
Pacific Coast and Alaska Pelagic Fisheries

INTRODUCTION

Several stocks of small pelagic fish species support fisheries along the Pacific Coast from northern Mexico to Alaska. The major ones are Pacific sardine, northern anchovy, jack mackerel, chub (Pacific) mackerel, and Pacific herring. Sardine, anchovy, and the two mackerels are primarily concentrated and harvested off California and Baja California. Pacific herring are taken along the west coast from California to Alaska.

Sardine and anchovy are the most prominent of the fisheries from a historical perspective. These small pelagic fish, like Peruvian anchovy and Japanese sardine, tend to fluctuate widely in abundance. California sardines supported the largest fishery in the western hemisphere during the 1930's and early 1940's when total catches averaged 500,000 metric tons (t). Sardine abundance and catches declined after World War II (Figure 14-1), and the stock finally collapsed in the late 1950's. In the mid 1940's, U.S. processors began canning anchovy as a substitute for sardine. Consumer demand for canned anchovy, however, was low, and catches from the mid 1940's to mid 1950's averaged only 50,000 t. Catches declined and remained low before starting to increase in 1965. Together with catches from Mexico, the total catch increased to 350,000 t during 1975–80. Thereafter, U.S. catches declined due mainly to significant price reductions for fish meal. Low prices and market problems continue to prevent a significant U.S. reduction fishery for anchovy in recent years. The other small pelagic species also have a tendency to fluctuate widely in abundance.

All these pelagic fishery resources are under management. The anchovy fishery is managed under the Northern Anchovy Fishery Management Plan by the Pacific Fishery Management Council. Pacific sardine, Pacific herring, and chub mackerel are managed by the State of California. Jack mackerel north of latitude 39° N are managed as part of the Pacific Coast Groundfish Fishery Management Plan. And the State of Alaska manages its inshore Pacific herring fishery.

PACIFIC COAST PELAGIC FISHERIES

Pacific Sardine

California's Pacific sardine abundance has gone through boom-and-bust cycles (Figure 14-1). The decline of the resource, from a biomass of more than 3,000,000 t in the 1930's to immeasurable low levels (a few thousand metric tons) in the 1970's, stimulated much debate as to whether fishing or an adverse natural environmental period was to blame. In retrospect, the intense fishing pressure on the resource at that time probably accelerated a long-term pattern of natural decline. The biomass of sardines remained negligibly low for about 40 years. Since 1986, sardine biomass has increased by 30–40% annually, and quotas have been allowed for commercial fishing. The biomass in 1997 was about 600,000 t.

In the past, sardines were harvested for fish meal, bait, and human consumption. Currently, there is no fish meal (reduction) fishery. Sardines are now taken for human consumption and bait. Commercial demand for sardines is strong and, as resource abundance grows, the fishery is expected

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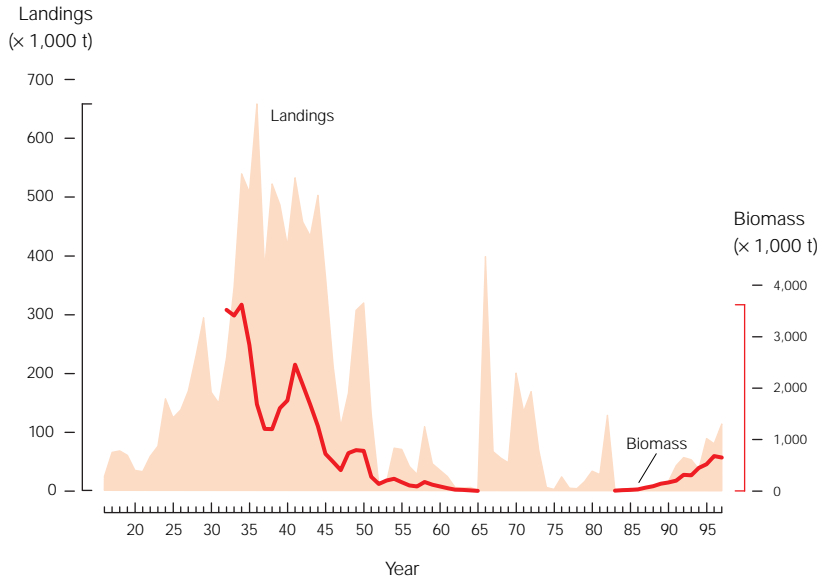


