Management of Marine Fisheries Resources of Alaska:

A Report to the Northern Forum

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Regional Information Report Number 5J95-04

Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
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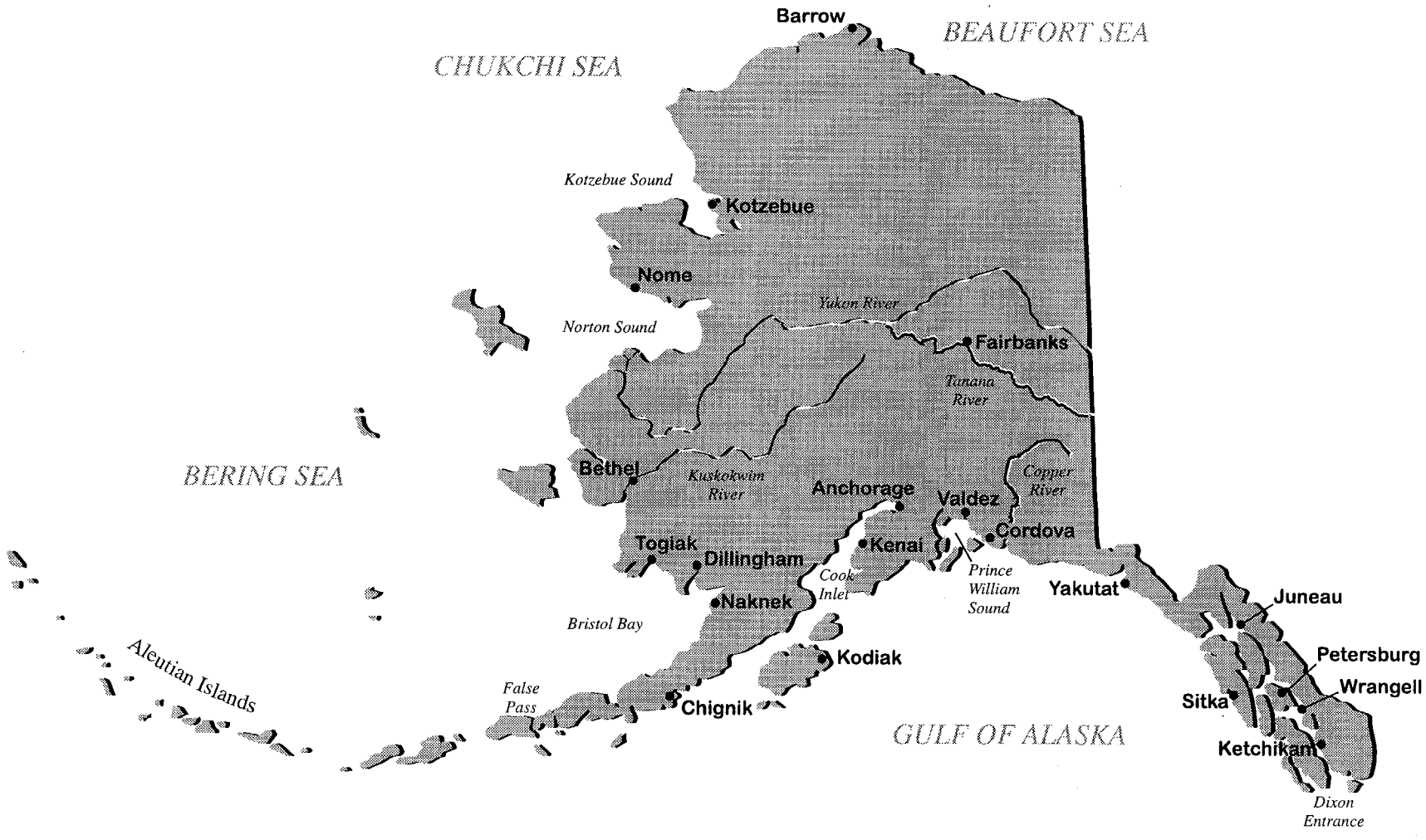
ABSTRACT

Based on archeological evidence, the fishery resources of Alaska have been harvested by human settlers since at least 10,000 B.C. Besides the extensive, high-volume commercial fisheries, a variety of fish and shellfish are still harvested as essential food sources by many Alaskan Natives today. In historic times the first substantial commercial harvests by U.S. fishermen were directed toward Pacific cod in the 1860s. After the U.S. purchase of Alaska from Russia in 1867, U.S. interest in Alaska fishery resources expanded, and salting and canning operations for salmon were initiated. Catch statistics go back to the 1880s for these operations. Over the next century many additional fisheries were added, including those for halibut (*Hippoglossus stenolepis*), herring (*Clupea pallasi*), crabs, and groundfish other than cod. Alaska's salmon fisheries still receive the most publicity, although the groundfish fishery is of equal value and far exceeds salmon in product volume. Fisheries for crab also rivaled the salmon fisheries in value during the early 1990s. Recent annual (exvessel) values for Alaska fisheries range between $1.2 and $1.6 billion. The production of Alaska's finfish (salmon, herring, and groundfish) fisheries are at historically high levels because of a favorable and pristine natural environment and a strong regulatory regime. However, bycatch, waste, marine mammal and bird population declines, resource allocations and, in some cases, habitat degradation present resource managers with serious problems.

ALASKA


ARCTIC OCEAN
Barrow
BEAUFORT SEA
CHUKCHI SEA
Kotzebue Sound
Kotzebue
Nome
Yukon River
Norton Sound
Fairbanks
Tanana River
BERING SEA
Bethel
Kuskokwim River
Anchorage
Valdez
Copper River
Cordova
Kenai
Togiak
Dillingham
Cook Inlet
Prince William Sound
Yakutat
Juneau
Naknek
Bristol Bay
Kodiak
Petersburg
Wrangell
Aleutian Islands
False Pass
Chignik
Sitka
GULF OF ALASKA
Ketchikan
Dixon Entrance
PACIFIC OCEAN

REGULATORY REGIME

After statehood in 1959, the State of Alaska took management control of its fishery resources from the federal government. In fact, control of its fisheries was a primary incentive of the statehood movement. The federal and state roles in fisheries management, however, again changed in 1977. Since the creation of the Exclusive Economic Zone (EEZ) within 200 miles of U.S. coasts by the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976, fisheries off Alaska have been managed by a combination of state and federal regulatory agencies. The Alaska Department of Fish and Game (ADF&G) is the primary state fisheries management agency and the National Marine Fisheries Service (NMFS) is the primary federal fisheries management agency. In general, with the exception of some small fisheries within the inside waters of Southeast Alaska and Prince William Sound, NMFS is primarily responsible for management of all groundfish fisheries off Alaska. On the other hand, in general, ADF&G is primarily responsible for management of fisheries for salmon, herring, crabs, and other invertebrates. However, in many instances, fishery management has evolved into a complex of state, federal, and international advisory and regulatory bodies that affect management of the fishery resources off Alaska.

Alaska's constitution is unique in that an entire section (Article VIII) is devoted to the management of natural resources. "Maximum benefit of its people" and "Management of renewable resources on a sustained yield basis" are two primary directives given to the legislature and executive branch by the state's constitution. To provide for an open public process and to give direction to ADF&G, the Alaska State Legislature created the Alaska Board of Fisheries (BOF). The BOF is responsible for developing fishery management plans, making allocative decisions, and promulgating regulations. ADF&G, which supports and takes direction from the BOF, has unique Emergency Order authority which provides ADF&G fishery managers with the essential ability to expeditiously open and close fisheries inseason. Besides its regulatory function, ADF&G has a substantial fisheries monitoring and research program to document catches inseason, assess stock condition, and determine appropriate harvest levels. Another state agency with regulatory authority is the Commercial Fisheries Entry Commission (CFEC). CFEC has the authority to establish moratoria or limited entry systems for state-managed fisheries.

Several federal laws substantially direct the regulation of some of Alaska's fisheries and actions of NMFS. Foremost is the MFCMA, which was enacted, in large part, because of unrestricted foreign harvests off Alaska. Created under the MFCMA, the North Pacific Fishery Management Council (NPFMC), a presidentially appointed 11-person committee, develops federal fishery management plans (FMPs) for fisheries occurring within the 3- to 200-mile EEZ. Four FMPs approved by the U.S. Secretary of Commerce are now in effect and include two groundfish fishery FMPs, one each for the Bering Sea/Aleutian Islands area and the Gulf of Alaska; a salmon FMP; and a Bering Sea/Aleutian Islands area crab FMP. A scallop FMP is now in draft. Each of these defer varying levels of management authority to the state. In each case, ADF&G still retains inseason management authority for all but the groundfish fisheries in the EEZ.

Implementation of two other federal laws, the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA), have been used to increasingly restrict Alaska fisheries for the protection of pinnipeds (seals and sea lions) and depressed salmon stocks of Oregon and Washington which migrate into Alaska waters. Two treaties between Canada and the U.S. regulate fisheries for transboundary salmon and halibut and influence management of other Alaska fisheries that

impact these stocks. As a revision of the International Fisheries Convention, the International Pacific Halibut Commission (IPHC) was created in 1953 to jointly regulate harvest and to conduct research on halibut (*Hippoglossus stenolepis*) in the North Pacific. The IPHC determines catch quotas, but within-nation catch allocations are implemented separately by Canada and in the U.S. through the NPFMC. The 1985 Pacific Salmon Treaty has established an international management regime designed to rebuild some salmon stocks, limit harvests in specific fisheries, and define equitable allocations between U.S. and Canadian fishermen. The treaty has been very controversial, and renegotiation of treaty annexes is a continuing process.

