Fisheries Management: An Historical Overview

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Introduction

At this 50th Anniversary of the Montlake Laboratory we have heard accounts of its role in studies of the fisheries resource and its environment, fishing and fishing methods, and utilization of the catch. Now we will explore the management of the fishery and marine mammal resources.

If we examine the history of these management practices, we can recognize at least three stages of development or goals: 1) To stop the decline and simply maintain the existing level of yield, 2) to determine, theoretically or empirically at least, the maximum sustainable biological yield and, most recently, 3) to extend the maximum biological yield to include the economic and social benefits as well. Each of these steps, in their time, were considered complex but are gradually being overcome through experience and the development of scientific knowledge. Yet to be resolved, however, are the added difficulties imposed by political pressure groups and legal decisions, all too frequently divorced from scientific fact or reason, and now broadly included within the concept of "social benefits" of the present goal of management.

Management of fisheries in the United States is quite different from that followed by most other countries: Here we have always considered that management of fisheries was a state's right and the jurisdiction of the Federal government has been generally limited to Territories, the high seas, and management under international treaty and/or administration and, in the case of salmon and certain other freshwater fishes, access and protection of fish in navigable waters. Needless to say, this fragmentation of management authority over fish and fisheries that share the waters of the several states or go beyond their coastal zones has been the source of innumerable conflicts between the states or between the states and the Federal government.

The United States Commission of Fish and Fisheries was established by law in 1871 with Spencer F. Baird of the Smithsonian Institution as its first Commissioner. By far, the greatest emphasis of the work of the Commission during its first years was directed toward the artificial propagation of food and game fish especially for the marine species along the New England coast. Billions of eggs were collected each year, incubated, and the young released in an effort to maintain the important fisheries of the United States. There were massive transplants made in those early years of American shad, *Alosa sapidissima*, and striped bass, *Morone saxatilis*, from the Atlantic to the Pacific coasts and, conversely, Pacific salmon, *Oncorhynchus* spp., trout, *Salmo* spp., from the west coast to the eastern streams. The scientific work of the Commission at that time generally centered around studies "to determine the best methods to be pursued in fish-culture, to ascertain the results of fish propagation and to study the habits, migrations, growth, food, enemies, and diseases of fish" (Brice 1898:138).

Although much of our early information on the fisheries of the Pacific coast came from the first surveys of the various salmon streams in a search for suitable locations for hatcheries, the Smithsonian Institution and the U.S. Commission of Fish and Fisheries undertook a comprehensive survey of the fish and fisheries of the United States, directed by Congress as a part of the 10th census (1880). The series of reports generated by the survey still provide a wealth of information on the histories of the various fisheries, their records of exploitation, and the early efforts at management.

David Starr Jordon, who was then President of Indiana University, was among the 19 scientists and experts chosen as associate authors for this survey by Spencer Baird of the commission and George Goode of the Smithsonian: These two and Jordan, along with Charles H. Gilbert, conducted the survey of "The Salmon Fishing and Canning Interests of the Pacific Coast" (Jordan and Gilbert, 1887). Soon afterwards, Leland Stanford University was founded at Palo Alto, Calif., and David Starr Jordan was appointed its first President. For nearly the next 50 years, the scientific investigations and the management activities of the U.S. Commission of Fish and Fisheries (and later, the U.S. Bureau of Fisheries) on the Pacific coast centered around Jordan, his faculty, and students at Stanford University.

The fishery research vessel *Albatross* was built by the U.S. Commission of Fish and Fisheries in 1882 initially for surveys along the Atlantic coast. In 1887 it was transferred to the Pacific coast and, for the next 25 years, was engaged in a wide variety of assignments extending across the North Pacific Ocean from

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California, Oregon, and Washington to the coasts of Japan and Russia and from the Pribilof Islands in the Bering Sea to the Hawaiian Islands.

It should be pointed out that the U.S. Commission of Fish and Fisheries (established in 1871) had little time to become actively involved in the management of the fisheries of the States of California (granted statehood in 1850) and Oregon (granted statehood in 1859), but the situation in Washington (granted statehood in 1889) was a little different: The salmon fishery began in 1877 while Washington was still a Territory and almost from the very beginning of the salmon fishery, there was conflict between U.S. and Canadian fishermen over the U.S. catch of sockeye salmon, *Oncorhynchus nerka*, that passed through U.S. waters on their way to spawn in the Fraser River which is almost completely within the Province of British Columbia.

The first attempt to resolve the conflict was through the International Joint Commission (United States and Canada), and the U.S. Commission of Fish and Fisheries was called upon to provide the Joint Commission with the appropriate background information and statistics. The U.S. Commission of Fish and Fisheries and its subsequent U.S. fishery agencies have continued to be plagued with the problems of international management of salmon fisheries for almost 100 years; and, although the organization of the International Pacific Salmon Fisheries Commission in 1937 took the pressure off the Fraser River sockeye and pink salmon, *O. gorbusca*, fisheries, conflicts over the other salmon species and areas continue to be a subject of negotiation between the two countries even at the present time.

Alaska was purchased from Russia in 1867 and Hawaii was annexed in 1900. Both remained Territories until statehood. While the coastal fisheries of Hawaii were of little importance, management of the fisheries of Alaska, however, was a completely different story. At the time of purchase, the United States inherited a very rich and developed northern fur seal, *Callorhinus ursinus*, industry—a resource that had provided the chief source of revenue to the Russian-American Company in Alaska, but the annual yield of which was already showing signs of serious depletion due to excessive kill. After about 2 years of private commercial sealing, the United States declared the Pribilof Islands a national preserve and the Federal Government assumed management of the fur seal resource in 1870.

The salmon fisheries began to show depletion within 20 years of the establishment of the first cannery in Alaska at Klawok (1877). The Pacific halibut, *Hippoglossus stenolepis*, fisheries began to decline in the early 1900's and the herring, *Clupea harengus pallasi*, fisheries in the 1930's.

These were the important fisheries of Alaska until statehood in 1959, and all have been the subject of a series of studies and recommendations, first by select groups of scientists from Stanford University, then by the organized research programs (such as the Pacific Fishery Investigations) at Stanford University and later at the Montlake laboratory, by the state agencies and universities, and by international fishery commissions.

Although the Federal government was relieved of its fishery management responsibilities for Alaska and Hawaii in 1959, the more recently enacted Marine Mammal Protection Act, the Endangered Species Act, and the Magnuson Fishery Management and Conservation Act of 1976 have placed broader and, in many ways, more difficult responsibilities within the Federal government's fishery laboratories and management organizations. It is the staff of the Northwest and Alaska Fisheries Center, with the heritage gained from the biological research conducted at the Seattle and Auke Bay Laboratories, that must now develop the scientific basis for policy and plans in the management of the fisheries within the 200-mile fishery conservation zones of the Pacific Northwest and Alaska, in other waters of the United States, and far beyond in response to international treaties and understandings.

Management of Fur Seals of the Pribilof Islands

The northern fur seal resource of the Pribilof Islands provides one of the earliest examples of successful management of an aquatic resource, especially in international management. It is an extremely valuable resource, attracting the attention of the early explorers from Russia, and the annual harvest provided the chief source of revenue for the Russian colonial government and the Russian-American Company during the 18th and 19th centuries.

Its history provides many examples of overkills and waste, the effects of severe environmental conditions (e.g., the extended ice conditions reported in 1834), problems of pelagic sealing and attempts at protection of the fur seals and international arbitration and, finally, the first international fishery management treaty by the United States. The author has taken the liberty of reprinting here, verbatim, the excellent description of the history of fur sealing by Baker et al., 1970: 2-4, 14-17).