Figure 14-1
Landings and biomass of Pacific sardine, 1916-97, in metric tons (t). No biomass data are available for the time period before 1932 and for 1966-82.

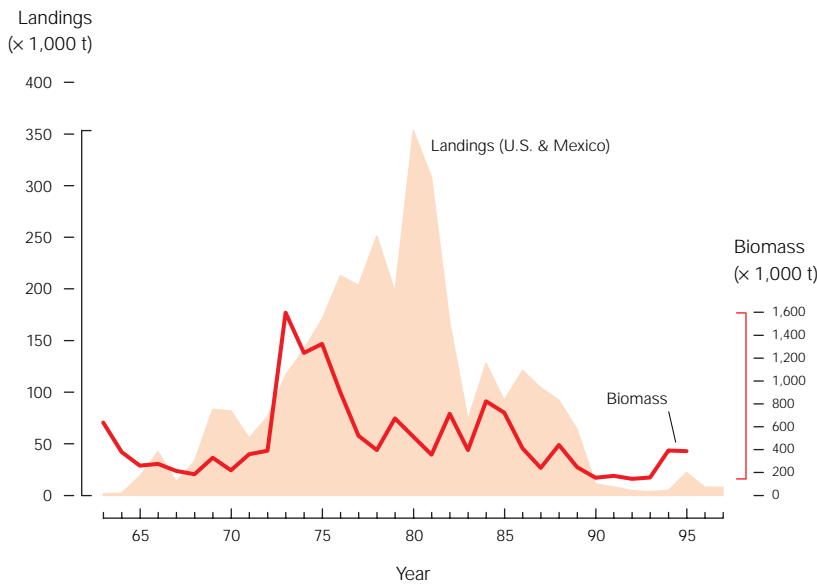


Figure 14-2
Landings and biomass of northern anchovies, 1963-97, in metric tons (t). No biomass estimates are available for 1995-97.

to revive. Thus, the sardine resource is recovering rapidly. Current potential yield is 63,000 t or about 44% of the long-term potential yield (Table 14-1).

Northern Anchovy

Northern anchovy, fished off California and Mexico, are divided into several subpopulations. The central subpopulation of the resource is the one that supports most of the U.S. fisheries. Anchovy are harvested for reduction into fish meal, oil, and soluble protein products. Other uses include human consumption (fresh, frozen, canned, and paste), and as bait (live and frozen) for recreational fisheries.

Anchovy landings in California have fluctuated more in response to market conditions than to stock abundance. Figure 14-2 shows the historical catch trend for the United States and Mexico. Landings by the United States have varied from less than 10,000 t to nearly 140,000 t. Since 1983, U.S. landings have been low (less than 10,000 t), and they have been used mostly for live bait and other nonreduction uses. The biomass trend for the anchovy resource (Figure 14-2) hit a peak of 1,400,000 t in 1985 and declined steadily to 126,000 t by 1994.

The well being of ecologically related species in the marine ecosystem is an important factor in management of the anchovy resource. The endangered brown pelican, for example, depends on anchovy as an important food source. Thus, the fishery management plan has specified a threshold for its optimum-yield determination to prevent anchovy depletion and provide adequate forage for marine fishes, mammals, and birds.

The anchovy resource is presently at a moderate level of abundance. Current potential yield is 88,000 t or 72% of the long-term potential yield (Table 14-1), but recent catches have been much lower (less than 10,000 t) due to a lack of commercial markets.