FISHERIES AND SPECIES OF IMPORTANCE

Salmon Fisheries

The salmon returning to Alaskan streams and rearing in Alaskan waters are the basis for one of Alaska's most important industries and underpin a traditional subsistence lifestyle in Native villages. In 1994, a total of 391 thousand mt of salmon were sold by commercial fishermen in Alaska. The value of the commercial harvest varies both with the size of the runs and with foreign currency exchange rates. For the years 1992, 1993, and 1994, fishermen were paid $575 million, $390 million, and $430 million for their catch. Because of the magnitude of commercial fisheries for salmon, state biologists collect extensive information and statistics for management decisions. Alaska also has very important, but less closely monitored, sport and subsistence fisheries for salmon, char, and trout. Many Alaskan Native populations still depend heavily on subsistence-caught salmon for food and cultural purposes. Fishery management plans give top priority to the subsistence use of fish resources.

The history of Alaska salmon fisheries predate recorded time. Commercial salmon fishing in Alaska began in the 1880s. Initial commercial harvests were primarily salted, and canning became predominant at the turn of the century. After Alaska was purchased by the U.S. in 1867, the U.S. federal government had jurisdiction over these fisheries until statehood. The White Act, passed in 1924, required a closure of the fishery after the halfway point of the runs. At this time, much of the catch was taken in large fish traps. Federal management was weak, poorly funded, and ineffectively enforced. After World War II and at the request of the salmon processing industry, W. F. Thompson of the University of Washington began investigations of salmon and their management in Alaska. After Alaska became a state in 1959, ADF&G implemented an escapement goal-based fisheries management system using principles laid out by W. F. Thompson and his students. This science-based management system remains in place today with only a few refinements. Local fisheries managers are given virtual autonomy to open and close fisheries to achieve two goals: The overriding goal is conservation to ensure an escapement of spawning stocks, and the secondary goal is an allocation of fish to various user groups based on management plans developed by the BOF. The BOF develops management plans in open, public meetings after considering public testimony and advice from various scientists, advisors, and interested groups.

By far, most salmon in Alaska are caught in troll, gillnet, and purse seine fisheries in which participation is restricted by a limited entry system. Troll gear works by dragging a baited hook through the water. Gillnet gear works by entangling the fish as it attempts to swim through the gillnet. Purse seines work by encircling schools of fish with nets that are drawn up to create giant "purses" that

hold the school until it can be brought aboard. Other kinds of gear used in Alaska's smaller fisheries include fishwheels, which scoop fish up as the wheel is turned by currents and even submerged fish traps.

Five Pacific salmon species spawn and have directed fisheries in Alaska: *Oncorhynchus nerka* (Walbaum) commonly known as sockeye or red salmon; *O. gorbuscha* (Walbaum) commonly known as pink salmon; *O. keta* (Walbaum) known as chum or dog salmon; *O. tshawytscha* (Walbaum) commonly called king or chinook salmon; and *O. kisutch* (Walbaum) commonly known as coho or silver salmon. Two other Pacific salmon species spawn exclusively in Asian systems and are not caught in Alaskan waters.

When they reach maturity, adult salmon usually return to the freshwater systems from which they originated. Adult Pacific salmon die after spawning. After hatching, salmon fry rear for a period of time in a freshwater environment and then migrate to the marine environment. The time spent in each environment varies by and within species. Outmigration from fresh water to the marine environment occurs in the spring or early summer. As young juveniles, salmon pass through the nearshore areas, where they grow rapidly and move into the open ocean as pelagic feeders. Salmon which outmigrate from North American streams range widely across the North Pacific Ocean and Bering Sea.

Pink salmon are the most numerous of the salmon species in the Alaska commercial catch and the most abundant salmon in the Pacific Ocean. Recent statewide commercial harvests have been near 100 million fish (Figure 1). Pink salmon are characterized by the smallest size as mature adults; the least dependence on fresh water as their fry migrate to the salt water directly after emergence from the gravel; and a fixed two-year life cycle that results in genetically distinct odd- and even-year runs. The adult diet consists of fish, squid, euphausiids, amphipods and other prey. In Alaska, pink salmon are harvested primarily by commercial purse seine fleets. Much of the pink salmon harvest is canned.

Chum salmon are the third most numerous salmon species in the Alaska commercial catch and the second most abundant salmon in the Pacific Ocean. Recent statewide commercial harvests have been near 10 million fish (Figure 1). Adults are the second largest in size next to chinook salmon. As with pink salmon, chum fry after emergence move directly out of fresh water; however, they may make more use of estuarine environments in the spring. Chum salmon spend between one and five years in the marine environment and have the widest distribution across the Pacific Rim of any salmon. In Alaska, chum salmon are harvested primarily by gillnet and purse seine fleets. This species is also important in subsistence fisheries in Western Alaska.

Sockeye salmon are the second most numerous in the Alaska commercial catch and the third most abundant salmon in the Pacific Ocean. Recent statewide commercial harvests have been near 50 million fish (Figure 1). This species of salmon is the most adapted to lake rearing in the juvenile stages. In some systems, sockeye salmon spawn and rear in streams and do not utilize lakes. Some sockeye salmon, known as kokanee, are landlocked and never enter the marine environment. However, the majority of sockeye salmon rear from one to three years in lakes prior to outmigration, and spend from one to four years in the marine environment before returning to fresh water to spawn. In Alaska, most sockeye salmon are harvested by gillnets, or in some cases, seine gear in limited entry fisheries. The Bristol Bay sockeye run is one of Alaska's most important commercial fisheries. This

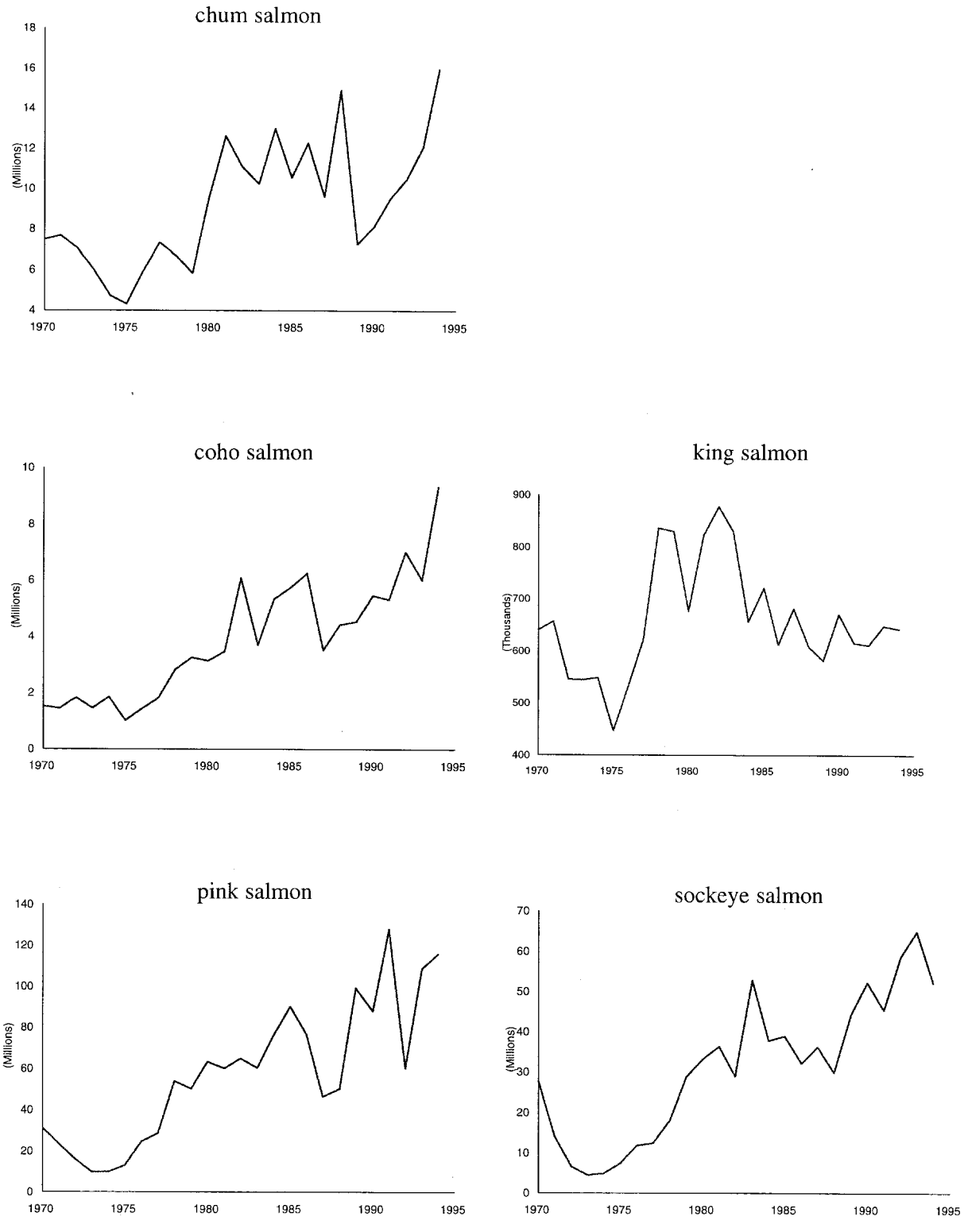


FIGURE 1. Recent commercial harvests of chum, coho, king, pink, and sockeye salmon in Alaska during 1970–1994.

run is harvested as the returning adult salmon migrate past the Alaska Peninsula in June and then as they pass the large gillnet fisheries in Bristol Bay. The Copper River adjacent to Prince William Sound has the earliest run of sockeye salmon in the world. The fishing industry watches the fishery on this run as a bellwether for prices in the coming season.