"In 1742 Georg Wilhelm Steller drew up the first scientific description of the fur seal after he had survived the wreck of the vessel commanded by Vitus Bering off what is now called Bering Island in the Commander Islands, U.S.S.R. These islands are one of the three principal breeding grounds of the northern fur seal.

"In 1783 Gerassim Pribilof, navigator in the service of Imperial Russia, joined the search for other breeding grounds of the North Pacific fur seals. The Russians originally came to this area in search of sea otters, and here they found fur seals as well. Each spring the seals were seen to swim northward through the pass of the Aleutian Islands and disappear into the fog and mist of the Bering Sea. In 1786, 3 years after his search began, Pribilof came upon the islands that now bear his name and found fur seals along the beaches in seemingly uncountable numbers. Almost immediately the teeming rookeries became a source of sealskins for the fur markets of the world, at about the time the 13 colonies on the Atlantic coast of North America were forming a new nation. Today northern fur seals breed on the Pribilof Islands, St. Paul and St. George, in the eastern Bering Sea, the Commander Islands, Bering and Tuyleni, in

the western Bering Sea, and on Robben Island off Sakhalin Island. Small colonies have become established in the Kuril Islands between Kamchatka and Hokkaido and on San Miguel Island off California.

"Two years before the discovery of the Pribilof Islands, adventurous skippers from New England and Europe had discovered commercial possibilites in the great herds of fur seals along South American coasts, in Antarctica and off South Africa. Even though the Spaniards expelled British sealers from the Falkland Islands in 1770, the United States' first experimental cargo of 13,000 pelts from the Southern Hemisphere appears to have been taken at the Falklands in 1784 by the crew of the American vessel *States* from Boston.

"In the 50 years that followed, the fur seal rookeries on Islo Alejandro Selkirk (formerly Mas Afuera), Juan Fernandez, the South Shetlands, Prince Edward, the Antipodes, and many other islands were destroyed as fast as they were discovered. Literally millions of pelts were taken to the Canton market to trade for tea, silks, and other products of China. The populations of fur seals south of the equator were rapidly decimated. Some herds survived, however, and still live off the coasts of South Africa, South America, Australia, New Zealand, the Galapagos Islands, and some of the subantarctic islands.

"The exploitation of the Alaska herd at first followed the same destructive methods as those pursued by sealers in the southern seas. Twice during the Russian administration the herd on the Pribilof Islands was threatened by annihilation: First, through failure to restrict the numbers of seals killed, and later by failure to give the females adequate protection. Russia forbade the killing of females after 1834, but according to H. W. Elliott the ruling was not enforced until 1847. Elliott was told about a wall of ice that prevented the females from landing on St. Paul Island and forced them to bring forth their pups in the water of the storm-tossed surf, which killed many of the mothers and most of the pups. The truth about this catastrophe and the condition of the seal population in 1836 cannot be verified. By 1867, when Alaska was purchased, the seal herd was reported to be thriving.

"After the purchase of Alaska by the United States, Congress passed legislation to protect the future seals of the Pribilof Islands from reckless slaughter. A number of independent companies had begun sealing on the islands and had taken about 300,000 skins the first season. To prevent this destruction, an Act of Congress of 27 July 1868 prohibited the killing of fur seals, and on 3 March 1869 the islands were set aside by the U.S. Government as a special reservation for the protection of the animals. Only local natives were allowed to kill fur seals, and then only for food. A year later the U.S. Treasury Department was authorized to lease exclusive rights to take seals on the islands, with the stipulation that no females were to be taken. Further legislation in 1874 authorized the Secretary of the Treasury to establish catch quotas and open seasons for the lessee.

"Fur seals are vulnerable to capture while at sea as well as on land. Pelagic sealing, or taking of fur seals at sea, began to develop on a commercial scale about 1879. As practiced extensively by American, Canadian, and Japanese sealers in the North Pacific, pelagic sealing resulted in the indiscriminate killing of the seals, without regard to age, sex, or the number taken. The pelagic take of sealskins reached a peak of 61,838 in 1894.

"In 1870 the Alaska Commercial Company, composed of several sealing competitors who had compromised in 1868 to gain control of the resource, was awarded the United States' first 20-year contract to seal on the Pribilof Islands. Under the first 20-year lease, the Alaska Commercial Company took 1,977,377 sealskins. Under a second 20-year lease (to the North American Commercial Company), only 342,651 sealskins were taken in the period ending in 1909. The leasing system was discontinued in 1910, and since then the Alaska fur seal herd has been under the management of the Federal government, first by the Secretary of Commerce through the former Bureau of Fisheries and now[1] by the Secretary of the Interior through the Bureau of Commercial Fisheries of the U.S. Fish and Wildlife Service.

"Early pelagic sealing had a devastating effect upon the fur seal herd. Almost a million skins were taken on the high seas from 1879 to 1909, and many of the seals shot or speared in the open sea were not recovered. The effect on the Alaska herd was disastrous, because females made up 60 to 80 percent of the pelagic catch. In 1912, when the first complete census was taken by David Starr Jordon and George A. Clark, 215,900 seals were counted or estimated on the Pribilof Islands. Although scientists believe this estimate was too low, the Pribilof herd had undoubtedly been reduced severely, and the smaller herds off the Pacific Asian coast were faced with extinction.

"After extended diplomatic negotiations and a long series of ineffectual bilateral agreements, the United States, Great Britain (for Canada), Japan, and Russia concluded a Convention on 7 July 1911, for the protection of the fur seals of the North Pacific. Pelagic sealing was prohibited except by aborigines with primitive weapons. Each country with fur seal rookeries agreed to share 30 percent of its annual take of sealskins—Canada and Japan each to receive 15 percent of the sealskins from the Pribilof Islands and the 15 percent of those from the Commander Islands; and Canada, Russia, and the United States each to receive 10 percent of the pelts from Robben Island.

"Worldwide political events affected the international agreements protecting the fur seals. The convention of 1911 provided for the first time a sound basis for the management of the North Pacific fur seals. It remained in force for 30 years, until terminated by Japan on 23 October 1941. From 1942 to 1957 the Pribilof herd was protected by a provisional agreement between Canada and the United States, which reserved to Canada 20 percent of the skins taken each summer on the Pribilof Islands. As a result of World War II, control of Robben Island and the Kuril Islands passed from Japan to the Soviet Union, giving

[1]Fur seals are now managed by the National Marine Fisheries Service, NOAA, U.S. Department of Commerce.

the U.S.S.R. complete control of all fur seal rookeries off the Asian coast.

"On 9 February 1957, a new interim North Pacific Fur Seal Convention was concluded by Canada, Japan, the Union of Soviet Socialist Republics, and the United States, similar in form to the 1911 Convention. The new convention, as amended by a protocol in 1963, has as its principal objective the achievement of maximum sustainable yields of fur seals in the North Pacific. It provides for a Fur Seal Commission comprised of representatives of the four Governments to coordinate research and management for the northern fur seal. It also provides that Canada and Japan each shall receive 15 percent of the sealskins taken commercially by the United States and the U.S.S.R.

"The Fur Seal Act of 1966 (Public Law 89-702) puts into effect domestically the international convention. It provides for the conservation and protection of the fur seal and sea otter and for the administration of the Pribilof Islands.

"Under international protection and rational management, the Alaska fur seal herd has increased from the low point of about 216,000 animals in 1912 to its present level of over 1¼ million animals. From 1940 to 1967 the herd has provided an average 59,758 male sealskins. Since 1958, over 738,000 have been harvested or taken for research under management policies approved by the North Pacific Fur Seal Commission." [Pages 2-4.]

