

# **A Review of Fishery Research in the Pacific Area**

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It is impossible to place a date on the beginning of fishery research. It no doubt existed in a primitive way among the earliest civilizations. For practical reasons, the scope of this paper is limited to the four countries bordering the North Pacific--Japan, Canada, Russia and the United States--and to research directed towards a better understanding and management of the fishery resources of commercial value. It is interesting that development of fishery research in three of the four countries was prompted by a serious decline in their salmon runs and by the adoption of hatcheries as a means to restore or maintain the depleted runs. The only difference was in Russia where fishery research began with a decline in sturgeon in the Volga and the Caspian Sea. In the Russian Far East, however, it again was a decline in salmon in the Amur and Sakhalin rivers and all were linked primarily to loss or damage to their freshwater environment. Overfishing and destructive fishing practices were recognized almost from the beginning but it was not until 1917 that the work of Thompson on Pacific halibut led to the development of modern theory of population dynamics for the management of the fisheries. Following are notes on the development of fishery research in each of the four countries.

## **Japan**

The first record of fishery research in Japan, although primitive, was in 1716. A samurai by the name of Buheji Aoto placed salmon in a fenced area of a stream to protect the spawning fish and eggs from natural enemies and adverse stream conditions. From all accounts, the salmon runs increased through his efforts and the program continued for more than 200 years. In another stream, the Gekko river, the adult fish were caught in the lower reaches of the stream and transported by a bamboo basket to the headwaters where conditions were more favorable for spawning and survival of the young.

Between 1601 and 1867, Japan was isolated from the rest of the world and there was no interchange with foreigners under penalty of death. There was a gradual breakdown of isolation after the visit by Admiral Perry in 1853 and ended in 1867 with the collapse of the Tokugawa Shogunate. This was the beginning of the Meiji period of westernization. For the next 30 years, Japan sent observers to major countries, studying and frequently copying every phase of living in the outside world. With it came modernization of the fishing fleet, products, fishery management and fishery research.

Shortly after the beginning of the Meiji period in 1868 and at the invitation of the Hokkaido government, a team of 45 agriculture experts was sent from the United States to Japan to assist in the development of farming. One member of the delegation, Mr. U.S. Treat, was familiar with the early salmon propagation methods being developed in the United States. With the assistance of local help, Mr. Treat tried to rear salmon in a crude hatchery in Sapporo in 1877 but without success, and there were several other attempts to rear salmon. It was not until 1889 and after sending a Mr. Ito to study hatchery methods in the United States for about a year that the first permanent hatchery was built at Chitose (Hokkaido).

It is interesting that from this early beginning, aquaculturists in Japan have been skilled at developing (and applying) methods for culturing various species of fish, shellfish, etc. For example, in addition to salmon, there was the success of Konkichi Mikimoto in 1893 of cultivating and producing the first cultured pearls. By 1990 aquaculturists were commercially growing about 25 species, had developed methods for culturing 8 species and were working on 5 additional species.

The Meiji Restoration in 1868 officially abolished the feudal system of government of the Tokugawa era. There was virtually no orderly management of the fisheries and there were disputes over fishing grounds. The fisheries were soon monopolized by local bosses to the detriment of the small-scale fishermen. To handle these disputes and restore some order to the fisheries, the Bureau of Fisheries was established within the Ministry of Agriculture and Commerce in 1885.

According to Yamamoto (2001), before World War II, there was no Fishery Research unit in the Bureau of Fisheries. However, about 1932 the Imperial Research Institute, which is now the Tokyo University of Fisheries, established a Fishery Research Division as a part of its educational program. In 1935 the Fishery Research Division became the Central Fishery Research Station, directly under the Ministry of Agriculture and Forestry and with several branch stations.

By July 1, 1948, the Bureau of Fisheries was upgraded to the Fishery Agency within the Ministry of Agriculture and Forestry (later, the Ministry of Agriculture, Forestry and Fisheries). There is a Director-General, Deputy and three major divisions: Administration (including the Research Department), Auxiliary/Branch Offices (including Research Institutes or Laboratories, Hokkaido Salmon Hatcheries and Pearls) and various Commissions/Councils.

In addition, before the war, almost every Prefecture had established Fishery Experimental Stations, to study their own local fisheries.

Management of fisheries in Japan is different from the other three countries. As pointed out by Yamamoto (1991), management of the coastal and offshore fisheries is basically undertaken by the fishermen who actually participate in the fisheries, their cooperatives and associations form a very tightly integrated system and probably most are involved in some kind of management-type research.