Coho salmon are the fourth most numerous in the Alaska commercial catch and the fourth most abundant salmon in the Pacific Ocean. Recent statewide commercial harvests have been near 5 million fish (Figure 1). Coho salmon are generally the latest spawners in Alaska, with runs well into the fall or even early winter. Like pink salmon, coho salmon normally spend one winter in the ocean and return to spawn the following fall. Unlike pink salmon, coho can remain in the riparian environment to rear for an additional year prior to outmigration. In the more southerly latitudes of its range, coho salmon mainly spend only one year in fresh water and one year in the ocean. With increases in latitude, an increasing percentage of coho spend a second year in fresh water prior to migration to the marine environment. Juvenile coho salmon in the nearshore environment initially feed on marine invertebrates, but the diet changes mainly to fish and some marine invertebrates as they grow. As piscivores, coho salmon feed on herring, smelt, sandlance, chum and pink salmon fry, and many other fish species. In Alaska, coho salmon are important in sport and personal use fisheries, as well as in the commercial troll and net fisheries. Because of their late run timing, many coho runs in Alaska may be lightly exploited or even unexploited. Because of poor weather during the coho spawning period, little information exists about run size and timing in many areas of the state.

Chinook salmon are the least abundant of the five salmon species found on both sides of the Pacific Ocean and the least numerous in the Alaska commercial harvest. Recent statewide commercial harvests have been near 650 thousand fish (Figure 1). Chinook salmon reach the greatest size of any salmon species and for this reason are called king salmon. Chinook salmon typically have relatively small spawning populations. The largest river systems tend to have the largest populations of chinook salmon. Chinook salmon can migrate to the marine environment the spring after they hatch or can spend up to two years in the riparian environment prior to outmigration. The timing of outmigration can vary between and within systems, although this generally occurs during the spring. Chinook salmon can spend five or more years in the ocean prior to spawning. In the estuarine environment, chinook salmon are largely opportunistic feeders. In Alaska, chinook salmon are important in sport and personal use fisheries, as well as commercial troll and net fisheries. A Southeast Alaska troll fishery operates on mixed stocks of migrating chinook salmon throughout the year, providing consumers with fresh chinook salmon during the winter.

From the period 1986 to 1989, 78% or more, by weight, of the salmon product entering commercial markets was sold as whole or eviscerated salmon. In that same period, between 10% and 16% entered the market as a canned product. The rest was sold as fillets or portions, cured product, or salmon roe. Generally, less than 25% of the fresh or frozen product went into domestic U.S. markets, with the rest exported. Japan purchased almost 80% of these exported products. Almost two-thirds of canned salmon went into U.S. domestic markets.

In much of their southerly range, wild salmon populations are declining, extinct, or at disastrously low levels. Poor fisheries management and the masking of poor management by hatcheries have combined with water-use conflicts, development, dams, agriculture, and logging to create an environment adverse to salmon survival. In Alaska, with few exceptions, our runs are in excellent

shape, supporting ever-increasing record harvests. The ocean environment was extremely favorable in the 1980s and early 1990s. Good fisheries management and a pristine environment have allowed Alaska's salmon populations to make the most of favorable ocean conditions.

The health of the salmon fishing industry in Alaska will depend largely on external forces. Alaska is one of the last places in the world with large wild salmon populations. But even with continued good management, the run sizes will largely be determined by oceanographic phenomena that are poorly understood and impossible to manage. The excellent ocean conditions of the last decade will surely end sometime in the future. The price of salmon is now driven largely by the worldwide supply of farmed salmon originating outside of Alaska, and this world supply will continue to lead to lower prices. Even so, Alaska's economy, culture, and even identity will continue to be shaped by salmon because of the size and history of its salmon fisheries.

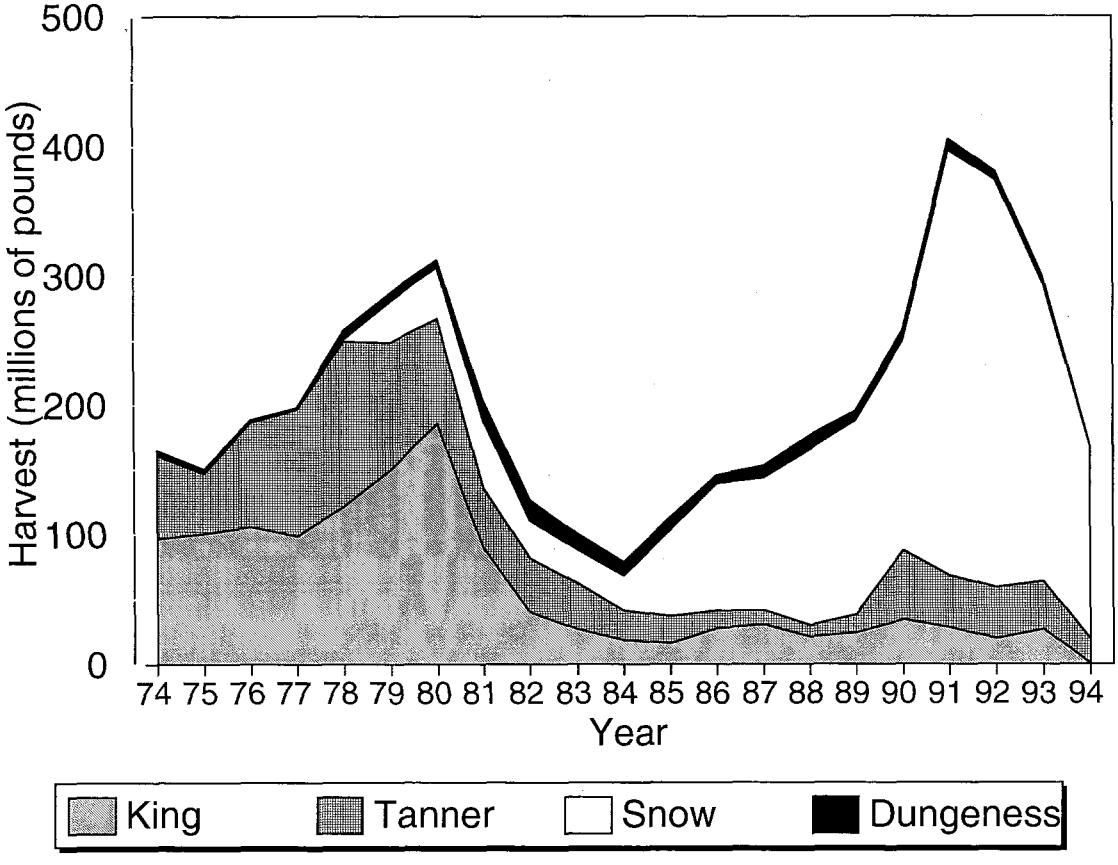


FIGURE 2. Landings of king, Tanner, snow, and Dungeness crabs in Alaska during 1974–1994.

Crab Fisheries

The Gulf of Alaska and Bering Sea support major commercial fisheries on seven species of crab: red king crab, *Paralithodes camtschaticus*; blue king crab, *P. platypus*; golden king crab, *Lithodes aequispinus*; Tanner crab, *Chionoecetes bairdi*; snow crab, *C. opilio*; hair crab, *Erimacrus isenbeckii*; and Dungeness crab, *Cancer magister*. A wide range of crab stock trends is evident from examining catch histories (Figure 2). Many stocks have crashed and not improved (e.g., Kodiak red king

crabs), others have crashed and begun rebounding (e.g., Southeast Alaska king crabs), while still others have maintained substantial fisheries (e.g., Bering Sea snow crabs). Success at sustaining crab fisheries for the long term has not been good: for the most part, only stocks with short (less than 15 years) exploitation histories remain healthy.

Management programs for crab resources in Alaska strive to maintain healthy stocks, provide sustained and reliable supplies of high-quality products to the market, and provide opportunities for subsistence and personal use fisheries. Harvest strategies vary among areas and species. All crab fisheries have minimum size limits and permit the harvest of male crabs only. Most crab fisheries are closed during molting and mating periods. Many red and blue king, Tanner, and snow crab fisheries are managed by exploitation rates where abundance estimates are available. Fisheries lacking such estimates are managed using quotas based on historical catches and comparing inseason fishery performance to historical catch-per-unit-effort. In general, Dungeness and golden king crab fisheries are managed by quota, minimum size limit, and sex restriction; but they are prosecuted during molting/mating periods. Additional management tools include the use of a threshold or minimum spawning biomass below which no fishery occurs, permits, onboard observers, registration areas, pot limits, reporting requirements, vessel tank inspections, legal gear specifications, and provisions for gear placement, removal, and storage.

Crabs are typically harvested for subsistence and commercial use with pot gear or ring nets. Harvest of crabs for personal use employs these gear or scuba gear. Pot design differs by species, but all pot gear in Alaska must have a biodegradable seam, panel, or other device that renders the pot incapable of holding shellfish or bottomfish for more than six months when continuously immersed in sea water. Dungeness crab pots are round and 1.1 to 1.5 m in diameter. They are covered with stainless steel mesh and each pot contains two 111.1-mm-diameter rings that allow sublegal crabs to escape. King, Tanner, and snow crab pots are built in several sizes ranging from 1.8 m by 1.8 m to 2.4 m by 2.4 m. They are 0.8 to 0.9 m in height, weigh between 136.1 to 362.8 kg, and are covered with tarred nylon web with mesh size varying on location (top, bottom, sides, tunnel, door). These pots were originally designed for king crab, but tunnels can be modified with "Tanner boards" to accommodate the smaller Tanner and snow crab while restricting king crab entry. In some areas a pyramidal pot designed specifically for Tanner crab is fished. Dungeness and king crab pots have two tunnels on the sides of the pot for crab entry and an opening side (door) for emptying the pot. Pyramid pots have a single tunnel forming the peak of the pot and a pursing bottom.

Pots are baited with chopped herring or fish (e.g., cod carcasses) and fished on a single buoyed line, except in the golden king crab fishery where a minimum of 10 pots are longlined. Single-line pots are placed in the water using a hydraulic pot launcher and set in rows (strings) that may run from a dozen to more than 100 pots. Longlined pots are set using a ramp over the stern of the vessel. The depth fished depends on the target species. Dungeness crabs are typically found in waters less than 20 m, snow and Tanner crabs are distributed between 100 m and 200 m, red and blue king crabs occur in depths less than 200 m, and golden king crabs are common between 200 m and 1,000 m. Pots are usually soaked at least 12 hours before retrieval, but soak time can vary dramatically depending on species, weather, and tides. Pots are hauled using a hydraulic crab block mounted near the gunnel. Once aboard, contents of the pot are sorted and sublegal male and female crabs discarded. Legal crabs are retained in live tanks with flow-through sea water.