"Fur seal habits are such that a program of wise utilization is readily devised; however, the success of the program depends on international cooperation because the seals live much of the time outside territorial waters. In Alaska, with few exceptions, fur seals come ashore only on the Pribilof Islands, always about the same date each year. Because seals are highly polygamous and the sexes are born in equal numbers, it is possible to take many males without adversely affecting the productivity of the herd. The young males, whose pelts are most valuable, habitually haul out on the islands apart from the breeding animals in the harems, so they are easily obtained.

"Seal measurements guide biologists in selecting seals to harvest. Harvesting of the seals is limited for the most part to the 3- and 4-year-old males. In 1918, the U.S. Government determined age-length relation from measurements of seals of known age, branded as pups in 1912. Until recently this age-length relation has served as the basis for selecting animals that are now classified into age categories by counting the annular ridges on canine teeth from a 20- to 30-percent sample. Also the overlap of lengths between ages is better understood through extensive recent measurements of tagged seals.

"The number of seals killed each year has varied for a number of reasons. From 1911 to 1917, seals were killed only by the residents of the Pribilof Islands to use as food. Commercial killing for skins was resumed in 1918 after the 1-year cessation. From 1918 to 1922, harvests of seals were high in relation to population size because of the accumulation of males. The kill declined after the excess males were removed, but thereafter steadily increased until 1940. From 1940 to 1955 it averaged about 66,000 males annually. Since then, the kill of males has varied from a high of 96,000 in 1956 to a low of 30,000 in 1959. Part of the difference between these extremes resulted from an extended season in 1956 which made available a larger proportion of the 3-year-old group, but recent fluctuations are caused primarily by variations in year class survival.

"In managing the fur seal herd, the Federal Government has adhered to a policy of taking pelts from seals considered surplus to breeding requirements. From 1923 to 1932, a minimum yearly breeding reserve of several thousand bachelors was provided by marking them with a brand or by shearing a patch of fur, then permitting them to return to sea. This precaution may not have been necessary but it ensured that the number of males escaping the kill would be adequate.

"From 1932 to 1955, a sufficient breeding stock was assured by limiting the killing season each year to a period from about the middle of June to the end of July. Only the male seals 41 to 45 inches (104-114 cm) long were taken as they appeared in the daily drives on the islands during the sealing season. From one-half to two-thirds of the animals in this group are 3 years old, and most of the remainder are 4 years old; a small number of 2- and 5-year-old males are included. The proportion of 3- and 4-year-old animals taken depends on the relative survival of year classes.

"In recent years Bureau of Commercial Fisheries managers have adjusted the sealing season to the number of young males that are available and to some extent to the age and size of seals that they wish to harvest. Early seasons produce a larger proportion of 4-year-old seals and later seasons a larger proportion of 3-year-old seals, because the older ones arrive earlier. The seasons for male seals now begins in late June and ends on 31 July. Close cropping of 3-year-old seals during a late season leaves relatively few 4-year-old males to be taken early in the following year. Forecasts of year class strength made before the 3-year-old seals appear in the kill are still in the process of development. The forecasts are based largely on averages. They give usefully accurate information in an average year but have not been satisfactory on a very strong or weak year class.

"Biologists consider the number of males that have been escaping the kill more than adequate, and, as a result, the upper size limit of harvestable male seals has been increased recently. This change permits closer cropping by taking animals that would have been rejected solely because of size under the former limit even though they had skins of good quality." [Pages 14-16.]

"On their respective islands the United States and the U.S.S.R. carry on research programs that emphasize population dynamics. Tagging, tag recovery, kill records by age and sex, and studies of mortality and reproduction are all essential for understanding fur seal populations. In addition, research on growth, pelage and other anatomical features, behavior, and parasitism and other infections are underway or completed. As knowledge of population dynamics accumulates, the probability increases that we can successfully forecast year class survival and the resulting harvest.

"Canada, Japan, the U.S.S.R., and the United States cooperate in a widespread investigation of the ocean life of fur seals. The distribution, ocean abundance, food habits, and intermingling of seals of different origins are studied. Most of the investigations aid management; in addition, certain broad principles of animal populations are being tested and zoological knowledge of marine mammals is being increased.

"Many seals are now held and studied in captivity. Studies are expanding on specialized aspects of seal biology. Scientists not employed by the Federal Government are expanding their specialized studies on seals." [Pages 16-17.]

Management of the Three Important Fisheries

Most of the history associated with the development of fishery management and research along the Pacific coast has been confined to salmon, halibut, and herring. In the very early years of the Pacific coast fisheries, Pacific cod, *Gadus macrocephalus*, was probably the target species that soon evolved into the halibut fishery. In more recent years, we have seen the development of very important pink shrimp, *Pandulus borealis*; king crab, *Paralithodes camtschatica*; and snow (Tanner) crab, *Chionoecetes tanneri*, fisheries in Alaska. There are numerous local, coastal fisheries which are important to certain communities or to a state but lack either the history or the volume and value of salmon, halibut, and herring. Furthermore, the general pattern of development of the salmon, halibut, and herring fisheries is similar and can be divided into the four characteristic periods described below.

Pre-1850

Subsistence fisheries, using primitive methods of fishing and preservation were limited to certain rivers and streams and to the immediate coastal waters. During this period, we see the first probes into the commercialization of the fisheries: There was barter for salmon between the Indian nations and tribes and between the early trading posts and settlers along the Fraser, Columbia, and other rivers in the Pacific Northwest. Near the end of this period, we also find the beginning of the export trade in salt salmon from Sitka to Moscow and western Russia and From Fort Langley (Fraser River) and the San Juan Islands (Puget Sound) to the Hawaiian Islands and the growing imports of salt needed to process the fish. The Russian-American Company at Sitka also depended upon fresh/salt herring and on halibut as part of their subsistence diet.

Although fishing rights at certain favorite places were recognized and the source of frequent intertribal conflict during periods of scarcity (and there were periods of scarcity of fish as well as famine), management per se was not practiced during this early period.

1850-1880

Exploration of our fisheries was associated with the discovery of gold in California, the rapid growth of the population in California, Oregon, and Washington and the purchase of Alaska from Russia. To satisfy the demand for food, numerous salteries for salmon and other fish were established along the Pacific coast. The first salmon canneries were started on the Sacremento River in 1858, on the Columbia River in 1866, and in southeastern Alaska in 1877 or 1878. The first U.S. deep-sea fishery in the North Pacific for cod and halibut began operating out of San Francisco in 1857 and, at about the same time, the United States negotiated with Russia on its first international fishery treaty in the Pacific area which provided for landing rights in the Aleutian Islands for its cod vessels and whalers operating in the area. Attempts were also made during this period to ship fresh halibut from Victoria, B.C., to San Francisco (but this was not too successful).

California was granted statehood in 1850 and Oregon in 1859. Soon thereafter, the first legislation was passed by these states to manage their fisheries, generally aimed at protecting the runs of salmon during their migration up the rivers and on the spawning grounds.

It was during this period that the United States established the Commission of Fish and Fisheries (1871) and, in 1875, established the first Pacific salmon hatchery on the McCloud River in California. The laws also encouraged the establishment of private hatcheries on the Clackamas River (1877) and the Rogue River (1878); both were operated originally by the Oregon-Washington Propagation Company under contract to the Oregon Fish Commission. Some of the first information on the salmon and other fisheries along the Pacific coast was found in the reports of the early investigators searching for suitable hatchery sites in the various areas.