The first Fishery University was organized in 1889 under the auspices of the Fisheries Society of Japan and was transferred to the Imperial Government in 1897 when research and experimentation were added to its curriculum. In 1929, the school was formally reorganized as the Imperial Fisheries Institute and after the war changed to the Tokyo University of Fisheries (Anon. 1947).

The origin of the College of Fisheries of the University of Hokkaido can be traced to the Hokkaido Development Office Temporary School in Tokyo in 1872, moved to Sapporo in 1875. The university went through a series of organizational and name changes and finally in 1947, under the new post-war educational system, was named Hokkaido University. The School of Fisheries was established in the university in 1907 and after a number of similar changes, was divided in 1947 into two institutions: College of Fisheries in Hakodate and the Department of Fisheries, Faculty of Agriculture at the University in Sapporo.

Research has grown rapidly over the last century and at the beginning of World War II totaled 9 Universities with fishery curricula, 32 technical schools, 118 National and Prefecture Research laboratories, 21 marine and freshwater field stations and 3 industry supported fishery institutes. Although the latest figures are not immediately available, after the war, the program was reorganized and at the present time totals about 17 universities with fishery curricula, 52 fishery technical schools, 85 National or Prefecture Laboratories and stations, and a broad fishery extension service.

### **Russia (Pacific Area).**

The first record of management-related fishery research was conducted in 1853-1856 by K.M. Behre on sturgeon in the Caspian Sea. This was followed by research on the fisheries of the Black Sea, then by research on the freshwater fisheries of Ladozhskoe and Baikal lakes. A Marine Biological Station was established at Sevastopol (Black Sea) in 1871 and at about the same time, a Freshwater Research Biological Station at Lake Glubokoe near Moscow.

Fishery research in Far East Russia was prompted by the decline of the summer runs of chum salmon in the Amur river. Between 1898 and 1904, several studies were made by V.K. Brazhnikov. This work generated a number of proposals on the need for management of the fisheries and finally a program was adopted in 1924, including the construction of a hatchery at Teplovka Lake in 1927, the first in the Russian Far East.

At about the same time, a study of the salmon runs to Sakhalin Island was made by P. V. Schmidt in 1900-1901.

Fishery research in the USSR can be conveniently divided into five categories: (1) Marine fisheries (VNIRO) under the national government and on commercial species exploited by the government-operated fisheries, (2) Freshwater fisheries (VNIORKH) was generally under the control of the local governments and on fishery resources exploited by the local people, cooperatives, etc., (3) Academy of Science usually conducts mostly basic research, (4) Universities and other schools undertake research projects suitable for student training in fishery science, (5) Others include independent research not supported by government or academic sources.

This paper will be limited to fishery research on the marine and anadromous species and generally the responsibility of the All-Union Research Institute for Fisheries and Oceanography (VNIRO), established in 1925. VNIRO had about 13 major laboratories or stations: Murmansk (PINRO), Leningrad (BaltNIRO), Riga, Talin, Kerch, Rostov, Batumi, Astrakhan, (CASNIRO), Baku, Makhachkala, Irasnovrmeisk, Aralsk and Vladivostok (TINRO). There are several branch laboratories not included in the above.

The first fishery research laboratory on the Pacific coast, the Pacific Fishery Research Station (TONS), was established in 1925. Within a three year period of time, the name was changed to the Pacific Fishery Research Institute (TIRH) and then to the Pacific Research Institute of Fisheries and Oceanography (TINRO). Following the recent change in government, it is now simply known as the Pacific Fishery Research Center (TINRO-centre).

Originally, TINRO had four branch laboratories: Magadan (MO TINRO-now MONIRO), Kamchatka (KO TINRO-now KamchatNIRO), Sakhalin (SakhTINRO-now SakhNIRO), Amur (AO TINRO now AONIRO) and a new one, Anadyr TINRO). TINRO and its branch laboratories have been the dominant fishery research agency in the Pacific area since it was established in 1925.

TINRO is responsible for a continuing assessment of the stocks being commercially fished, for the recommendation of the Allowable Biological Catch (ABC), the Total Allowable Catch (TAC), the determination of the statistical fishing areas, fishing seasons, fishing effort, etc.

TINRO also conducts research on the ecosystem, monitors oceanographic conditions, develops new technology in the processing and use of seafood, and designs and tests new types of fishing gear.