Crabs commercially harvested in the Bering Sea and Aleutian Islands are sold alive to catcher-processor vessels, floating-processing vessels, or shoreside processors. In Southeast Alaska, Prince William Sound, and the Kodiak area, processing is conducted exclusively shoreside except for isolated processing of Tanner crab aboard floaters around Kodiak Island to prevent the spread of bitter crab disease. King, Tanner, and snow crabs are cleaned and either cooked and brined or left raw. Final product forms include crab clusters, claws, and meat. The product is frozen, packed in bulk, and shipped out of Alaska for reprocessing in the Seattle area or the Far East. Even products that are in a retail form are generally shipped to reprocessors for packaging, labeling, cold storage, and marketing. A very small amount of king crab is shipped live to Asian markets. Dungeness crab are cooked and processed as fresh or frozen, whole or sectioned product. Dungeness crab are also shipped live. Hair crabs are cooked whole.

All king, Tanner, and snow crab production in the U.S. comes from Alaska. Approximately 77% of king crab and 51% of Tanner and snow crab production is consumed domestically and the remainder is exported. Japan is the main export market for Alaskan crab products. About 30% of the U.S. production of Dungeness crab originates in Alaska, but 97% of the Alaskan product is consumed domestically. Conversely, 100% of the hair crab product is exported. A minimal amount of commercially harvested crab is moved to consumers in Alaska. However, personal use and subsistence take of crabs is high near many of the coastal communities.

Crab resources for the species discussed here are fully utilized in Alaska. During the 1992–1993 season, a total of 303 million lb (137,400 mt) of crabs worth $344 million exvessel were landed (Table 1). Fisheries in the Bering Sea and Aleutian Islands accounted for the majority of these landings. During the 1992–1993 season, the species contributions were: 28 million lb (12,700 mt) of king crabs worth $96 million, 231 million lb (104,760 mt) of snow crabs worth $173 million, 37 million lb (16,780 mt) of Tanner crabs worth $66 million, 4 million lb (1,800 mt) of Dungeness crabs worth $4 million, and 1 million lb (450 mt) of Korean hair crabs worth $4 million.

Status of the stocks in 1994 is summarized in Table 1. At the northerly range of commercial crab stocks, St. Matthew blue king crab is at relatively high and stable levels. Analysis of onboard (observer) samples from the 1994 Norton Sound red king crab fishery indicates low recruitment, a possible sign of impending stock decline. The closed fishery for Pribilof Island blue king crab and poor fishery performance for red king crab are indicative of poor health of these stocks.

Notably, the Bristol Bay red king crab stock is depressed, and the largest king crab fishery in the state was closed this year for the first time since 1983. Abundance of mature female red king crab in Bristol Bay declined below threshold triggering the fishery closure. Recruitment of male crabs is also poor and outlook for the fishery in the near future is not good. Causes of the collapse are not well understood, but high natural mortality coupled with high harvest rates and low spawning stocks are thought to have led to continued poor recruitment in Bristol Bay. The bycatch of Bristol Bay red king crabs will be minimized in the directed fishery for Tanner crab by BOF closure of half of this fishery's traditional grounds. The NPFMC has also taken emergency action to close a portion of Bristol Bay to the trawl fleet to minimize red king crab bycatch. Additionally, the NPFMC has closed an area surrounding the Pribilof Islands to trawl fishing to protect blue king crabs. In the Gulf of Alaska, crab habitat from Kodiak Island to Unalaska Island has been closed to non-pelagic trawling and scallop dredging to protect king and Tanner crab stocks.

TABLE 1. Current status, harvest and value of king, Tanner, snow, Dungeness, and Korean hair crabs in Alaska by stock.

SPECIES	1994 STATUS	1993 Harvest POUNDS (millions)	1993 Harvest VALUE (millions)
KING CRAB			
St. Matthew Blue	High & Stable	3.00	$ 7.50
Norton Sound Red	Medium & Declining	0.34	0.43
Pribilof Red	Low & Declining	2.61	11.73
Bristol Bay Red	Depressed & Closed	14.50	55.83
Adak red	Low	1.29	6.51
Adak Golden	Low & Declining	4.90	11.52
Dutch Harbor Golden	Low & Declining	0.90	1.94
Southeast Red	Low & Stable	0.20	0.82
All other stocks	Depressed & Stable	0.00	0.00
		TOTAL	**$96.35**
TANNER AND SNOW CRAB			
Bering Sea Snow	Sharp Decline	231.00	$173.25
Bering Sea Tanner	Declining	35.10	59.67
Kodiak Tanner	Depressed & Closed	1.32	2.77
SE/Yakutat Tanner	Average & Stable	1.66	2.82
Cook Inlet/PWS Tanner	Depressed	0.53	0.88
Aleutians Tanner	Depressed & Closed	0.00	0.00
		TOTAL	**$239.40**
DUNGENESS CRAB			
Southeast	Low & Cyclic	2.20	$2.35
Yakutat	Low & Cyclic	0.77	0.67
Kodiak	Low & Cyclic	1.40	1.29
		TOTAL	**$4.33**
KOREAN HAIR CRAB			
Bering Sea	Med–High	1.20	$3.60
		TOTAL	**$3.60**
GRAND TOTAL			**$343.68**

Bering Sea Tanner and snow crabs are declining, but this trend appears to be leveling out as some recruitment of juveniles is occurring. Bering Sea hair crab stock abundance is average at present but is dependent on one or two age classes which are passing through the fishery. Most Aleutian Island area and Gulf of Alaska crab stocks are depressed. Adak red and golden king crabs and Dutch Harbor golden king crabs all have only small guideline harvest levels. King and Tanner crab fisheries in Dutch Harbor, Alaska Peninsula, Kodiak, Cook Inlet, and Prince William Sound areas are closed. Red king crab in Southeast Alaska appear to have rebounded, and a small fishery was prosecuted this year for the second year in a row after a decade of closure. Tanner crab in Southeast Alaska are generally healthy and abundance is at an average and stable level. Fisheries for Dungeness crab are open throughout the state with the exception of the Kachemak Bay, Prince William Sound, and Copper River areas due to depressed stocks. Dungeness crab has provided consistent fishing opportunities for small boat fleets in the Southeast Alaska and Kodiak areas. One

redeeming aspect of low stock abundances is high demand and resulting high value. Red king crab was selling at over $7.00/lb ($15.44/kg) in Kodiak during September 1994.

Product quality issues in Alaska's crab fisheries include Paralytic Shellfish Poisoning (PSP) and Bitter Crab Syndrome. PSP has resulted in some closures of Dungeness crab fisheries in the Kodiak area and Southeast Alaska. Harvest of Tanner crab in several areas of Southeast Alaska and Kodiak has been curtailed due to bitter crab.

Herring Fisheries

Commercially exploitable quantities of Pacific herring (*Clupea pallasi*) occur in Alaska from its southern boundary at Dixon Entrance (55° N) to Norton Sound (64° N) (Figure 3). Herring spawn in nearshore areas and deposit their adhesive eggs on intertidal and subtidal vegetation. Spawning begins as early as late March in southern Southeast Alaska and continues through mid July in the northern Bering Sea. Gulf of Alaska herring are genetically distinct from Bering Sea herring and are smaller and non-migratory, generally moving less than 100 miles among spawning, feeding, and wintering grounds. Bering Sea herring are much larger and longer lived. Most travel to offshore central Bering Sea wintering grounds, with some herring migrating over 1,000 miles annually. Herring are planktivores and provide a key link in pelagic and nearshore food chains between primary production and upper-level piscivores.

Alaska has a colorful history of herring fisheries beginning with its earliest aboriginal inhabitants who depended on herring for food. Southeast Alaska Natives still savor herring eggs which they obtain by allowing herring to spawn on hemlock boughs that have been placed in the water during the spring. Traditional dried herring remains a major staple of the diet in Bering Sea villages near Nelson Island.

Early European settlers in the Pacific Northwest caught herring and preserved them with salt, as they had done with herring from the North Sea. Salted and pickled herring production peaked after World War I, when about 14,000 tons (12,700 mt) were harvested annually (Figure 4). During the 1920s herring became increasingly valued for oil and meal. Reduction plants to "reduce" herring to meal and oil sprang up all over Alaska from Craig to Kodiak. Harvests during the 1920s and 1930s, as high as 125,000 tons (113,400 mt), were probably too high and may have caused the stocks and fisheries to decline. During the 1950s, lower cost Peruvian anchoveta severely impacted the oil and meal markets. The last Alaska herring reduction plant closed in 1966.

A large foreign fishery for herring food products existed in the Bering Sea in the 1960s and 1970s. When inshore domestic fisheries began to fully utilize Bering Sea herring around 1980, foreign harvests were eliminated under provisions of the MFCMA.

When their herring stocks declined during the 1960s, Japan began importing herring roe from other countries. A lucrative market for herring eggs and eggs on kelp prompted the development of Alaska's roe herring fisheries and remain the principle utilization of herring at present.