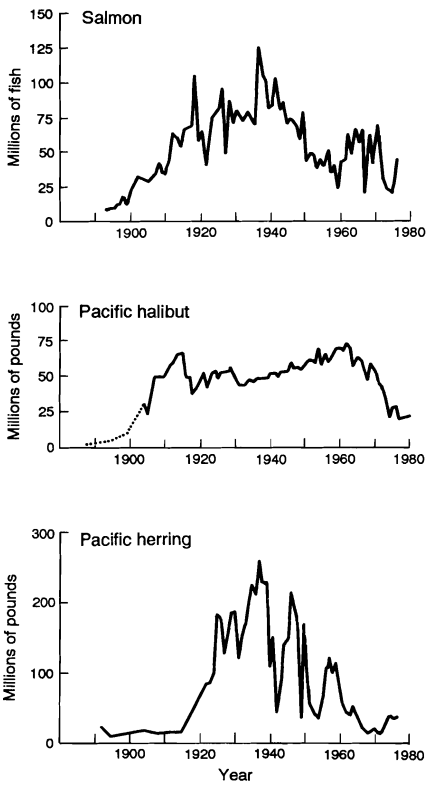

Figure 1.—Annual catch of salmon (Alaska only), Pacific halibut (United States and Canada), and Pacific herring.

1880-1919

Exploitation of the salmon, halibut, and herring fisheries along the Pacific coast states and Alaska and the growth of these fisheries is illustrated in Figure 1. The beginning of this period is marked by the first comprehensive survey of the fisheries of the United States as part of the 1880 census. The number of salmon canneries grew from about 40 canneries in 1880 to a near maximum number of 189 in 1919, and a maximum pack of

canned salmon of 8.5 million cases were filled in 1917.

The commercial halibut fishery began about 1888 with three boats and increased to a maximum number of 18 "steamers" by 1913, then declined to 9 in 1919; the catch reached a peak of 68.8 million pounds in 1915 (U.S. and Canadian vessels) and fell to 38.0 and 40.5 million pounds in 1918 and 1919, respectively.

The first information on the extent of the commercial herring fisheries along the Pacific coast appeared in 1882, amounting to a little more than 3 million pounds for that year, increasing to and fluctuating between about 6 and 32 million pounds, until the development of the popular "scotch cure" method of preservation in 1917. There was an increase in landings to 48 and 38 million pounds in 1918 and 1919, respectively, and rapid rise in catches in the years thereafter.

The rapid development of the fisheries during this period is related to: 1) The growth in population along the Pacific coast and 2) the introduction of a number of technological improvements into the fishing industry. For example, in the State of Washington the population grew from about 75,000 in 1880 to about 1,400,000 in 1920—a twentyfold increase in the 40-year period. Much of the growth in population and the resulting commerce was associated with the completion of the transcontinental railroads: The Canadian pacific in 1885, the Northern Pacific in 1887/1888, the Great Northern in 1893, and other railroads that followed. Gold was discovered in Alaska in 1889, firmly establishing Seattle as the "Gateway to Alaska," and many businesses operating in Alaska worked out of Seattle.

With the growth in population came the effects of industrialization, especially upon the salmon streams of California, Oregon, and Washington. Many of the runs were destroyed by destructive logging and mining practices, frequently blocking the migration of salmon by dams along with the scouring or silting of the spawning areas. Similarly, the first hydroelectric and irrigation projects were completed during this period and many streams were further blocked by the dumping of rocks from road and railroad construction into their channels. Salmon were rarely considered in the development of the various water-use projects—after all, what's one stream among the hundreds that were available to salmon at that time—yet now, when you add them all up, the cumulative losses must have caused a very serious reduction in the salmon fisheries in these states.

There was considerable destruction of the herring runs in California, Oregon, and Washington due to the loss of spawning beaches but fortunately in Alaska, both the salmon and herring fisheries generally escaped the effects of industry and population growth during this period. Halibut, of course, live in the ocean far from shore and would not be affected by these kinds of land-based activities.

There was little change during this period in the methods used to fish for salmon. The fishery in the Sacramento River used gill nets fishing from sail or row boats: It is interesting to note that the salmon fishery of Bristol Bay, Alaska, depended for many years upon fishermen from the San Francisco area and the same type of fishery was used up until the middle or late 1950's. Pile-driven traps were introduced into the Columbia River and Puget Sound salmon fisheries in 1879-80; soon afterwards, in 1885, pile-driven traps were introduced into Cook Inlet, Alaska—followed in 1907 by the development of a floating trap. Both the pile-driven and floating traps were found to be efficient types of gear and remained the dominant fishery throughout this period.

Halibut were taken by baited longline, setting the gear from dories—a method introduced from the east coast. However, in 1889 the first halibut was shipped to the east coast by rail and as the market developed and the demand grew, the fishery, which was originally confined to the coastal and inside waters of British Columbia and southeastern Alaska, began to gradually expand farther offshore. The extension of the fishery was closely associated with: 1) A shift from the sailing schooners to "steamers," 2) the availability of ice and cold storage plants (1892 to about 1905), especially in Alaska, and 3) the depletion of the halibut stocks in the coastal waters. The year 1910 is generally recognized as the birthdate of the deep-sea halibut fishery (Thompson and Freeman, 1930).

The early herring fishery employed a Norwegian method of seining from oar-propelled seine boats, but in the early 1900's, the western-style purse seine was first used in the herring fishery and gradually replaced the Norwegian-style gear, totaling 6 or 8 vessels in southeastern Alaska by 1919 and about 10 vessels in Prince William Sound. The growth of the herring fishery in Alaska is due to the European demand for edible herring during World War I and the introduction of the "salt cure" method of processing to meet that demand (note that in 1917, the U.S. Bureau of Fisheries sent Aug. H. D. Klie and several assistants (including Clarence Anderson) to Alaska to introduce the Scottish method of curing herring) (Rounsefell, 1931; Rousefell and Dahlgren, 1932).

The first efforts at the management of the fisheries occurred during this period. First, of course, Oregon and California were already states and, in 1889, statehood was granted to Washington; appropriate agencies were later established in the state governments to manage their fisheries.

In 1888, U.S. legislation was enacted providing for the U.S. Commissioner of Fish and Fisheries to be a salaried officer (instead of on-loan from the Smithsonian Institution) and restating the duties of the Commission, namely: Survey the aquatic resources of the United States, describe and develop methods of fishing, collect statistics of the fisheries, and engage in artificial propagation fish to maintain the fishery resources.

In the next year (1889), the Alaska Salmon Fisheries Act was passed to protect the salmon fisheries of Alaska. At that time, a favorite method of taking salmon in Alaska was to place a weir or other barricade in the stream (a method ommonly used by the Indians) which prevented the salmon from reaching their spawning grounds. The Act specifically prohibited the erection of dams or other obstructions on salmon streams and directed the Commission to

further investigate the salmon fisheries of Alaska.

As a result of the investigations, the Act was amended in 1896 and again in 1900, prohibiting fishing in streams above tidewater and providing for closed areas, fishing seasons, and gear restrictions (but only after public hearings) and provided for fines or other penalties for violations.

In 1900, the Act of 1896 was further amended to require that each sockeye salmon cannery in Alaska establish and operate a salmon hatchery, releasing each year four times the number of young as were taken as adults from the stream the previous year, i.e., brood year. The law was a disaster in many ways: There was no effective way to enforce the law nor to verify the accuracy of the "plants" made by most of the canneries. But, perhaps most tragic was that most of the young sockeye salmon were generally released directly into the saltwater bays or lagoons when the life history of the species (unknown at the time) required that all juveniles spend at least 1 year in a freshwater lake before migrating to sea. Thus, even for those canneries that were trying to satisfy the law (such as the one at Karluk) the returns were nil.