Jack Mackerel

Jack mackerel catches have fluctuated widely with changing market demands and the ability of the fleet to fish for other species which were more

Species	Recent average yield (RAY)	Current potential yield (CPY)	Long-term potential yield (LTPY)	Fishery utilization level	Stock level relative to LTPY
Pacific Coast					
Northern anchovy	11,000 (4,000) ¹	88,000 (62,000) ¹	120,000 (84,500) ¹	Under	Near
Pacific sardine	69,000 (35,000) ¹	63,000 (32,000) ¹	145,000 (73,700) ¹	Full	Near
Jack mackerel	2,000 ¹	100,000 ²	100,000 ²	Under	Above
Chub mackerel	20,000 ¹	22,000 ¹	28,000	Full	Near
Pacific herring ^a	6,000	6,000	7,000	Full	Near
Alaska					
Pacific herring					
Gulf of Alaska	11,500	15,900 ³	Unknown	Full	Near
Bering Sea	34,000	39,300 ³	Unknown	Full	Near
Total	153,500	334,200	455,200		
Total (U.S.)	112,500	277,200	348,400		

Table 14-1

Productivity in metric tons and status of Pacific Coast and Alaska pelagic fishery resources.

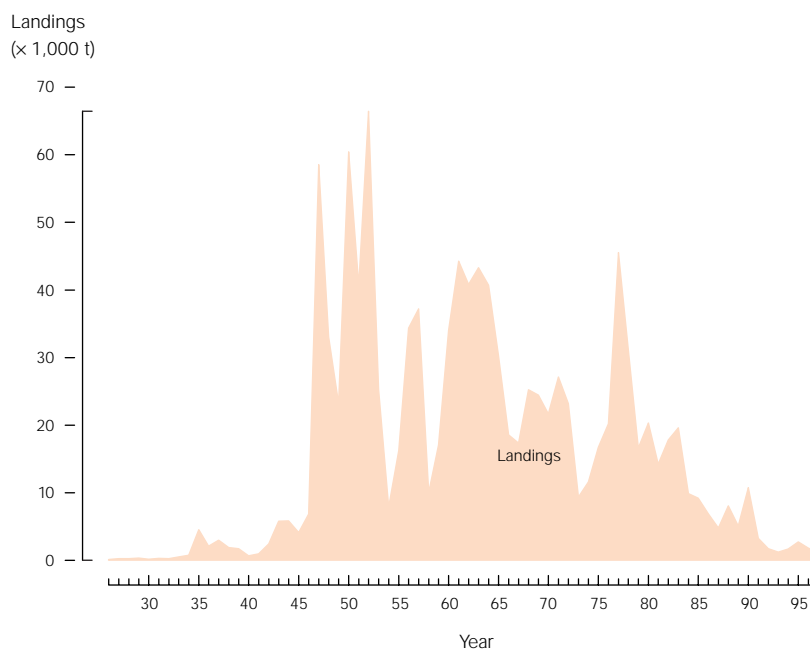
¹U.S. (California) only.

²Crude estimate.

³Uses 1995 data only.

profitable or available, especially sardines and chub mackerel. In addition, the availability of jack mackerel can also be very erratic. Jack mackerel has two distinct behavior patterns during its life cycle: juveniles are found inshore off southern California and Baja California, while adult fish are distributed offshore and farther north, in some years as far as the Gulf of Alaska. Adult jack mackerel found offshore are sometimes caught incidentally by trawlers, particularly those targeting Pacific whiting.

The foreign trawl fisheries of the 1970's resulted in jack mackerel being placed in the groundfish fishery management plan, and a bycatch quota of 12,000 t/year (north of latitude 39° N) was set. Restrictions on fishing for other groundfish species, including Pacific whiting, were thus avoided. The recent history of jack mackerel commercial landings, mostly as incidental catch, is shown in Figure 14-3. In 1991, interest in jack mackerel increased, and the catch limit was raised to 52,000 t to allow a target fishery to operate. While this fishery has not yet materialized, signs of commercial interest continue. A purse-seine fishery for jack mackerel has continued at a low level. Currently, it has no catch limit. Jack mackerel have been occasionally important to the partyboat sport fishery off southern California. It is also

**Figure 14-3**

Landings of jack mackerel off California, 1926-97, in metric tons (t).

fished recreationally off piers.