Sac roe fisheries harvest herring just before spawning using either purse seine or gillnet gear. Herring are transferred from the catcher boats to larger tenders, which deliver the herring to large, Japanese "tramp" freighters. After the herring are transported to Japan, the roe is removed from the

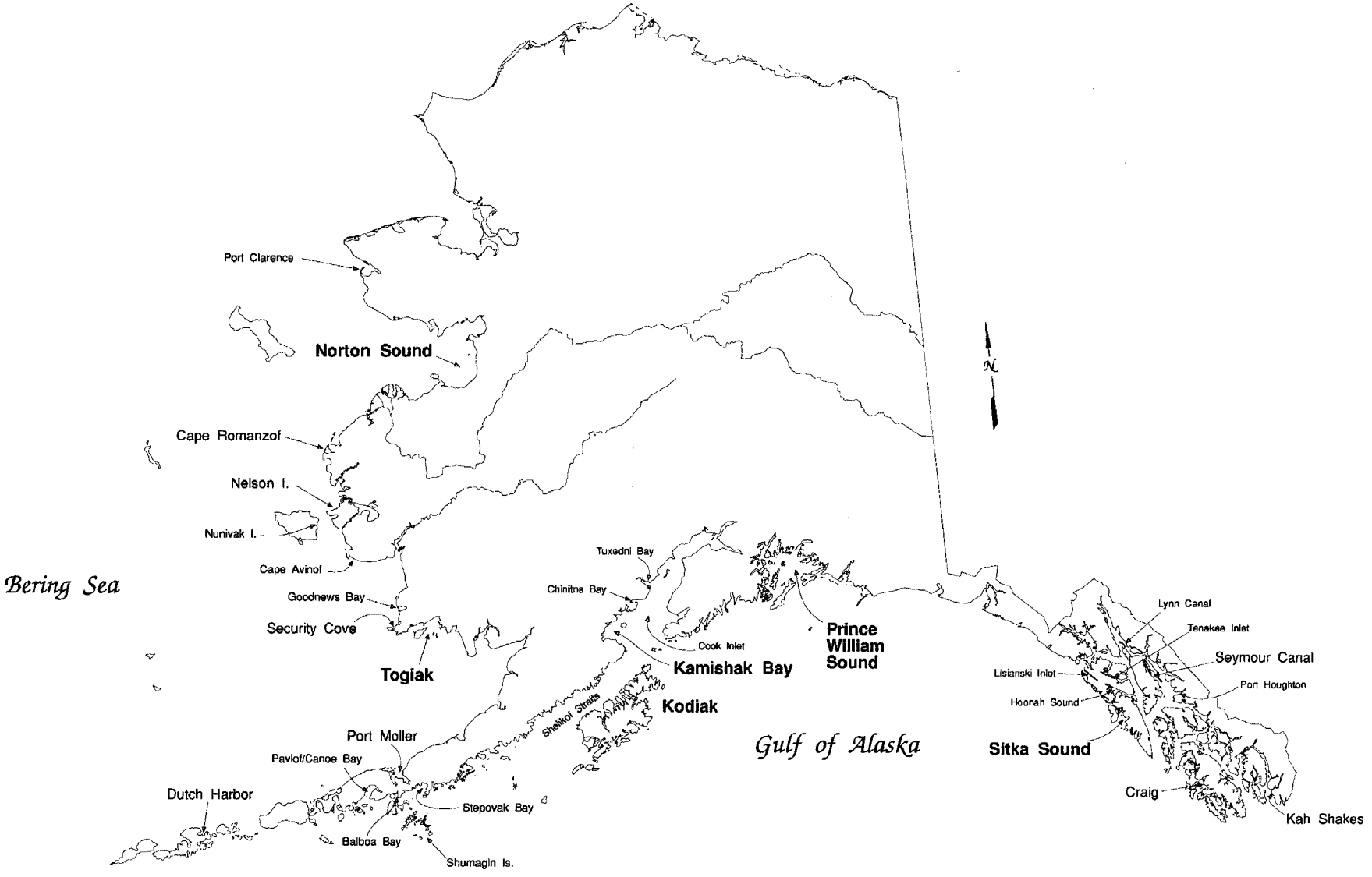


FIGURE 3. Locations of Alaska herring fisheries.

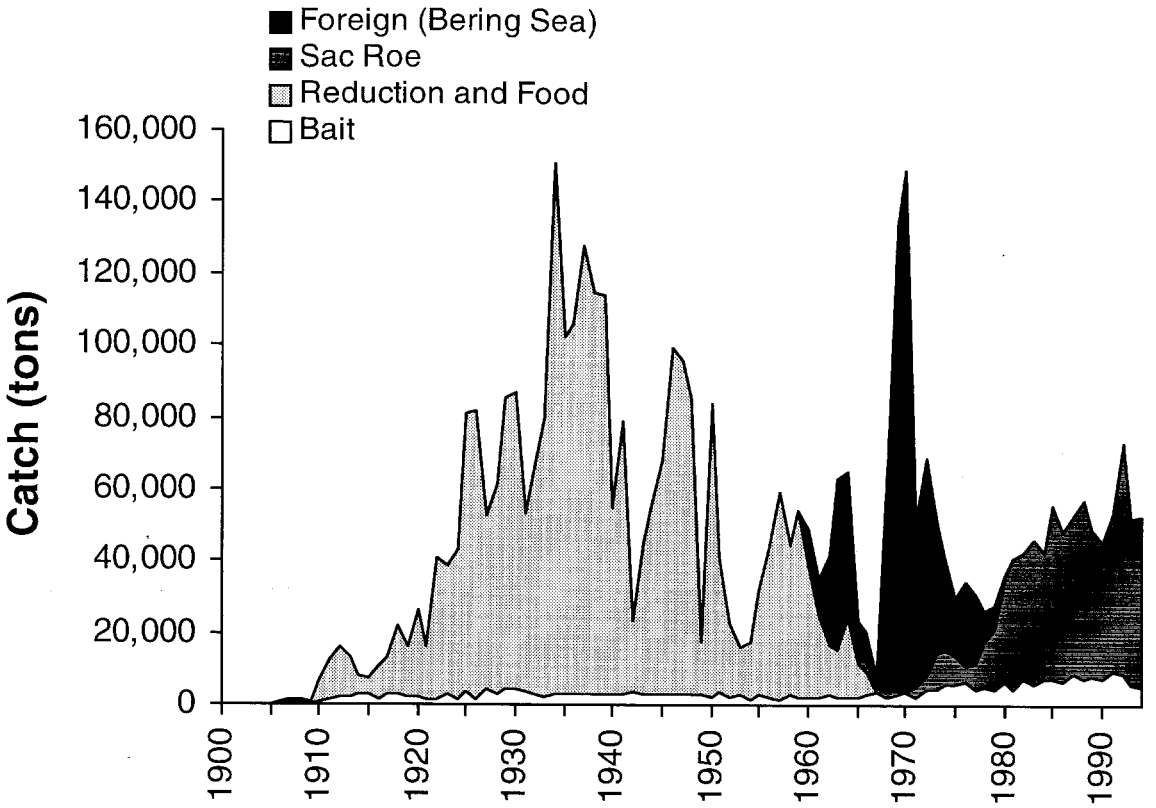


FIGURE 4. Pacific herring landings in Alaska by fishery during 1900–1994.

females, and their carcasses, along with the males, are made into fish meal. The roe is salted and packaged as a product that sometimes sells for over $100/lb ($220/kg) in Japan. In recent years the Alaska sac roe harvest has averaged about 48,000 tons (43,500 mt) (Figure 4), almost all of which ends up in the Japanese marketplace.

Spawn-on-kelp fisheries harvest herring eggs after they are deposited on vegetation. Naturally spawned eggs are collected by scuba divers from brown kelps and *Fucus* in Prince William Sound, and by rakes and by hand from *Fucus* growing in intertidal areas at Togiak in Bristol Bay. At Craig and Hoonah Sound in Southeast Alaska and in Prince William Sound, herring spawn-on-kelp is harvested from herring that have been confined in impoundments or "pounds." In these fisheries herring are captured by purse seines and slowly transported to net enclosures. Herring are released from the pounds after they have spawned on the *Macrocystis* kelp fronds which are suspended in the pounds.

The commercial catch of herring for bait in Alaska began around 1900 and remained relatively stable, typically 2,000–3,000 tons (1,800–2,700 mt), in spite of very large fluctuations in the herring catch for the reduction, foreign, and sac roe fisheries. The development of extensive crab fisheries in the 1970s greatly increased the demand for herring bait. Average harvests have been about 8,000 tons (7,300 mt) in recent years (Figure 4).

In Gulf of Alaska areas, herring bait fisheries usually occur during the fall and winter. When used for bait on hook and line gear, fall- and winter-caught herring are retained longer on the hooks than those caught in spring and summer. Herring fat content is high during the summer, and summer-caught herring do not preserve as well. However, high oil content is desirable for some methods of preserving herring for food. Production of herring food products has been minimal in recent years.

Most herring fisheries in Alaska are regulated by management units or regulatory stocks (i.e., geographically distinct spawning aggregations defined by regulation). Those aggregations may occupy areas as small as several miles of beach or as large as all of Prince William Sound. Herring sac roe and spawn-on-kelp fisheries are always prosecuted on individual regulatory stocks. Management of food and bait herring fisheries is more complicated because they are conducted in the late summer, fall, and winter when herring from several regulatory stocks may be mixed together. If more than one herring fishery harvests a particular regulatory stock, BOF regulations usually allocate percentages of the allowable harvest to each fishery.

In general, Alaska herring fishery quotas are based on a variable exploitation rate harvest policy. The BOF has established a maximum exploitation rate (fraction of the spawning population removed by the fishery) of 20%. Fisheries are closed if stock size falls below the threshold level — the minimum stock size thought necessary to guarantee sustained yield from the stock. Lower exploitation rates are usually used when herring stocks decline to near-threshold levels.

The BOF also enacts regulations that control the types and amounts of fishing gear that may be used, allocate the allowable harvest among user groups, and determine the range of dates allowed for fisheries. ADF&G determines the exact opening and closing times each season. For sac roe fisheries, openings are timed to occur when herring have produced the maximum amount of roe. The duration of openings is also set to achieve harvest quotas as closely as possible. Entry into most herring fisheries in Alaska has been limited under the authority of CFEC.