In 1903, the Department of Commerce was established and the functions of the U.S. Commission of Fish and Fisheries were transferred from the Treasury Department to the Bureau of Fisheries. Shortly before this reorganization, however, a Special Commission was appointed by President Theodore Roosevelt to investigate the condition of the Alaska salmon fisheries and to make appropriate recommendations for management of the fisheries. David Starr Jordan was appointed to head this study.

The recommendations from the Special Commission only reiterated the position of the Commission of Fish and Fisheries which was adopted almost at the time of its inception in 1871: Namely, the need for artificial propagation as the primary means of maintaining the various fisheries of the United States. Thus, an Act was approved in March 1905 establishing one or more Federal salmon hatcheries in Alaska: A hatchery was established that same year at Yes Bay (McDonald Lake) in southeastern Alaska, and in 1907 a second hatchery began operating near Litnik Bay on Afognak Island. In addition to these two Federal hatcheries, six private hatcheries operated in Alaska, and 44 operated in California, Oregon, Washington, and Alaska. By 1915, the total number of salmon hatcheries along the Pacific coast (including Alaska) was 62.

The report sparked several other actions by Congress. The Alaska Salmon Fisheries Act of 1906 established the first license tax on salmon landings but, perhaps more important, the Act also provided for a tax rebate to those companies operating salmon hatcheries and, if anything, only aggravated the damage that was already being inflicted upon the salmon runs where hatcheries had been established by the local canneries. Other legislation was enacted to prohibit aliens from fishing in Alaska; this was the aftermath of an attempt by a Japanese company to establish salmon salteries on Attu or Agattu Islands in the early 1900's.

As we review the history of fishery management during this period, we are impressed by the direction of the work by some of the most qualified people of that time—scientists like Baird, Goode, and Bean from the Smithsonian or the National Museum; Jordan, Gilbert, Evermann, and Snyder from Stanford University; and Cobb, who later established the College of Fisheries at the University of Washington—but their recommendations and decisions were generally based upon "common sense" theory and not fact and were frequently marked by disaster because of the lack of knowlege. The scientists knew this, and thus, in the early 1900's, we find the beginning of biological studies directly related to problems of management.

Fred Chamberlain of the Bureau of Fisheries undertook the first marking experiments on salmon in 1903 in southeastern Alaska. Here, both ventral fins were removed in order to determine the age and place of return of the marked fish. Most of the fish came back at ages 4, 5, and 6, but some returns were reported from Karluk and other distant areas, apparently from fish with "naturally" missing fins.

In addition to the initial studies by Chamberlain, a similar marking study was made at Klawak cannery/hatchery in 1907, at Quadra Hatchery in 1911, and no doubt there were others. A notice was issued in 1908 requiring written permission of the U.S. Commissioner of Fish and Fisheries or his agent in Alaska before a company release marked salmon from their hatcheries.

The scientists who were engaged in the studies and management of the Alaskan salmon fisheries were soon to recognize the need to know the desired ratio between catch and escapement, i.e., how many salmon should be reserved from the run to assure that the future runs of salmon might be maintained and expanded. In 1908, the Wood and Nushagak Rivers were closed to commercial fisheries and a joint investigation was begun by the U.S. Bureau of Fisheries, the Alaska Packers Association, and the Alaska-Portland Packers Association with a controlled catch and a weir to count the number of sockeye salmon escaping into the Wood River system and to get estimates of the numbers of salmon that entered the Snake and Igushik Rivers.

The results of these studies indicated that in the Nushagak, at least, the fishery normally took an average of 69 percent of the total run (range, 64-75 percent). Thus, an escapement of 50 percent of the run to the spawning areas should be reasonably sufficient to rebuild the depleted salmon runs and to maintain them. This was the concept later adopted in the White Act (1924).

These studies were continued until 1919 when Charles H. Gilbert, who had been in charge of the Alaskan studies since about 1909, decided that additional information would be desirable from other areas, and the work was transferred to Chignik and Karluk.

The other important series of studies begun during this period was the determination of the age of salmon by Gilbert (1913), who first used the scales of fish collected from the Columbia and Fraser Rivers. Within the next few years he and his assistants expanded the collections to include the various runs of sockeye salmon in Alaska as well. The age determination techniques developed by Gilbert were soon adopted by other scien-

tists working on Pacific salmon and provided an understanding of the cyclic patterns of the returns of salmon and a major advance in the management of the fisheries.

There was little interest by the government agencies either in the management or research on the herring fisheries of Alaska and probably elsewhere along the Pacific coast as well. The story was different, however, for the halibut fisheries. In 1915, W. F. Thompson, one of Jordan's students from Stanford University, began his investigations of the halibut fisheries of the North Pacific (Thompson, 1916a, b; 1917); one of his reports dealt with the life history of the halibut, one with the statistics of the fishery, and the third with protective measures needed to maintain the fisheries.

Although there had been previous investigations of the salmon fisheries of Alaska and the Pacific coast, these studies on the halibut were, in many ways, the first scientific studies made on a Pacific coast fisheries aimed at management of the fisheries. They showed quite conclusively that there was a serious decline in the abundance of halibut with a shift in the fisheries away from the coastal areas to maintain their catches. The studies supported the efforts by the industry for a 3-month closure of the fishery in winter during the spawning period and pointed out that such a closure was not really sufficient to stop the decline and other conservation measures were necessary (Thompson and Freeman, 1930).

There followed the introduction of U.S. legislation providing for both the closed season and for a nursery area, to become effective upon similar action by the Canadian Government. It failed to pass the House.

Shortly thereafter (in 1918), the problems of international management of the halibut fisheries (along with similar problems of management of the Fraser River sockeye salmon fisheries in Puget Sound/Gulf of Georgia) were submitted to a joint commission. The action, taken as a wartime agreement, facilitated the entry of United States and Canadian vessels into the ports of both countries, but offered no provisions for conservation of the halibut fisheries. The agreement was terminated in 1921.

1920-1945

In this period, the following events took place: Expansion of the salmon and herring fisheries and all-time record catches of 1936 and subsequent declines, recovery of the halibut fisheries under international management, elimination of salmon traps on the Columbia River and in Puget Sound, initiation of the comprehensive water development projects on the Columbia and Sacramento Reivers, establishment of fishery research programs and initiation of fishery management programs based on the results of research, boom years of the 1920's, Depression of the 1930's, and World War II.

During this period, the catch of salmon in the Pacific coast states an Alaska increased from about 50 million fish in 1921, to a peak of 139 million in 1936, and subsequently declined to a level of 75-90 million fish during the war years of 1942-45. Over 90 percent of the catch was made in Alaska: During the same period, the number of canneries increased from about 127 in 1921 to a peak of 202 in Alaska, Puget Sound, and the Columbia River in 1929, and then declined to an average of 109 during the war years of 1942-45.

The halibut landings increased from 46.9 million pounds in 1920 to a peak of 56.9 million pounds in the "crash" year of 1929 followed by a sharp decline to 44.2 million pounds as the fishery came under international regulation and a gradual recovery to some 53.9 million pounds in 1945; the first accurate information on the number of regular halibut vessels fishing appeared in 1930 with a total of 378 vessels plus 100 to 125 "small" boats. By 1945, the number had increased to 591 regular vessels and about 400 to 500 "small" boats.

The catch from the herring fishery increased from a low of 37.7 million pounds in 1921 to 263.2 million pounds in 1937. It then declined to only 46.3 million pounds in 1942 and recovered to 153.7 million pounds in 1945—again, similar to the salmon fisheries; almost all of the herring was taken in Alaska, mainly southeastern and central. The number of vessels operating in the fishery increased during this period from about 16 in 1921-22 to 80 in 1927, then declined to only 15 in 1942 (the early years of World War II), and subsequently recovered to 38 in 1945. Much of the fluctuation in catch is believed to be due to the wide variation in survival of herring, especially in the earlier stages of life, and not closely related to fishing effort.