Assessment and management of jack mackerel are difficult because of limited data and its broad distribution. The most recent estimate of biomass was made in 1983. Spawning biomass was estimated at 1,500,000 t, and total biomass at 1,630,000–1,990,000 t. Its potential yield is little

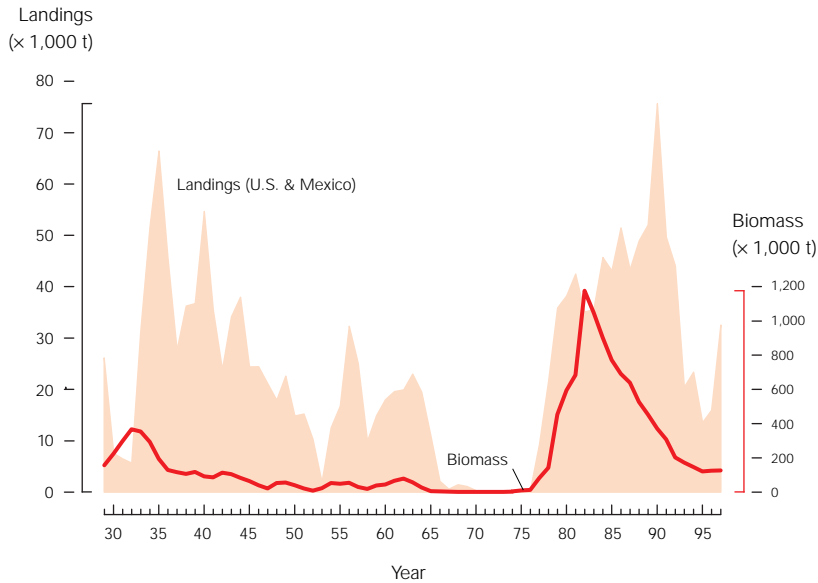


Figure 14-4
Landings and biomass of chub mackerel, 1929-97, in metric tons (t).

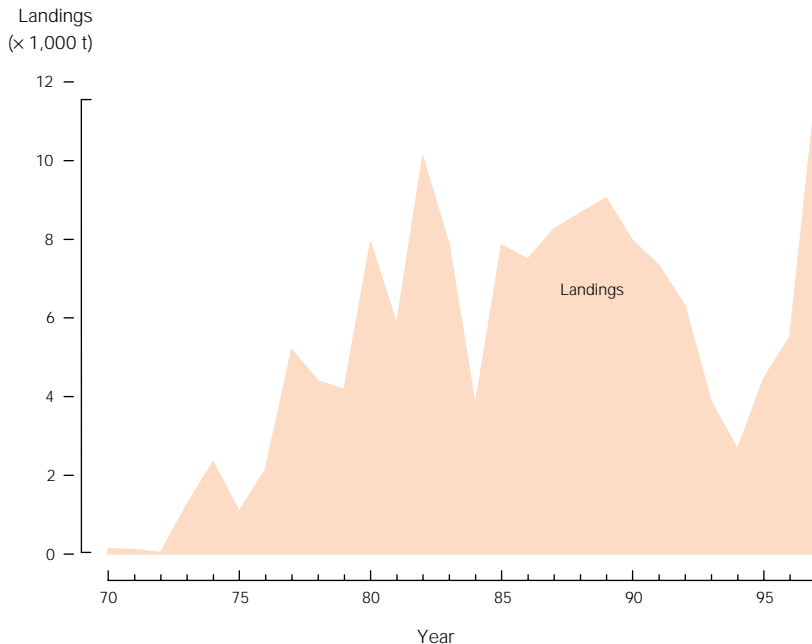


Figure 14-5
Commercial landings of Pacific herring, 1970-97, in metric tons (t).

more than an educated guess at this time (Table 14-1).

