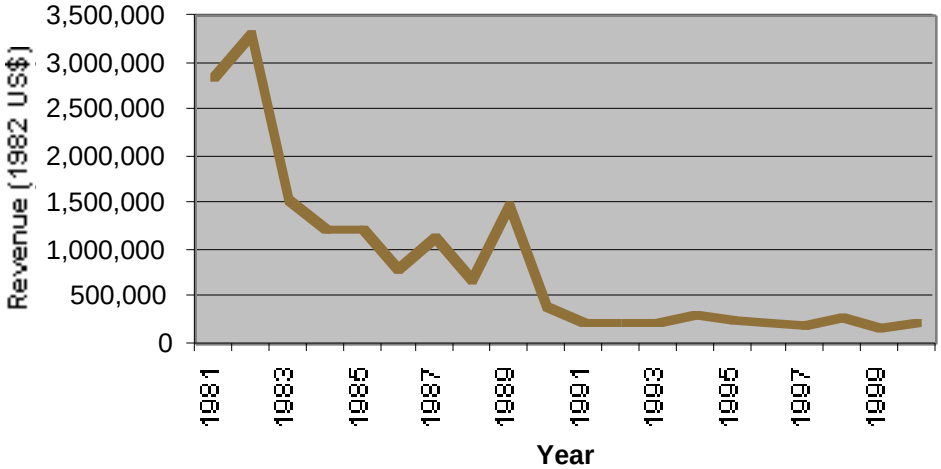

Figure 5
Inflation Adjusted Ex-Vessel Value Added for Pacific Mackerel, 1981-2000