The most significant change in the method of fishing for salmon occurred in 1935 with the passage of Initiative 77 by the Washington State Legislature which eliminated all fixed gear, i.e., traps and set nets, from state waters and divided the Puget Sound fishing area into two areas—an inner area mainly reserved for gill nets and the outer area for all remaining legal gear, i.e., purse seines, etc. Shortly thereafter, the expected happened: The number of both gill nets and purse seines immediately increased as a replacement for the traps.

The herring fishery remained predominantly purse seine and the halibut fishery, set line. This period is also marked by a rapid expansion of the motorization of the fleets. For example, diesel power which was introduced into the fishing fleet near the end of the previous period had not been very successful, and it was not until after World War II that diesel engines became common in the various fishing fleets, providing the necessary power for the large herring purse seiners and the range and efficiency necessary for the distant-water halibut fishery.

Although there had been a number of attempts towards management of the fisheries along the Pacific coast, these efforts were generally not as successful; this was attributed to the lack of knowledge about the life histories of the fish and the relative abundance of the various stocks of those fish. However, at the beginning of this period, the research that had been started some 10 or 15 years earlier began to mature and provide a basis for what we might now call "scientific fishery management."

In 1922, action was taken by Presidential Executive Order to create fishery reservations on the Alaska Peninsula and in southwestern Alaska, to define

districts and zones within these reservations and to issue permits to operate with limitations on the size and mesh of the gear operated, the number of operations, and the size of the pack. Steven Pennoyer points out that this action was strongly opposed by the Alaskan residents as the salmon fisheries at that time were basically controlled by the canneries (with their own boats and permits) and the only way in which an "outsider" could enter the fishery was to become a tenant of the cannery (Pennoyer, 1979).

The White Act of 1924 (an Act for the Protection of the Fisheries of Alaska, and for Other Purposes (6 June 1924)) was perhaps the most significant development in the management of the salmon fisheries of Alaska during this period. This Act provided, in part that: 1) All salmon streams in Alaska would be weired, or adapted by some other means, in such a manner that the number of salmon migrating upstream could be counted with accuracy and that an escapement of at least 50 percent of the total run must be attained, 2) no salmon would be taken by the commercial fisheries during a 36-hour weekend closure (except for personal use), 3) violators of this Act or of the Act of 1906 would be punished by a fine not exceeding $5,000 or jailed for 90 days, or both, and 4) that designated employees of the Bureau of Fisheries enforce the provisions of the Act, in addition to the U.S. Marshalls.

Although the prescribed escapements were based upon the recommendations of Gilbert's experiences at the Wood River weir site and the Act did provide for greater means of enforcement and heavier penalties, it was soon found that the Act was impossible to enforce, especially the necessary escapement counts to define the 50 percent level. Nevertheless, this policy remained basically in effect until statehood in 1959.

Even though the total catch of salmon continued to increase until after the peak of 1936, it became increasingly apparent that many of the individual stocks were disappearing because of overfishing or other causes and there was increasing pressure from the industry for more effective management of the salmon fisheries in Alaska. In 1939, the Commissioner of Fisheries resigned. The Bureau of Fisheries was transferred to the Department of the Interior and merged with the Biological Survey to form the Fish and Wildlife Service.

All of the salmon management problems, however, were not confined to Alaska. Since the late 1800's, there had been a series of disputes between U.S. and Canadian fishermen over the regulation of the catch of sockeye salmon returning to the Fraser River of British Columbia by the fisheries in Puget Sound and the Gulf of Georgia. This was an international problem which involved a decrease in the production from this run of some 2.4 million sockeye salmon in 1913 to only 0.2 million salmon in the cycle year of 1933.

A Treaty was negotiated between Canada and the United States in 1930 but was not ratified by the two countries until 1937. The Treaty provided for an international scientific staff to make the necessary studies and 8 years of investigation before the Commission could begin regulation of the fishery. It is of interest to note that the Commission soon found that the cause of decline was not overfishing but an obstruction caused by the residue from a massive rock slide at Hell's Gate in the Fraser River canyon during construction of the Canadian National Railroad in 1911.

A similar crisis arose in the salmon fisheries of the Columbia River from the construction of the Rock Island Dam near Wenatchee by a private utility company (fishways completed in 1932) and from the development of plans by the U.S. Army Corps of Engineers for the construction of 10 multipurpose dams on the river that were presented in their "308 Report" (1932). These were the Depression years and the first two dams, at Bonneville and Grand Coulee, were started late in 1933 as Public Works Administration projects and completed in about 1938.

In one sense, Bonneville Dam was most critical since it was the first major obstruction to the passage of salmon on the Columbia River, and ways had to be found to successfully pass salmon over the dam or the very valuable salmon fisheries of the Columbia would be virtually lost. In other ways, the problems at Grand Coulee Dam were equally difficult: The dam would be about 350 feet in height and believed to be too high to even consider ways to pass salmon over the dam, and thus the very extensive "up-river runs" that were blocked by the dam had to be collected and transplanted to new "home streams" below the dam Both of these projects were firsts in the management of the salmon fisheries and placed new and important responsibilities on the state and Federal management agencies.

If we examine the management of fisheries (excluding fur seals as a different type of management problem), the first and probably the best example of marine fishery management by any agency is found in the work of the International Fisheries Commission (later, the International Pacific Halibut Commission). There was, of course, a decline in the fishery throughout the early 1900's and a growing concern for the fishery by U.S. and Canadian fishermen who shared the remaining profitable fishing grounds in the more and more distant waters from port. Key elements, however, in the eventual management of the fishery, as pointed out in the previous section, were the results of the early studies by W. F. Thompson—one of Jordan's students from Stanford University.

The first efforts at international control in 1919 failed to be approved by the two countries, but in 1922 a second draft, which confined the work of the Commission to investigations and limited regulation of the halibut fisheries, was finally ratified in October 1923. It provided for the formation of a Commission with a Director of Investigations and an international scientific staff as well as regulation of a 3-month winter closure and incidental catch taken by other fisheries during this closed season.

The permanent and continuing programs of research and biological studies that related to management of the salmon fisheries began in about 1908-09 at Stanford University and started to mature soon after the end of World War I (beginning of this period). Because of the previous studies by Gilbert on Bristol Bay's Wood River and the subsequent provisions of the White Act, one weir was established and operated at Karluk

in 1921, and other weirs were operated at Karluk and Chignik in 1922. Four weirs were used in Alaska in 1923 and the numbers increased until they reached a peak of 28 in 1931; they then declined to seven in 1945. These weirs provided a series of sites for extensive research into the life histories and survival of the various species of salmon, although they were never quite adequate enough to fulfill the intent of the White Act.

Other studies were made on the Copper River, in southeastern Alaska and elsewhere; beginning in 1922, there was a series of tagging experiments which continued through 1930 and after in Bristol Bay, along the Alaskan Peninsula, around Kodiak Island, in Cook Inlet, in Prince William Sound, and in southeastern Alaska.

The description of the life history of the sockeye salmon at Karluk Lake was published by Gilbert and Rich (1927), and a limnological study was conducted as part of the Karluk studies, by Juday, Rich, Kemmerer, and Mann between 1926 and 1930, Juday et al., 1932). It was also during the mid-1920's that studies of the herring fisheries of Alaska were begun with considerable attention given to the identification and interrelation of the various stocks of herring in southeastern Alaska and Prince William Sound.