Chub (Pacific) Mackerel

Chub mackerel has a worldwide distribution in temperate and subtropical seas. On the Pacific coast, it is most abundant south of Point Conception, Calif. It supported one of California's major fisheries during the 1930's-40's and again in the 1980's. It was second only to sardine during the heyday of the southern California sardine fisheries in the 1930's-40's. The peak catch reached 73,000 t in 1935 and declined steadily thereafter. In 1970, a moratorium was placed on the fishery after the stock collapsed.

A series of successful year classes in the late 1970's stimulated a recovery of the stock, and the fishery was reopened under a quota system in 1977. The resource is now harvested by three separate fisheries: the California commercial fishery, a sport fishery, and a Mexican commercial fishery. The recent U.S. harvest history is shown in Figure 14-4. From 1980 to 1989, the California recreational catch averaged 1,462 t/year.

The trend in chub mackerel biomass is also shown in Figure 14-4. Recent peak abundance was 754,000 t in 1982. Abundance has since declined to about 20,000 t by 1995 and has stabilized there. Analyses of fish-scale deposits in ocean bottom sediments off southern California indicate that the prolonged period of high chub mackerel biomass levels during the late 1970's and 1980's may have been unusual and would only be expected to occur, on average, about once every 60 years. In 1985, it was estimated that chub mackerel might sustain average yields between 26,000 and 29,000 t/year under management systems similar to that currently used to manage the stock by the State of California. The commercial catch is currently restricted by a quota of about 32,000 t. If the biomass dips below 18,000 t, commercial fishing will be stopped.

Pacific Herring

Pacific herring are fished primarily off California. The fishery in Puget Sound, Wash., is small by comparison. The fishery off California

has peaked three times during this century: during 1916–19 near 3,600 t, during 1947–53 near 4,500 t, and above 10,000 t in 1982 (Figure 14-5). In the earlier years, herring were harvested for reduction into fish meal and for pet food and bait. Some were canned to supplement the declining supply of sardines. Canned herring proved to be a poor substitute for sardines, and the fishery for human consumption ended in 1954.

Since 1973, herring in California have been harvested primarily for their roe for export to the Japanese market. Landings declined in 1984 when El Niño caused a corresponding decline in the herring population. However, most stocks have recovered somewhat and so have catches. The herring roe fishery is limited to California's four largest herring spawning areas: San Francisco Bay, the Tomales-Bodega Bay area, Humboldt Bay, and the Crescent City harbor. San Francisco Bay has the largest spawning population of herring and supplies over 90 percent of the state's herring catch. The four spawning areas are managed separately by the California Department of Fish and Game, with catch quotas based on population estimates.

Another lucrative phase of the herring industry is the roe-on-kelp fishery. Beginning in 1965, scuba divers harvested species of marine vegetation with herring eggs attached in Tomales and San Francisco Bays. This product is exported to Japan as a holiday delicacy. The fishery has evolved into the present roe-on-kelp fishery. Giant kelp is harvested from the Channel Islands off southern California, brought to San Francisco Bay, and suspended from 60×40 foot floating rafts. The rafts are towed to areas where herring spawning is expected to occur and are anchored. After spawning has ended, the kelp with herring eggs attached is removed from the rafts and packed in salt. Catches have been generally low (Figure 14-6) but valuable.