A second research group, the Pacific Department of Applied Research for Fishing (TURNIF), was established in 1970 and was responsible for applied research on conditions affecting fishing by the commercial fleet. They operated about 60 vessels with a scientific staff of biologists and oceanographers and their work was closely coordinated with the scientific staff of TINRO.

Much of TURNIF's work entailed a continuing search for the best fishing areas, reporting their findings back to the fleet and monitoring their catches. In the winter and spring, TURNIF was especially valuable in reporting the ice conditions in the Bering and Okhotsk Seas. They also trained the vessel crews in communication, sonic equipment, etc. and were responsible for the preparation of monthly reports of the catch and other technical detail.

TURNIF is now just a small fishing company operating 3 small factory trawlers and there is no longer a separate agency for applied research for fisheries.

During the USSR period, all aspects of fisheries and fishing were under the control of the Ministry of Fisheries that operated as a huge monopoly. With reorganization in 1991, Fisheries was down-graded from a Ministry to a Fishery Committee and the industry completely privatized by 1993. The Fishery Committee has complete responsibility for management of the fishery and depends upon the Regional and Central Councils for advice and support. Members of the Councils are composed of temporary appointees from the fishing companies, the Committee of Fisheries, the research institutes. They have no independent scientific staff but rely mainly upon the advice and recommendations of TINRO for quotas, seasons, gear and vessel restrictions, etc.

The change in government in 1991 resulted in a drastic reduction in fishery scientists. One report states that the staff of the Central office was reduced from 2200 to about 300. TINRO and the branch laboratories lost about 20-30 percent of their scientists.

It was a very critical period due to the lack of funds. For example, until recently, the staff would be paid for only four or five months of the year and there was very limited money for vessel operation, maintenance or for new equipment.

There was no direct appropriation from the Government but TINRO was basically dependent upon support from the industry. However, the industry had little to provide. TINRO owned a limited quota and they could sell the catch from their surveys for support. There were some funds from cooperative agreements with foreign companies and countries for vessel charter and fishery expertise. Somehow TINRO has survived and little by little their financial picture has improved. At present TINRO receives some funds from the budget of the Committee of Fisheries and has been promised a regular appropriation from the Government, beginning perhaps next year. At last, TINRO will be on a fixed budget.

## **Canada**

Although in its infancy, there were many surveys and studies made during the latter part of the 1800's relating to the establishment of hatcheries in Ontario, Quebec and the Maritime Provinces for Atlantic salmon, whitefish and several species of marine fish. At the time, hatcheries were considered an easy answer to the rapid decline of many of the fisheries on the Atlantic coast. Although there was no sign of a decline in the salmon runs on the Pacific coast, a salmon hatchery was established at Bon Accord on the Fraser river in 1882 to offset the rapidly rising catch.

The growing need for fishery research was recognized by Canada in 1893 with the appointment of Dr. E. E. Prince, a recognized fishery scientist, as Canada's Commissioner of Fisheries.

In 1898, Parliament established a Board of Management and appropriated funds for the first research station, temporary, in a sense, since it was built on a barge so that it could be moved from area to area where needed. It served well for about 9 years (1899-1907).

Permanent research stations were established in 1908: An Atlantic station at St. Andrews, New Brunswick, and a Pacific station at Nanaimo, B.C. The Board of Management became the Biological Board of Canada under a special Act of Parliament in 1912 and its administration broadened to include Board members from the fishing industry and broader academic expertise from the Universities.

Interesting, at the time, the research stations had a Director but no scientific staff. Instead they depended upon "volunteer" scientists from the Universities (which was also true for the U.S. Fishery Laboratories at Woods Hole Massachusetts and Beaufort, North Carolina). Parson (1993) notes: "The opening of the first marine biological stations provided a great opportunity for on-the-spot research and hence attracted many university researchers. Although some of these scientists became involved with fishery problems, the majority pursued goals that were mainly "curiosity-driven" rather than "mission-oriented" research." For example, there was no permanent scientific staff other than the Director at St. Andrews until 1925.

The year 1925 also marked a decided change in the direction of the research program towards fishery problems. Technological stations were established at Halifax, Nova Scotia, and Prince Rupert B.C. and the Nanaimo station initiated studies on salmon propagation and migration, herring and pilchards, oysters and other shellfish, trout propagation and oceanography. Most important and controversial was the position adopted by the Board that where stocks of salmon were able to maintain their runs under natural environmental conditions, artificial propagation was unnecessary and the cost did not warrant the expenditure. As a result, the Department of Fisheries closed all salmon hatcheries in British Columbia.