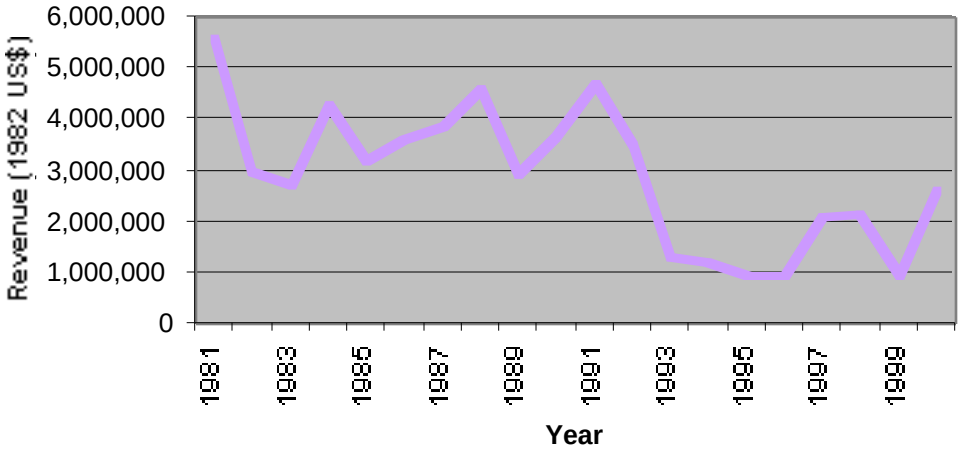

Figure 6
Inflation Adjusted Ex-Vessel Value Added for Pacific Sardine, 1981-2000

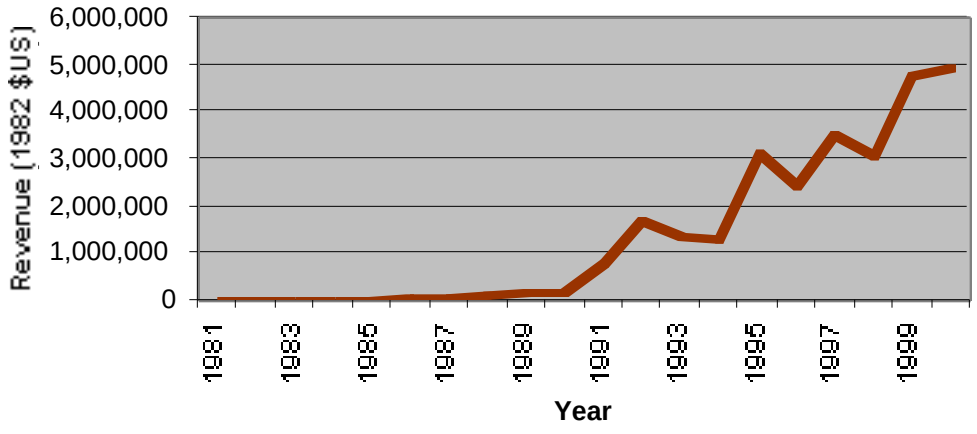

Figure 7
Inflation Adjust Ex-Vessel Value Added for Market Squid, 1981-2000

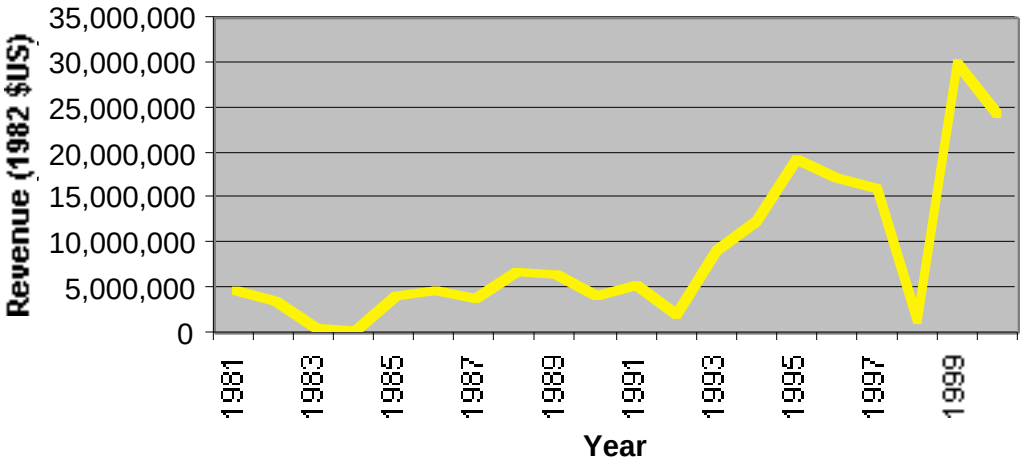

Figure 8
Inflation Adjusted Ex-Vessel Value Added for All "Coastal Tuna" and Bonito, 1981-2000