The herring spawning populations in Tomales and San Francisco Bays are estimated annually from hydroacoustic and spawning ground surveys. The spawning biomass has fluctuated widely in both areas since the 1983 El Niño through the more recent 1997–98 El Niño. The 1996–97 season estimates were a relatively low 1,331 tons in Tomales Bay and a relatively high 81,260 t in San Francisco Bay. Humboldt Bay supports a

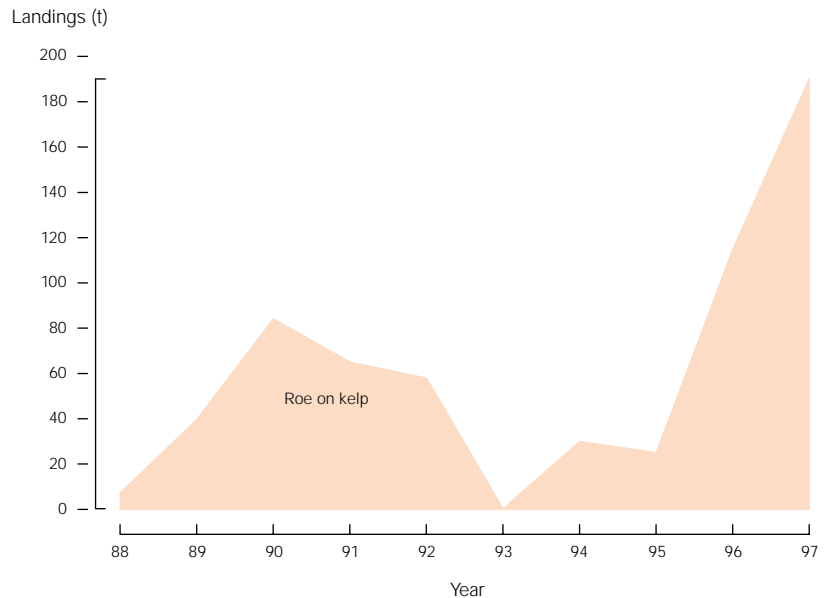


Figure 14-6
Landings of herring roe and kelp from the roe-on-kelp fishery in California, 1988–97, in metric tons (t).

smaller spawning stock, estimated in 1991 at 400 tons. Population estimates have not been made for the Crescent City herring stock, but observed spawning suggests that the population is large enough to support a minor fishery there.

ALASKA PELAGIC FISHERIES

Pacific Herring

Pacific herring is the major pelagic species that is harvested in Alaska. The fisheries occur in specific inshore spawning areas of the Gulf of Alaska and the Bering Sea. In the Gulf of Alaska, spawning fish concentrate mainly off southeast Alaska, in Prince William Sound, and around the Kodiak Island-Cook Inlet area. In the Bering Sea, the centers of abundance are in northern Bristol Bay and Norton Sound. This fishery occurs within state waters (3-mile limit), and it is therefore monitored and managed by the Alaska Department of Fish and Game by 20 separate fishery statistical areas.

Herring spawn every year after reaching sexual maturity at 3 or 4 years of age. The number of eggs varies with the age of the fish and averages 20,000. Average life span for these fish is about 8 years in southeast Alaska and up to 16 years in the Bering Sea.