This position of the Board was further strengthened in 1934 when action was taken to phase out the participation of "volunteer" scientists, which had dominated the stations' activities since they were established in 1908. In 1937 the Biological Board of Canada became the Fisheries Research Board of Canada and managed to stay active with restricted funds and manpower during the following war years.

During the war years, the main emphasis of the research being carried out in the Pacific area was on the migratory patterns and exploitation rates of the Skeena river sockeye salmon. These studies were chosen to complement studies already being done by the International Pacific Salmon Fisheries Commission on the Fraser river.

The research programs increased significantly after the end of the war, prompted by participation in four International Commissions: whaling (global) and fur seals, salmon, and halibut (North Pacific). In addition, two large research vessels were acquired: the A.T.Cameron for the Atlantic and the G.B.Reed for the Pacific. The results of their research on pink and red salmon, herring, bottomfish, and oceanography were outstanding.

For over 50 years, the Biological Board of Canada, later the Fisheries Research Board of Canada, served as the Canadian Government's agency for basic and applied research related to both domestic and international fisheries. But during this period, there was growing conflict between the Biological Board and the Department of Fisheries over the choice of projects and coordination of research. Finally, after a review by a Royal Commission, all research programs were finally transferred to the Ministry of Environment in 1973 and placed in one of two administrative divisions.

Fishery Management included resource management, conservation and enforcement, and Oceans and Aquatic Affairs included oceanography and the effect of the environment upon freshwater and marine life. Fishery research was generally a part of Fishery Management and administered through a Director General for each of the five regions (Pacific, Central, Quebec, Maritime and Newfoundland).

A considerable increase in the amount of effort was required preparing for and carrying out the new 200 mile fishing zone, effective January 1977. The appropriation and staff nearly doubled, mainly for direct survey and assessment of the stocks of fish for management.

In 1979 the Fishery and Marine Services was split off from the Ministry of Environment to form a new Department of Fisheries and Oceans. The research program was multidisciplinary and included a wide array of scientific studies. In addition to the continuing assessment of the stocks of fish, the objective was to develop a basic understanding of the aquatic ecosystem and to move towards multi-species management.

To attain these goals, the fishery research program of the Department of Fisheries and Oceans was restructured in 1986. One example for the Pacific area was the study of the marine survival of salmon including physical oceanography as well as fishery biology.

The Provincial Department of Fisheries also played an important role in initiating fishery research in British Columbia. Dr. Gilbert was hired in 1913 to study the sockeye salmon fisheries of the Fraser, Skeena and other river systems. Based on his recommendation and as an aid to management, the age composition of sockeye salmon to the various streams have been collected and published annually by the Province for forty years or more. The Province also hired Dr. W.F.

Thompson to study the decline in the halibut stocks along the British Columbian coast. His studies of the relation between catch, fishing effort and the resulting recruitment led to the establishment of the International Halibut Commission and an effective management of the fishery. Both scientists were from Stanford University. Later, the Province began a series of annual reports on the Pacific herring fisheries and has continued to sponsor research on other fisheries and to publish the results of special interest to the industry.

Although the University of British Columbia was authorized in 1890, it was not until 1915 that it was actually established. It is considered one of the top universities in fishery training and research in Canada. In addition to the University of British Columbia, the Province formally authorized two new universities: the University of Victoria and Simon Fraser University. Both have grown rapidly and have gained recognition in fishery circles, but especially Simon Fraser in Fishery Economics.

### **The United States.**

Fishery research in the United States began with a serious decline in Atlantic salmon in the rivers and streams of Maine and other New England states due to construction of dams, pollution and overfishing. In 1865 the Atlantic salmon had disappeared from all but five or six of the thirty rivers known to have had significant runs of salmon. This led to the formation of several small State Fishery Commissions in the 1860's.

While conducting biological studies at Woods Hole (Massachusetts), Dr. Spencer Fullerton Baird, a highly respected scientist and Assistant Secretary of the Smithsonian Institution, became deeply concerned about the decline in the fisheries. In January 1871 he proposed to the Appropriations Committee of the US Congress that a Federal Inquiry be made of New England's fishery problems.