Aside from establishments of annual catch quotas and allocations, several issues affect herring fisheries. In recent years, herring roe markets have begun to deteriorate as the consumption of herring roe declines in Japan. Processors are becoming reluctant to purchase all of the available herring. This usually happens in the northernmost and last sac roe fishery of the year, Norton Sound. Persistent ice floes and the opening of the year's first salmon fisheries also tend to diminish processors' interest in Norton Sound herring.

With the degradation of herring roe markets, herring processors have been increasingly concerned about product quality. Recently, fishermen, ADF&G, and the processing industry have renewed efforts to increase roe percentages and reduce the length of time herring are held before processing. Roe percentages have improved in some areas. Managers also are attempting to better match the rate of harvesting with the rate of processing, so that herring can be more quickly frozen to prevent product deterioration.

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Herring are sometimes taken as bycatch in Bering Sea trawl fisheries, principally those targeting pollock (*Theragra chalcogramma*). Before full observer coverage in the late 1980s, this bycatch may have been as high as 8,000 to 10,000 tons (7,300 to 9,100 mt). Federal regulations preclude the retention of herring aboard these trawl fisheries, and because survival of trawl-caught herring is very low, the entire trawl bycatch is wasted. In the early 1990s the NPFMC adopted regulations which have successfully limited this bycatch to 1% of the biomass of Bering Sea herring. Bycatch of herring in all other fisheries is very low.

Because herring eggs are deposited on intertidal and subtidal vegetation, herring are particularly vulnerable to oil spills that occur near the time of spawning, such as the *Exxon Valdez* oil spill of 1989. Although immediate mortality of herring following the *Exxon Valdez* oil spill was thought to be low, a population crash that became apparent in 1993 may be linked to the earlier spill.

Most herring spawning habitat in Alaska is undeveloped and has not been degraded by human activities. However, there are occasional concerns about the impact of herring roe fishing vessels on herring spawning activities. Discharges from large pulp mills in Southeast Alaska have been linked to herring mortality on a number of occasions. The longer-term effects of pulp mill effluents on herring populations are unknown.

Because herring are an important food source for other species, commercial utilization of herring has always been controversial. In Southeast Alaska, halibut and salmon fishermen began vociferously objecting to herring fisheries early in the 20th century. Their objections continue to be heard by the BOF and have been one of the principle reasons for the conservative herring harvest policies adopted by the Board. A group representing these interests, as well as those of sport fishermen and naturalists, unsuccessfully sued the State of Alaska to prevent a herring fishery near Ketchikan in 1993 and 1994. The decline of marine mammal populations, such as the Steller sea lion (*Eumetopias jubatus*), have highlighted an apparent diet shift away from herring to pollock over the last few decades. While the role of these diet shifts, as well as the role of commercial fisheries in altering herring, pollock, and marine mammal population levels remains unclear, the potential endangered species listing of the Steller sea lion has renewed interest in potential conflicting utilizations.

Groundfish Fisheries

The earliest commercial groundfish fishery off Alaska targeted Pacific cod. In 1865 the first fishing expedition was made into the Bering Sea by the schooner *Alert*. The following year the schooner *Porpoise* sailed to the Shumagin Islands and returned to San Francisco with 30 tons (27 mt) of salted cod. This early fishery peaked between 1916 and 1920 and then steadily declined until 1950. Commercial exploitation of halibut and sablefish (*Anoplopoma fimbria*) began in the inside waters of Southeast Alaska during the 1880s. Slow ships and lack of refrigeration restricted these "fresh" fish fisheries to the winter months. With the advent of diesel power, hook and line vessels expanded these fisheries rapidly. By the early 1920s some vessels were regularly fishing the central Gulf of Alaska, and catches were measured in thousands of tons of halibut and hundreds of tons of sablefish.

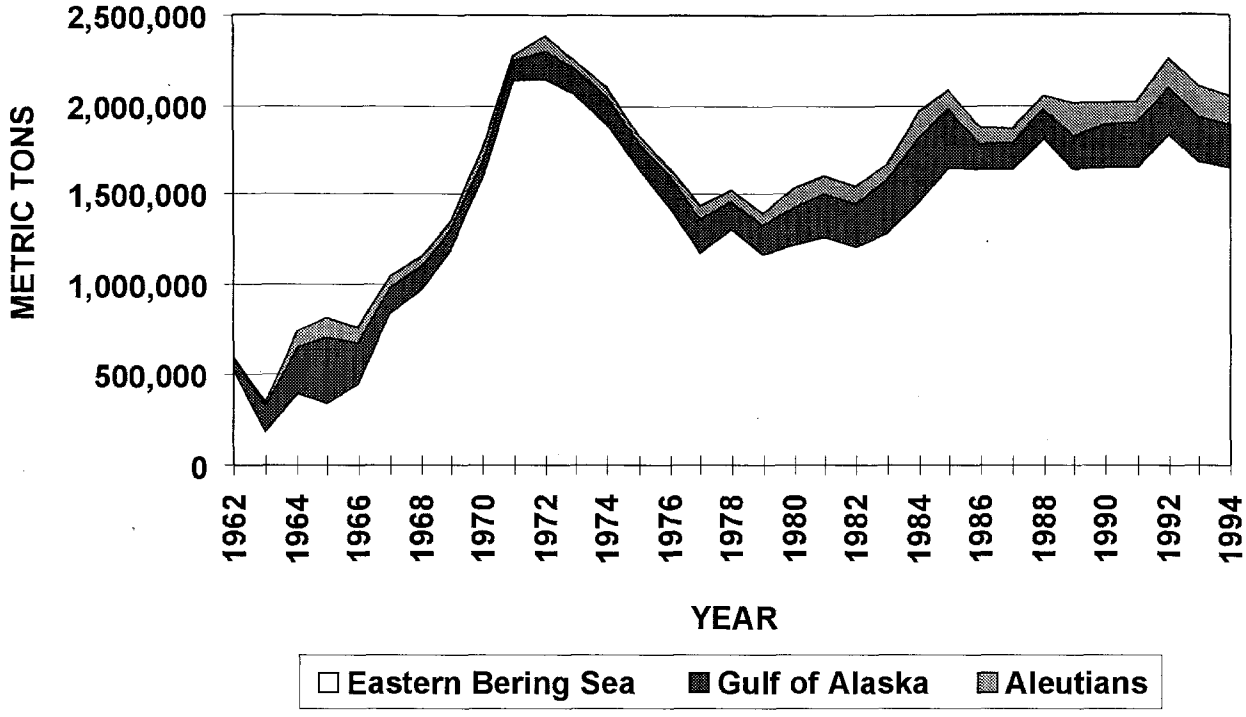

FIGURE 5. Alaska groundfish landings from Eastern Bering Sea, Gulf of Alaska, and Aleutians during 1962–1994.

Besides U.S. fishermen, Canadians regularly fished off Alaska for halibut. As part of a negotiated settlement after both Canada and the U.S. extended their fisheries jurisdictions to 200 miles, the Canadian fishery was phased out of U.S. waters and ended in 1980. Excluding Canada as one of the six foreign nations that have fished off Alaska, Japan had the longest history of exploitation. After an exploratory expedition to the Bering Sea in 1930, Japan targeted on pollock between 1933 and 1937 and yellowfin sole (*Limanda aspera*) in 1940 and 1941. Fishing again resumed in 1954 concentrating on flounders for meal. This fishery peaked in 1960 at approximately 500,000 mt and then declined with the collapse of the yellowfin sole population. The Russian fleet, which entered the Bering Sea in 1958, contributed to these catches and subsequent flatfish decline. By the early 1960s some Japanese trawlers had begun targeting pollock. Pollock catches peaked in the Bering Sea in 1972 when over 1.7 million mt were taken by the Japanese fleet (Figure 5). This coincided with the Russian maximum harvest peaks between 1971 and 1973 of over 300,000 mt annually. Fishing effort was extremely high. During 1971 over 450 foreign fishing vessels entered the fishery. With a small Korean fleet also working the Bering Sea during the late 1960s and early 1970s, Bering Sea foreign fisheries reached a record total catch of 2.2 million mt of pollock, flatfish, rockfish, cod, and other groundfish in 1972. Total groundfish harvests then dropped dramatically in the Bering Sea and Aleutian Islands area.

The Japanese fleets moved into the Gulf of Alaska in 1960 and were quickly followed by the Russian trawl fleet in 1962. The primary target was Pacific ocean perch (POP, *Sebastes alutus*). Catches of this species combined with other red rockfish peaked at 350,000 mt in 1965. As POP declined, flatfish, cod, pollock, and sablefish became alternative targets and effort continued to increase. Other nations also entered the Gulf fishery during the 1970s. Japanese, Russian, Korean, and Taiwanese longliners focused on sablefish and cod, and trawlers from these nations and

Poland, West Germany, and Mexico fished as well. The late 1960s and early 1970s represent a period of overharvest. Because of the active U.S. crab and halibut fisheries in the Gulf, it was also a time of extreme gear conflicts between domestic and foreign fishermen. Bycatches of halibut taken by foreign trawlers in the Gulf peaked at an estimated 9,000 mt (1.5 million fish) in 1965 and declined to about 4,000 mt in 1974. These catches were roughly a third of the directed harvest. Alaskans' interests in extending U.S. jurisdiction and controlling foreign fisheries was at a peak by the early 1970s.

With the implementation of the MFCMA in 1977 came authority and direction to "Americanize" the Alaska groundfish fishery. From 1978 through 1986 was the time of the foreign-U.S. joint ventures (JVs) and a transition to a fishery by U.S. vessels only. From a catch of only 44.6 mt in 1978, JVs (including Russia, Korea, Japan, Taiwan, and Poland) expanded rapidly and surpassed domestic catches in 1980. The JV fishery peaked at 1.3 million mt in 1987, which was also the last year of any foreign directed catch. The JVs provided for a 13-year foreign-to-U.S. transition. By 1991 all groundfish harvest was being taken by the U.S. fishery.