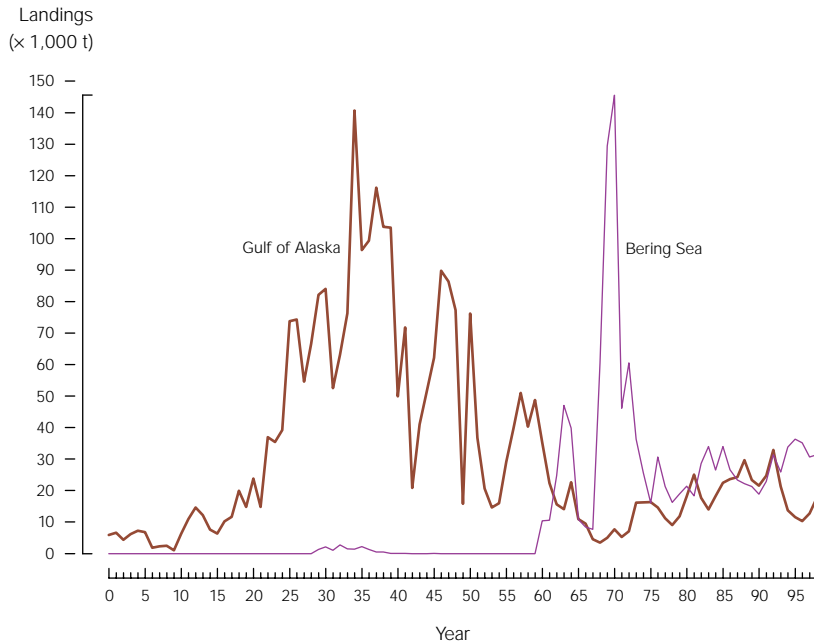


Figure 14-7
Landings of Pacific herring off Alaska, 1900–98, in metric tons (t) (1998 is an estimate of sac roe only).

Alaska's herring industry began as early as 1878 when 30,000 pounds were marketed for human consumption. The total value was \$900. By 1934 the catch had reached a record 140,000 t. The Bering Sea fishery began in the late 1920's. A large foreign offshore fishery developed in the 1950's and peaked dramatically in 1970 at more than 145,000 t. It then fell off sharply to 16,000 t in 1975 (Figure 14-7). Since 1977 Bering Sea herring have been harvested primarily in inshore sac roe fisheries, and catches have since risen slowly but steadily, reflecting better stock conditions. A portion of the Bering Sea harvest is taken as bycatch in the groundfish fishery. Regulations now limit bycatch to about 1,000 t.

From catch records, it is evident that herring biomass fluctuates widely due to influences of strong and weak year-classes.¹ Currently the herring populations in Alaska remain at moderate levels and are in relatively stable condition, with the exception of Prince William Sound. Herring abundance levels typically increase abruptly following major recruitment events, then decline slowly over a number of years because of natural and fishing mortality. Prince William Sound

¹A year-class comprises the new generation of young fish entering a stock in the same year.

herring continue to be depressed from a disease outbreak in 1993, but have recovered to above-threshold levels. In more recent years, statewide herring harvests have averaged about 45,000 t with a value averaging around \$30,000,000. About 10% of the commercial harvest is taken for food and bait, and the rest is taken in the sac roe fisheries. In addition, there is a roe-on-kelp fishery that harvests about 400 t of product annually with a value of around \$3,000,000. The 1998 sac roe fisheries was forecast to be about 45,900 t, with a stock status ranging from moderate to high, while the Prince William Sound status remains at a depressed level.

ISSUES

Transboundary Stocks and Jurisdiction

Mackerels, sardines, and anchovy are transboundary stocks exploited by both U.S. and Mexican fleets, but no bilateral management agreement has yet been reached for coordinated management of the stocks. Harvest levels are increasing in Mexican waters, and the absence of a governing bilateral agreement is compromising management of the same stocks that both countries fish.

Underutilized Species

Jack mackerel is an underutilized species, while the Pacific sardine is increasing in abundance after decades at low levels. These species may support an increased harvest by U.S. fishermen in the near future.

PROGRESS

National Marine Fisheries Service scientists continue to work closely with state biologists and the Pacific Fishery Management Council in assessing and managing the stocks. Stock assessment models have been developed for northern anchovy, Pacific sardine, and chub mackerel. The new models are more reliable and precise than earlier ones. The models now use more data, including fish-spotter data from pilots employed by commercial fishermen, and the

California Cooperative Oceanic Fisheries Investigations' long-term ichthyoplankton data base.

FOR FURTHER READING

California Cooperative Oceanic Fisheries Investigations (CALCOFI) Reports, volumes 36–39.

Hill, K. T., M. Yaremko, L. D. Jacobson, N. C. H. Lo, and D. Hanan. 1998. Stock assessment and management recommendations for Pacific sardine (*Sardinops sagax*) in 1997. California Department of Fish and Game Administrative Report 98-5.

Yaremko, M., J. T. Barnes, and L. D. Jacobson. 1998. Status of the Pacific mackerel resource during 1997 and management recommendations for the fishery. California Department of Fish and Game Administrative Report 98-3.