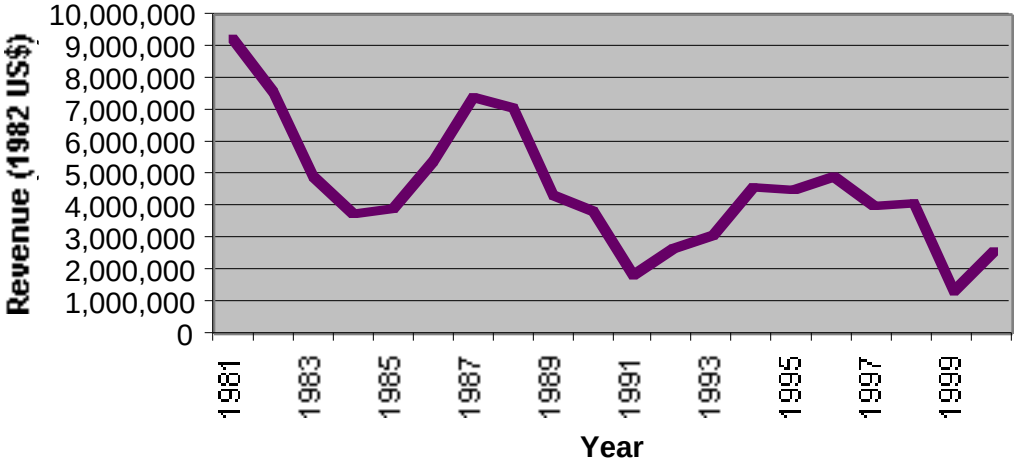

Figure 9
Inflation Adjusted Ex-Vessel Value Added for Bluefin Tuna, 1981-2000

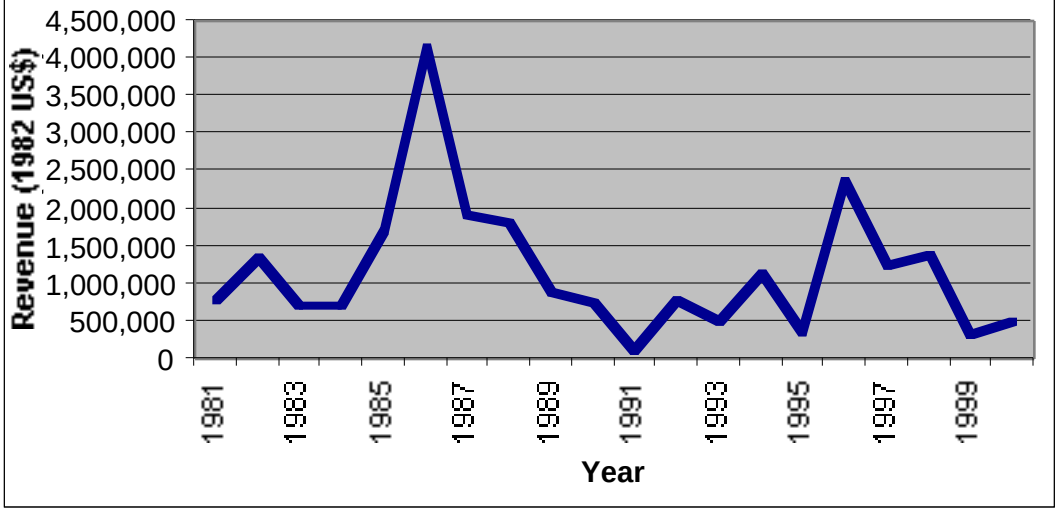

Figure 10
Inflation Adjusted Ex-Vessel Value Added for Pacific Bonito, 1981-2000

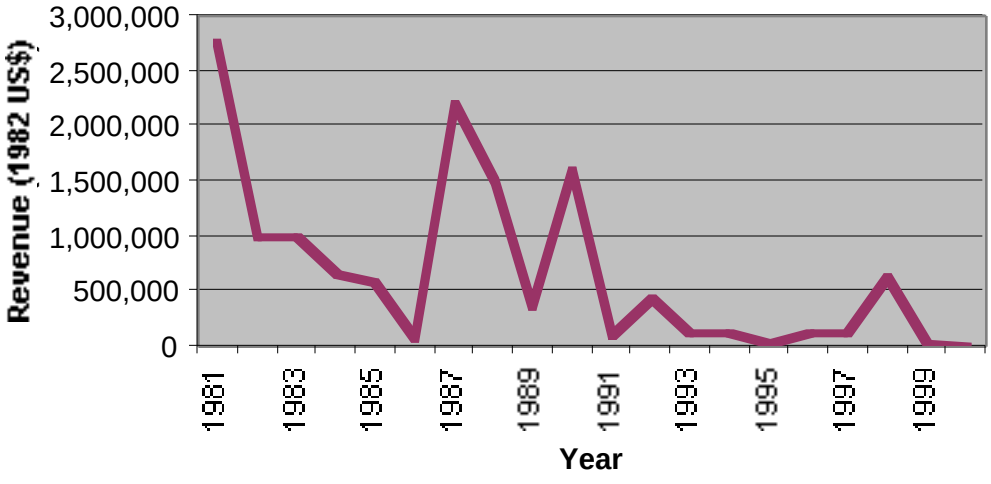

Figure 11