Since the advent of the first independent factory trawler (*Arctic Trawler*) in 1980, dramatic changes have occurred in the U.S. fishery. Catches and value have increased enormously, but overcapitalization has lead to reduced seasons and proposed limited effort programs, yet to be implemented. Individual fishing quotas (IFQs) are to be implemented in 1995 for halibut and sablefish longliners. For other groundfish fisheries, IFQs and license limitation proposals (similar to Alaska's salmon limited entry system) are undergoing intense public and agency review. Arguments among gear groups, between shorebased and offshore operations, and among groundfish versus salmon, crab, and halibut fishermen over bycatch have almost overwhelmed the regulatory process. Animosity between Alaska resident and nonresident fleets has replaced the negative feelings once reserved for foreign fleets. Growing pains for the Alaska groundfish fishery have been intense, and it will be a minimum of two to three more years before the primary allocation decisions can be settled. The problem of bycatch and the discard of thousands of tons of fish and shellfish will be much more difficult to resolve. Bycatch caps for crab and halibut and various gear, time, and area restrictions are in place. For example, in the Bering Sea trawlers are allowed 3,775 mt of halibut mortality and 200,000 captured king crabs prior to being closed for the season. Caps also exist for herring, Tanner crab, chum salmon, and Gulf of Alaska halibut. However, because fishing effort shifted from one area tends to create bycatch problems in other areas, gear modifications and various incentive programs for the fishermen have been proposed.

Total discard (waste) is considered a serious problem. Of the 2.1 million mt of groundfish caught in all fisheries, approximately 16% is discarded. Yet, discard rates close to and greater than 50% are common for bottom trawl flatfish and cod fisheries. These groundfish discards do not include the prohibited species categories, including 7,600 mt of halibut mortality, hundreds of thousands of salmon, or millions of crabs which are legally required to be discarded.

Regardless of these serious problems, the Alaska groundfish fishery has provided new jobs in both Alaska and Washington state. Over 80 factory trawlers with crews of 10–30 fish off Alaska. Hundreds of smaller boats deliver their catches to small, coastal communities like Ketchikan, Sitka, Homer, and Sand Point which have been enhanced economically because of relatively recent groundfish landings. Many processing plants in Kodiak and Homer now provide employment year round. The value of the entire fishery (exvessel) has declined recently to somewhat over $400 million in

1993. Primary product forms are headed and gutted, fillets in various forms, and pollock surimi. Total groundfish catches range between 1.7 and 2.1 million mt. Although high-value species such as rockfish and sablefish have retained their value, pollock, which makes up 70% of the catch, is about half as valuable as it was in 1991. Any decline in pollock prices directly affects total value. Foreign exchange rates and availability of product substitutes on the world market substantially influence prices and cause significant price variation. Primary stocks, except Gulf of Alaska pollock, are considered healthy or rebuilding, and yields are projected to remain high for the near future. Of much greater uncertainty than stock conditions are future market conditions and impacts of the regulatory process.

Stock condition is assessed by age- or length-based models, trawl and longline abundance surveys, catch and effort data provided by onboard observers, and landing records. Most stocks are managed by a fixed exploitation rate strategy based on biological reference points and an estimate of exploitable biomass. Annual catch quotas or Total Allowable Catch (TAC) are determined by a range of methods, including synthesis models for data-rich stocks to simple average annual harvests for a few stocks for which there are minimal data. Stock status analyses are completed by NMFS and ADF&G scientists. At its annual December meeting the NPFMC, based on the advice of its scientific and industry committees, sets the annual TACs for each stock. These recommended TACs are generally accepted by the U.S. Secretary of Commerce and placed in regulation by NMFS for the following year's fishery.

Fisheries for Other Species

Overview

Aside from salmon, crabs, herring, and groundfishes, there are a variety of other species harvested in Alaska. Whereas some of these species are taken during directed fisheries, many of these other species are taken incidentally by groundfish fisheries. A wide variety of species are taken during trawl, pot, and longline groundfish fisheries within the 200-mile EEZ, including squid, octopus, sculpins, sharks, skates, eulachon, smelts, and capelin. These species are managed as "other groundfish species" by federal management plans for the EEZ fisheries. Unfortunately, historical catch records for these species are poor. Recent catches have been calculated from bycatch rates estimated by onboard observers. These observations indicate that approximately 94% of other species catches were discarded in 1994. That is, approximately only 3.2 million lb (14,500 mt) of a total catch of 52.7 million lb (23,900 mt) of other species were retained. Individual discard rates varied: 47% for smelt, 54% for squid, and 100% for sculpins. Clearly, these are underutilized species.

Some species caught incidental to groundfish fisheries are delivered to shoreside processors. Records of such shoreside landings are good (Figure 6) because records of landings and sales are required by Alaska. During 1969–1993 landings of other fish species totaled 13.3 million lb (6,030 mt) and included a number of species of skates (75.5%), rattails (12.5%), sharks (11.0%), eels (0.7%), and others (0.3%). Most (70%) of these landings of fishes are attributable to skate catches during the last five years alone (Figure 6).

A variety of other invertebrate species are harvested by directed fisheries off Alaska, and catch records for them are also well kept. Catches of these species totaled 178.6 million lb (81,000 mt)

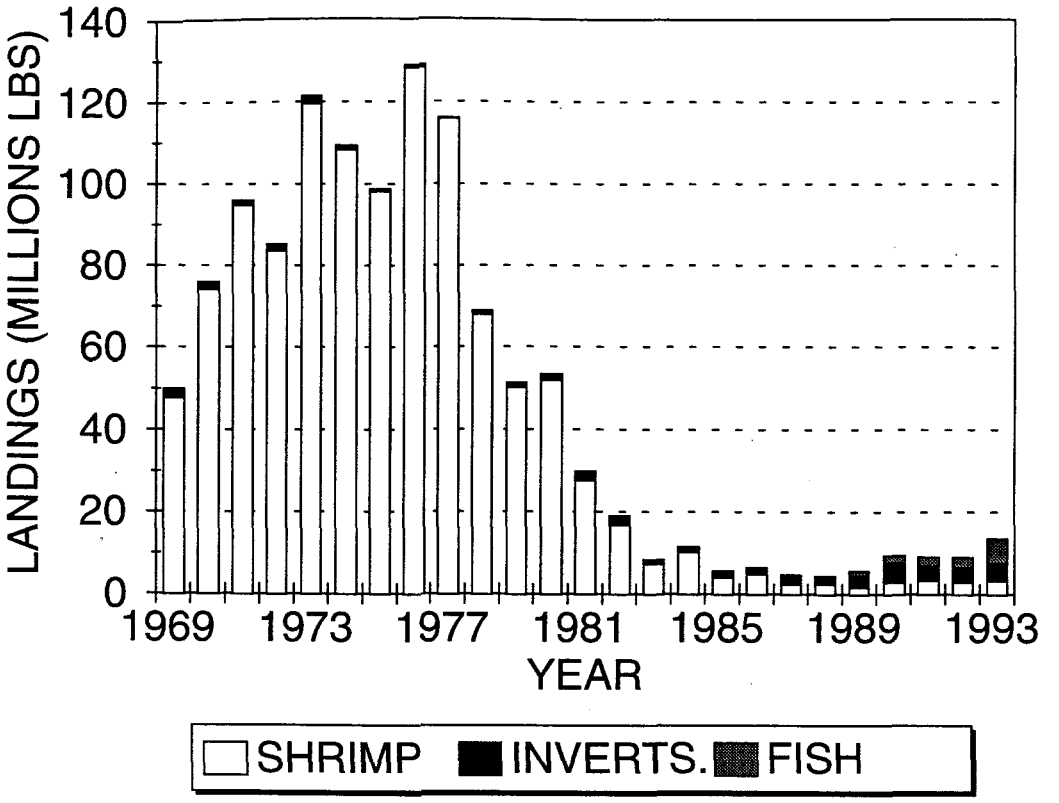

FIGURE 6. Alaska shoreside landings of "other species" of shrimp, invertebrates, and fishes during 1969–1993.

during 1969–1993 (Figure 6). Because these invertebrates dominate the landings of "other species," the remainder of this section focuses on these invertebrates.

Depending on the species, these invertebrates are harvested by a wide variety of gear, marketed in many product forms, and sold to either domestic or foreign markets or both. In declining order of mean percentage of the landings since 1969, these include shrimps (76.8%), scallops (10.9%), clams (4.5%), sea cucumbers (4.2%), sea urchins (1.6%), abalone (1.1%), octopus (0.6%), snails (0.2%), squid (<0.1%), coral (<0.1%), and oysters (<0.1%).

The species composition of landings from directed fisheries for other species have changed dramatically over time (Figure 6). For instance, in 1976, shrimp constituted 99.8% of these invertebrate landings, whereas shrimp constituted only 46.7% of these landings in 1993. This change is mostly due to crashes of pink shrimp stocks. Total shrimp landings dropped from a high of 129 million lb (58,500 mt) in 1976 to a low of 2 million lb (900 mt) in 1989. On the other hand, a number of new fisheries for invertebrates have developed in recent years. For example, from trivial landings in 1980 significant fisheries have developed for sea cucumbers (164,000 lb/74,400 kg), sea urchins (283,000 lb/128,000 kg) and snails (329,000 lb/149,000 kg) by 1993. In association with the loss of large shrimp fisheries and development of other invertebrate fisheries, there has been a shift from low-valued frozen or canned meat products to extremely high-valued fresh or live products. Fisheries for some of the most valuable invertebrates are described in greater detail as follows.