All of the above research was initiated by the U.S. Bureau of Fisheries research unit stationed at Stanford University and reflected the role of that University in the development of fishery management in the Pacific Northwest and Alaska in those early years. In 1931, the Bureau's research was transferred to the newly completed fishery laboratory on Montlake Boulevard in Seattle where the work in southeastern Alaska and in Bristol Bay was expanded considerably to obtain a better understanding of the life histories and survival of salmon and herring in Alaska and contributed much to the management of fisheries during this period. (Detail of this work is given in Atkinson (1988) and is not reviewed further here.)

Of even greater significance at the time were the studies on the life history, movements, and abundance of halibut conducted by the staff of the International Fisheries Commission beginning about 1923. It was here that the concept of the theory of fishing was refined and developed, based on theory advanced by the Russian scientist Fedor I. Baranov in 1918, and applied to the successful management of the halibut fisheries. The International Fisheries Commission was also a part of the Montlake Laboratory from 1931 to 1936 and an integral part of its heritage.

1946-1976

Notable during this period were: Post-World War II adjustment in the fisheries with declines in the yield, effect of foreign fisheries and some recovery, statehood for Alaska and transfer of management authority from the Federal government, elimination of fish traps in Alaska and shift from sailing gillnet boats to power in Bristol Bay, development of the quantitative sciences and their application to fishery management, and studies on the effect of the ocean environment regarding the distribution and survival of salmon and other fish.

During this period the catch of salmon decreased from about 17.8 and 26.4 million fish in 1946 and 1947, respectively, to 10.8 and 18.2 million fish in 1951 and 1952, respectively, followed by a further decline to an all-time low of 7.1 million fish in 1973. The Japanese high-seas salmon fishery, operating west of 155°W and which during some years took as many as one-third of the total run of Bristol Bay sockeye salmon, was a major factor contributing to the lower catches between 1952 and the early 1970's. The catch by the sport fisheries (especially in Washington, Oregon, and California) increased markedly during this same period—from about 300,000 salmon in 1946 to 1.6 million in 1976.

The halibut catch averaged about 56 million pounds in 1945-49, increased to more than 70 million pounds in 1962, and then fell to less than 25 million pounds by 1974. The decline has been attributed to the following three factors: 1) An increase in the effectiveness of the setline gear, 2) an increase in the incidental catches of halibut by the trawl fisheries—both domestic and foreign, and 3) unfavorable environmental conditions in the nursery areas of the young halibut.

The catch of herring also suffered a severe decline during this period, decreasing from about 218.2 million pounds in 1946 to about 12.8 million pounds in 1968 with a recovery to about 36 million pounds in 1976. The increased catches in 1974, 1975, and 1976 were due to a growing demand for herring and herring roe in Japan and the curtailment of the foreign fisheries for herring in the eastern Bering Sea.

The salmon fishery in Bristol Bay has an interesting history. The fishery has traditional been by gill nets operated from a sailboat—a type of fishery that was common in the San Francisco Bay area, and many of the fishermen still come from that area. For many years, this was the only type of gear allowed to fish in the Bay. The boats were difficult to operate and the cause of many deaths due to sudden storms, and were about as inefficient as any gear used in the salmon fisheries. In 1952, in response to growing pressure from the fishermen and the industry, the regulations were modified to allow motor boats to replace sailboats.

In 1959, with the granting of statehood in Alaska, action was taken by the state to eliminate traps in the salmon fishery that had traditionally operated in southeastern Alaska, Prince William Sound, Cook Inlet, Kodiak Island, and along the Alaskan Peninsula—a total of about 250 floating and pile-driven traps. Only those on the Metlakatla Indian Reserve in southeastern Alaska were allowed to continue fishing. As would be expected, there was almost an immediate increase in both gillnet and purse-seine vessels in the fishery.

There were also a number of improvements in fishing gear and technology that appeared after World War II. Perhaps most revolutionary was the introduction of synthetic (nylon) netting (lighter and stronger than the traditional natural fiber nets) and development at about the same time of the power block by Mario Puretic and the Marco[1] com-

[2]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

pany, which completely changed the purse-seine fisheries. The seine and gillnet drum method of fishing also appeared during this period and there were a number of minor modifications in fishing, such as increasing the distance between hooks in the halibut set line. Also, there was the gradual introduction of various new sonic and radar instruments, all of which made fishing safer and more profitable. All in all, the greatest changes in fishing and fishing technology in the Pacific coast fisheries occurred during this period.

On 30 June 1940, in accordance with the President's Reorganization Plan No. III, the Bureau of Fisheries and the Biological Survey were merged to form the Fish and Wildlife Service in the Department of the Interior; and reorganization also provided for the establishment of five Regional Offices in the various sections of the United States.

It was not until 1950 that the sixth Regional Office was established in Alaska with a primary function of facilitating the administration of Alaska's fisheries. At this time, the installation and operation of weirs and other similar activities were made the responsibility of the Regional Office under "management biology," which separated them from the research programs originally developed at Stanford and later at the Montlake laboratory in Seattle. Although there was close cooperation between the two units, repetitive questions arose as to what is "fishery research" and "management biology" and there was some fragmentation of effort.

In the meantime, the salmon fisheries of Alaska continued to decline. Increasing pressure and criticism was leveled against the Fish and Wildlife Service by the fishing industry, and a virtual rebellion occurred among many of the fishermen making enforcement difficult. It was during this same period, with concern for the resource and a desire for local control of fisheries, that the Alaska Fisheries Board and the Department of Fisheries were formed in 1949 as well as the establishment earlier of the Institute of Fisheries Research at the University of Washington under contracts with the Alaska salmon industry.

Finally, in 1952, Alaskans voted in a referendum (20,500 to 5,500) to request Congress to give them control over their fisheries. This growing opposition was sparked by the desire of many Alaskans for future statehood; provisions were generated within the Fish and Wildlife Act of 1956 for reorganization of the administration of Alaska's fisheries.

An Office of the Administrator of Fisheries was established in Juneau with increased authority over the management of the fisheries of Alaska, and all research relating to the Alaskan fisheries (except the research being conducted for the International North Pacific Commission) was transferred from the Montlake laboratory to Alaska. At that time or shortly thereafter, one of the primary functions of the Administrator of Fisheries was to prepare for the orderly transfer of management functions of the Federal government to the State of Alaska.

Statehood was granted to Alaska in 1959; in 1960, management of Alaska's commercial fisheries was turned over to the Alaska Board of Fish and Game and to the Alaska Department of Fish and Game. Although three have been good years and bad, the state has been able to stabilize the catches of salmon during the following years, and now, after three-quarters of a century of effort to maintain and rebuild the salmon fisheries of Alaska, the state, with its flexibility of regulations based on an accumulation of scientific fact and experience, has been able to restore the yields from this very important resource.

The role of the International Pacific Salmon Fisheries Commission served as an example of good salmon fishery management practice. The Commission was established by treaty between the United States and Canada in 1937, and after establishing and remedying the cause of decline in the salmon fisheries at Hell's Gate in the Fraser River Canyon, began to manage the sockeye salmon fisheries in 1946.

Not only did their program include the voluminous collections of statistics on catch and escapement, but they undertook studies of the movement of the sockeye salmon through the fisheries and on upstream to their spawning grounds. In addition, the hydrological conditions that affected the migration of the salmon were considered, as well as the various environmental factors that affected their survival in fresh water, in estuaries, and at sea. Steps were initiated that would restore once productive but now barren salmon spawning and nursery areas.

Management of the pink salmon fisheries of the Fraser River was added in a new Convention in 1957. The success of the Commission's program is found in the history of the sockeye catches: A low of 443,000 in 1947 reached a peak of 10.5 million fish in 1958 and averaged about 2.0 million fish in the 4-year cycle of 1973-76. The Commission, however, would be the first to point out the need for additional biological studies and information. There is growing political pressure between U.S. and Canadian interests and between the Indian and the non-Indian fishermen—the job of the Commission has not been an easy one.