Inflation-Adjusted Ex-Vessel Value Added for Skipjack Tuna, 1981-2000

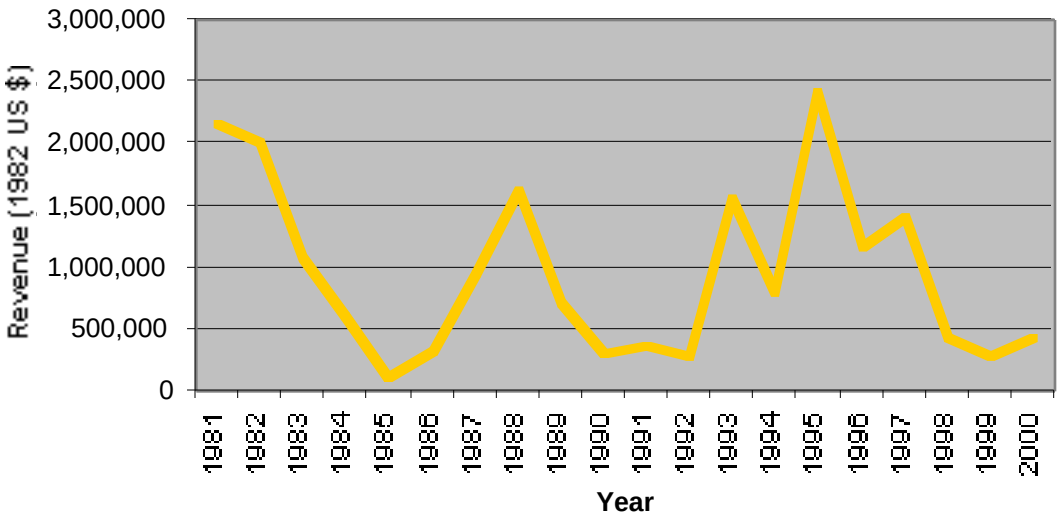

Figure 12
Inflation-Adjusted Ex-Vessel Value Added for Yellowfin Tuna, 1981-2000

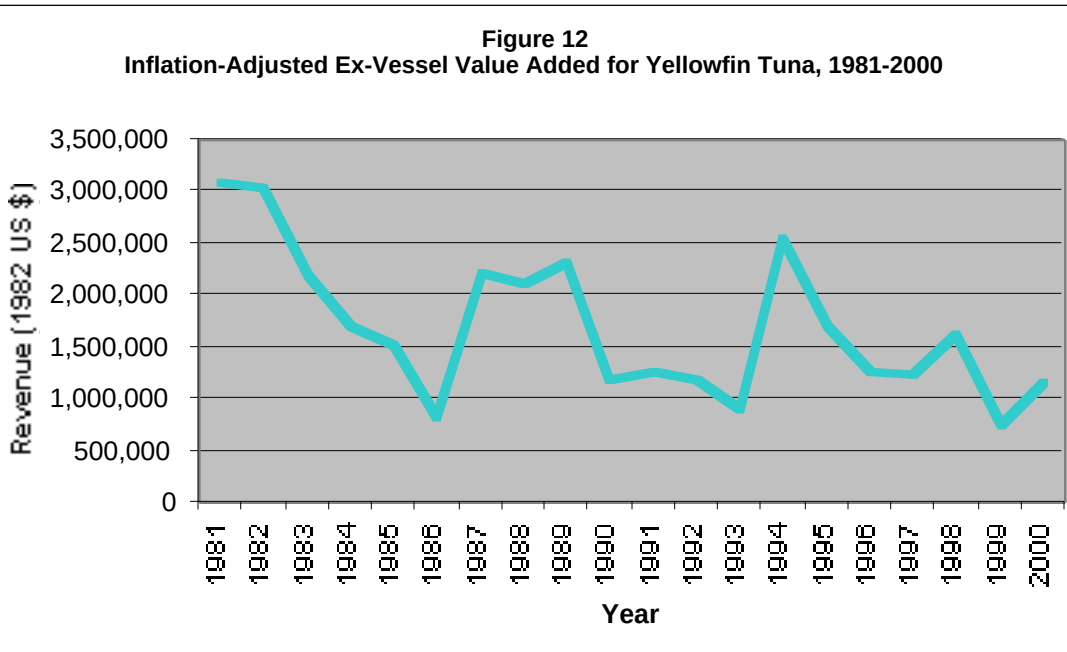

Figure 13
Share of Total Real Processor Value Added by Species or Species Group, 2000 (Median Estimate)