Shrimps

During 1969–1993, shrimp landings were comprised of: pink shrimp (*Pandalus borealis,* 88.0%), coonstripe shrimp (*Pandalus hypsinotus,* 5.2%), spot shrimp (*Pandalus platyceros,* 4.5%), sidestripe shrimp (*Pandalopsis dispar,* 2.3%), and humpy shrimp (*Pandalus goniurus,* <0.1%). The Alaska shrimp fishery began near Petersburg in 1915. Historically, large fisheries for pink shrimps were prosecuted in Kodiak and along the Aleutian Peninsula in the western Gulf of Alaska. Shrimps are harvested by trawl or pot gear. Pink, sidestripe, and humpy shrimps are caught almost exclusively by trawls. Otter trawls are the common trawl gear, although a beam trawl fishery has been prosecuted in Southeast Alaska for many years. Spot shrimp are caught in pots by fisheries primarily in Southeast Alaska and Prince William Sound and coonstripe shrimp are caught largely in a pot fishery in lower Cook Inlet. Most shrimp are shelled by mechanical peelers and processed into a frozen product by at-sea or shoreside processors. Much of the catch of spot, coonstripe, and sidestripe shrimps are sold as a live or fresh product to local Alaska and foreign markets.

Shrimp stocks are generally fully utilized. Causes of stock collapses of pink shrimp in Alaska have not been well studied nor fully explained. Bycatch has not been a very significant issue for shrimp trawl fisheries largely due to the current low level of directed fishing effort. However, marked increases in abundance of groundfish on historical shrimp fishing grounds during the past decade indicate a strong potential for future bycatch problems if shrimp stocks rebound in the future. To date, with rare exception, conflicts among commercial, sport, and subsistence users have been minimal. Small subsistence pot fisheries exist statewide.

Shrimp are managed by the State of Alaska. Major stocks are assessed by trawl surveys, and occasional pot surveys have been conducted in Prince William Sound for spot shrimp. Assessed stocks are managed by an exploitation rate strategy, and depressed stocks below a threshold are closed to fishing. Stocks lacking surveys are managed by adjusting harvest levels based on indicators of stock status obtained from fishery catch-per-unit-effort and changes in stock age composition and size frequencies.

Scallops

The primary scallop species harvested in Alaska is the weathervane scallop, *Patinopecten caurinus.* Small harvests of other species *(Chlamys* spp.) have also been taken in recent years. The scallop fishery was pioneered in 1967, and by 1969 landings of shucked meats were 1.85 million lb (839 mt). After 1970 landings declined dramatically, in part due to reduced scallop densities and the availability of more lucrative fishing opportunities. Since 1990 landings have exceeded 1 million lb (455 mt) annually. Historically, principal harvest areas were Kodiak and Yakutat, and to a lesser extent, Dutch Harbor. Recently, a large fishery in the Bering Sea has begun. Scallops are caught by vessels towing a pair of dredges identical to those used in the sea scallop *(Placopecten magellanicus)* fishery along the east coast of the U.S. Scallops are processed at sea and marketed as frozen meats largely to domestic markets.

Traditionally, the scallop fishery has been managed by the State of Alaska. Previously, catch levels were unregulated, but since 1993 catch quotas for traditional fishing areas have been set based on historical average catches. Adoption of a pending federal management plan will establish joint state-federal management. Whereas most management measures will be handled by the state, the

federal plan deals with a few major issues: a moratorium to stop recent growth in vessel participation, a fee collection program to fund onboard observers, and a permit system to ensure that all vessels comply with both state and federal regulations. Although there is potential for growth of the scallop fishery into new areas (e.g., Bering Sea) or for other species *(Chlamys)*, many scientists believe that weathervane scallops are generally fully exploited in Alaska.

Concerns exist about sustainability of scallop harvests due to the lack of stock assessments, low scallop biological production parameters, and the history of scallop overfishing worldwide. Concerns also exist about bycatch and habitat degradation by dredges. A number of scallop beds in crab or juvenile fish habitats remain permanently closed to scallop dredging, and the harvest of scallops in a number of management areas (e.g., western Gulf of Alaska and Bering Sea) has been curtailed by crab bycatch caps.

Sea Cucumbers and Urchins

Sea cucumbers and urchins are recently developing fisheries. The first commercial landings of urchins were made in 1980, whereas the sea cucumber fishery started in 1983. Harvests of urchins peaked at 468,000 lb (212 mt) in 1992, whereas sea cucumber harvests peaked at 220,000 lb (100 mt) in 1990. Sea cucumbers and urchins are handpicked by divers. Harvested species are the red sea cucumber *(Parastichopus californicus)* and the green *(Strongylocentrotus droebachiensis)* and red *(S. franciscanus)* sea urchin. Each species is widely distributed, but significant fisheries presently occur only in Southeast Alaska and Kodiak. In the case of sea cucumbers, animals are eviscerated at-sea by the divers, but they are still alive when delivered to shorebased processors. At the plant, sea cucumbers are processed by hand into frozen meats and dried skins for domestic and Asian markets.

In the case of sea urchins, live animals are delivered unprocessed to shorebased processors. In the case of green sea urchins, animals tend to be shipped live to Japan, whereas only the fresh roe of red sea urchins is shipped due to the large size of the whole animal. Roe is consumed as sushi in Japan.

The State of Alaska manages sea cucumbers and urchins. In Southeast Alaska sea cucumber abundance is assessed by three-year rotational surveys. Harvest is managed by a fixed, conservative exploitation rate. A similar approach is now being employed for sea urchins in Southeast Alaska. Elsewhere in the state, surveys are not conducted for these species. Instead, harvests are managed based on historical fishery performance.

There are a number of issues surrounding sea cucumber and urchin fisheries in Alaska. During the development of the sea cucumber fishery in Southeast Alaska, concerns existed about potential conflicts between subsistence and commercial harvesters. To a large degree, these conflicts have been addressed with the implementation of a fishery management plan that provides for conservative harvest rates in specific areas that for subsistence preference be closed to commercial harvest. Product quality is a major issue for the urchin fisheries, because sushi markets are very sensitive to roe color, texture, developmental stage, and freshness. Another issue has been escalating effort. Overfishing of stocks in other Pacific Coast states has led to reduced harvests and fishery closures. This has caused many participants from those fisheries to seek employment in developing fisheries in Alaska. Fishery sustainability is a major concern for sea cucumbers and urchins, particularly for

stocks that lack stock assessments. Urchin fisheries are also jeopardized by heavy predation from sea otters *(Enhydra lutris)* due to a marked increase in their abundance and distribution in Alaska.

Abalone

The principal commercial species of abalone in Alaska is the pinto abalone *(Haliotis kamtschatkana)*. Harvests are taken almost exclusively from Southeast Alaska. Alaskan Natives have a long history of harvesting abalone for food, trade, and shell ornaments. In the commercial fishery, abalone are handpicked by divers and delivered to shorebased or floating processors.

A sporadic fishery occurred from 1964 through 1976. By 1977 harvests were 180,000 lb (82 mt) live weight, and annual harvests exceeded 100,000 lb (45 mt) through 1982. Since 1983 landings have averaged only about 50,000 lb (23 mt). Abalone are considered a gourmet food and are often marketed in Japan.

Abalones are managed by the State of Alaska. No stock assessments are conducted and annual harvests are adjusted based on historical fishing success. The abalone fishery is currently fully exploited. Low catch rates suggest that abalone stocks are depressed, and it is generally recognized that stocks were overfished in the late 1970s and early 1980s. Allocation conflicts among commercial and subsistence users were significant during this period. Since that time, establishment of large commercial area closures have minimized allocation conflicts. However, as with the sea urchin, recolonization of Southeast Alaska by sea otters poses a serious threat to the future existence of an abalone fishery.

PROBLEMS, CONCERNS, OR OPPORTUNITIES

Presently, the greatest concern for Alaska fisheries is the potential for overharvest. Substantial stock declines impact not only the commercial fisheries but also have serious implications for indigenous peoples of Alaska who are dependent on fish for sustenance and maintenance of their culture. In 1990 there were about 265 rural villages which had a combined population of about 90,000. Although the average subsistence harvest per person is 118 kg per year, the average for communities most dependent on subsistence fishing is over 250 kg annually.

The history of overexploitation prior to statehood has made Alaskans very conscious of the need to conserve. Specific management measures are addressed under each fishery description above. Present record salmon returns show that Alaska has learned from past experience. With the improving knowledge of shellfish biology and some conducive environmental conditions, ADF&G is hopeful that new management approaches can bring about sustainable crab fisheries at some time in the future. Other opportunities for increased harvests include species not presently harvested directly — squid, smelts (including capelin), sharks, lampreys, hagfishes, and skates. This assumes conservative exploitation of these resources as well. Bycatch or discard of these and other species, a high-visibility issue, is addressed as pertinent within each major fishery section.

An associated issue is condition of Steller sea lion and Pacific harbor seal (*Phoca vitulina*) populations which have continued in a steep decline since the 1970s. The Steller sea lion, now classified as threatened under the ESA, will most likely be classified as endangered in the very near future. This more severe listing will mean even greater, but as yet undefined, restrictions on Alaska

fisheries, even though the cause of the decline for both of the pinnipeds is not known. Pollution and habitat degradation are not suspected. In general, habitat problems are localized and associated with urbanization and extractive resource activities such as mining and logging. The 1989 *Exxon Valdez* oil spill, which covered the central Gulf of Alaska, is an exception. Within northern Prince William Sound contamination of shellfish relied upon by villagers and continued low abundance of some fish and invertebrate populations (e.g,. herring, shrimp, crabs) remain problems. Although many resources are recovering, the long-term impact is as yet unknown and monitoring activities are continuing. Because healthy habitat is essential to sustained productivity of Alaska's fisheries, both the state and federal agencies have active permitting and monitoring programs. Balancing economic development against habitat protection will continue as a critical issue for Alaskans.

There are a multitude of other issues, including the preservation of subsistence use, the impacts of hatcheries and farms on wild fish stocks, future endangered classifications of bird, mammal, and fish species, and world market competition. These all present diverse and complex problems for Alaskans. The challenge is to learn from our prior mistakes while using the best analytical tools available and keeping an eye to the future.