A valuable lesson was also learned from the experience of management of the halibut fisheries by the International Pacific Halibut Commission. From the time of the beginning of regulation in about 1932, the catch and catch per unit effort of the halibut fisheries had increased rather consistently from year to year, with over 90 percent of the catch being taken by the regular longline fleet and with little change in the fishing methods or in the vessels.

As noted by the International Pacific Halibut Commission (1978: 41), "Since 1960, important changes have occurred including increases in: 1) The effectiveness of the set line gear, 2) the proportion of the catch taken by small, set line vessels and salmon trollers, particularly in British Columbia and southeastern Alaska, 3) the incidental catch in domestic (and Canada) trawl and pot fisheries, and 4) the incidental catch by foreign vessels (Japan, Korea, and USSR). Further, environmental factors apparently have contributed to the decline in abundance of young halibut."

The precipitous decline appears to have been stopped in the early 1970's and now begins the task of once again rebuilding the stocks of halibut to the estimated level of maximum sustainable yield—a combined total of 70 million fish for Areas 2 and 3.

The herring fisheries posed quite a dif-

ferent management problem. Although there were brief peaks in the catches of herring after World War II (1946-50) and again in 1957-60, the general trend of the catches has been downward, reaching a low of about 5,800 metric tons (t) in 1968. From the evidence available, this decline was not due to overfishing but to: 1) The depressed market conditions for herring products, i.e., economic conditions, and 2) strong political pressure to reserve the herring as a food organism for other fish, mainly salmon.

The analysis required by the International North Pacific Fisheries Commission, for herring to qualify for abstension from the Japanese high-seas fisheries, failed to show that these stocks were either being fully utilized or being managed to obtain the maximum sustainable yield. Thus, this species was removed from the list of abstention species.

The conditions changed suddenly in 1974 with an increased demand for herring roe in Japan, and the U.S. catch jumped to about 17,000 t; this amount more than tripled in 1978 after the enactment of the Magnuson Fishery Management and Conservation Act of 1976 and the establishment of the 200-mile fishery conservation zone.

This period is also marked by the trend toward greater cooperation between the various fishery agencies of the States and between the states and the Federal government. In 1947, an interstate compact was approved by the states and the Federal government, creating the Pacific Marine Fisheries Commission for the purpose of: 1) Conserving the coastal-offshore fisheries of interest to the citizens of the Pacific coast states, 2) agreeing upon uniform regulations for such conservation, 3) agreeing upon uniform legislation (if required) to be presented to each legislature for such regulation, 4) agreeing upon means of enforcing uniform regulations, and 5) developing a program on the various species of marine life and deciding how such a program should be carried out.

The Commission has served as an invaluable medium for the discussion and evaluation of the current fishery developments along the Pacific coast and the planning and coordination of a number of research programs dealing with multistate fisheries. The Commission has not been particularly effective in the development of uniform regulations for management.

There were a number of other coordinating groups established during this period, mainly to determine the needs of the fishery management agencies and to plan and to review the results of research. Some examples are the Technical Committee of the U.S. Army Corps of Engineers, the Inter-Agency Fishery Research Coordinating Committee, the First and Second Governor's Conferences, and others.

Research and investigations in fishery management continued to expand during this period. (The biological research programs conducted at the Montlake Laboratory are also described in some detail in Atkinson, 1988.) Most significant, however, were their accomplishments in the studies of freshwater survival of salmon in the Sacramento and Columbia Rivers and in Alaska, the outstanding work on passage and guidance of salmon at dams, on separation of the Asian and North American salmon in the high-seas catches of the Japanese, and on the life history and populations of king crab in the eastern Bering Sea.

Of direct application to management, however, were the studies undertaken at the Montlake Laboratory for the International North Pacific Fisheries Commission applying to the criteria established by the treaty for Japanese (and in some cases, Canadian) abstention from fishing our stocks of salmon, halibut, and herring. The major requirement was proof that the stocks were being fully utilized by our fisheries and, perhaps more difficult, that these stocks were being managed to provide the maximum sustainable yield from the resources.

Although, conceptually, the fishery management agencies were attempting to obtain the maximum sustainable yield from their fisheries—to prove that to the Commission was another story. The cases that were prepared by the scientists at the Montlake Laboratory, the International Pacific Halibut Commission, and in other agencies very pointedly demonstrated a general lack of adequate and sufficiently precise information for "scientific" fisheries management.

Also important to fishery management was the creation of the Fisheries Research Institute at the University of Washington, financed initially by contract with the Alaska salmon industry. Its work, beginning with a series of comprehensive studies on salmon in Alaska, has expanded into almost every area of fisheries science—most, if not all, have been directly applicable to management problems.

The contributions to fishery management made by the several universities along the Pacific coast should also be recognized. Soon after the end of World War II, perhaps in the early 1950's, the universities offering curricula in fisheries added courses in population dynamics of fishery stocks with direct application to management problems, and those courses were generally made a required part of a student's training program.

As we review the events in fishery management that have occurred since World War II, we cannot help but be impressed by the increasing dependence of fishery agencies on the results of research and scientific analysis as a basis for their regulations. There have been successes and failures as well as mistakes in judgment, the misapplication of theory, and the continuing need for new information and study; but the success—the results of work by the International Pacific Halibut Commission, the International Pacific Salmon Fisheries Commission, the Alaska salmon story, and other examples—well demonstrate that the modern principles of fishery management can work when based upon the collection of adequate observations and data and an understanding of the biology and environment of the particular species.

1977-1985

This period has included enactment of the Magnuson Fishery Conservation and Management Act of 1976 and jurisdiction over fisheries within the 200-mile fishery conservation zone, joint state-federal management of the fisheries within the 200-mile zone by regional fishery management councils, development of coordinated management research programs, and regulation of do-

mestic and foreign fisheries based on the determination of the maximum sustainable biological yield, the optimum yield, and similar population parameters.

The enactment of the Magnuson Fishery Conservation and Management Act of 1976 has established a completely new organizational structure for the management of the offshore marine and anadromous fisheries and has overcome the previous difficulties and political resistance in regulating both the "interstate" fisheries and the foreign fisheries off the coasts of the United States. The Act established six regions to be administered by regional councils composed of representatives of state and federal fishery agencies, the industry, and the public. The councils in turn, appoint various advisory and scientific committees to assist in developing the various management programs and in determining the conditions of the various stocks of fish and the appropriate levels of catch that should be allowed. The councils provide for extensive hearing schedules to allow for the expression of opinion from the industry, fishermen, and the public; and, they coordinate many of their regulations with those of the state agencies responsible for the fisheries in the coastal areas. The councils take necessary action to protect the operation and development of the U.S. fisheries within the 200-mile zone and give particular attention to the effect of the foreign fisheries on the domestic catch.

The North Pacific Fishery Management Council, which controls the fisheries in the 200-mile zone off Alaska, has been greatly assisted by the experience gained by the programs of the International Pacific Salmon Fisheries Commission, the International Pacific Halibut Commission, and the International North Pacific Fisheries Commission—all of which are aimed at management of the several fisheries by determining the levels of maximum sustainable yield. Many of the fisheries, e.g., the groundfish fisheries, lacked this background of information and experience and have required much effort to be able to provide even approximate levels of catch and of population.

Although it is still too early to try to evaluate the success of management of the resources within the 200-mile fishery conservation zone, the administration to date by the North Pacific Fishery Management Council, although at times cumbersome, is working and there is every indication their efforts will be a success.

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