This led to the formation of the US Commission of Fish and Fisheries in 1872 to inquire into the condition of the fisheries in general, with authority to take steps for the propagation of food fishes. The Commission, under various names, has been the Federal Agency for Fisheries in the United State and the precursor of today's National Marine Fisheries Service.

At that time, artificial propagation seemed to be the best way to restore the fisheries. Beginning in 1867 and under the sponsorship of the New England States, Charles Atkins developed methods to culture Atlantic salmon and other freshwater fish and later his work was extended to cod and other marine fish. News of Atkins' success in rearing Atlantic salmon spread rapidly and soon the first salmon hatchery on the Pacific coast was established in 1872 on the McCloud river, a tributary to the Sacramento river in California, and then on the Clackamas and Rogue Rivers in Oregon.

In 1880 and as part of the US Census, David Star Jordan, president of Indiana University, was called upon to make the first comprehensive survey of the fisheries of the Pacific coast and Alaska. Jordan brought Charles Gilbert, a young biologist from the University, to work with him. This was the first description of the salmon fisheries and canning industry in the United States.

In 1885 Jordan was appointed to be the first President of Stanford University, and Gilbert became the head of the Biology Department at the University. Because of their previous experience, they were immediately drawn into fishery research. For example, they were instrumental in arranging for the Albatross, a U.S. Fish Commission vessel, to make a series of annual surveys in the Aleutian area of Alaska, the Bering Sea, along the coasts of Washington, Oregon and California, and even in the distant waters of Japan and Hawaii.

In 1903 the President chose Jordan to head a select committee to investigate the reasons for the decline in the fisheries of Alaska. A little later (1909), Gilbert was named as the scientist in charge of all Pacific Fishery Investigations of the U.S. Bureau of Fisheries. For the next 22 years, the Bureau's research center for fisheries of the Pacific coast and

Alaska remained at Stanford. The influence of Jordan, Gilbert, Everman and Snyder and their students dominated all fishery surveys and investigations made in the North Pacific and beyond.

After World War I, the center for the North Pacific fishing industry began to shift from Stanford and the San Francisco Bay area to Seattle. The University of Washington established a College of Fisheries about 1919 and by 1922 or 1923, students and the first graduates began to appear in the industry and in the Bureau's research and management programs. The staff of the International Fisheries Commission (i.e., the "Halibut Commission") was established at the University of Washington in 1922 or 1923 and in 1931, the federal research programs for salmon and other North Pacific fisheries were transferred from Stanford to the new Montlake laboratory in Seattle.

Differing from Japan, Russia and Canada, in the United States the individual states have control over their fisheries (i.e., freshwater and marine within the 12 mile territorial waters) and they are responsible for their management. Accordingly California, Oregon, and Washington all developed highly competent research staffs and programs aimed at their own local fisheries. Alaska was the exception for it remained a territory until Statehood in 1959 and the federal government was responsible for the management and supporting research of Alaska's fisheries as well as tuna and other fisheries beyond the 12 mile territorial waters.

After World War II, federal fishery research on the Pacific coast consisted of four major laboratories: The Montlake laboratory in Seattle and new laboratories at Auke Bay for Alaskan fisheries, at La Jolla California for Eastern Pacific tuna, sardines and other more southern species and Honolulu Hawaii for tuna and other fisheries in the Central and South Pacific.

In 1971, the administration of Federal fisheries was changed from the Bureau of Commercial Fisheries in the Department of Interior to the National Marine Fisheries Service in the National Oceanic and Atmospheric Agency of the Department of Commerce. The Montlake Laboratory was changed to the Northwest Fisheries Center and later, to the Northwest and Alaska Fisheries Center. The overall program was divided into some 12 units and the stated objective was 1) to provide a better understanding of marine resources and their environment, and 2) to develop options for the utilization of these resources.

In the years that followed, the direction of the research program shifted toward the problems and information necessary for the prediction of the abundance of fish and the optimum level of harvest.

A major shift in research came in 1976 with passage of the Magnuson Fishery Conservation and Management Act declaring a 200 mile economic zone off the coasts of the United States and establishing Regional Councils to manage the fisheries within the 200 mile zone. Each Council has voting members from each of the State Agencies and the National Marine Fisheries Service, their own administrative staff and a Technical and an Industry Advisory Committees. There are three Regional Councils for the Pacific Region: the North Pacific Management Council, the Pacific Management Council and the Southwest Management Council. The federal research laboratories were responsible for developing the initial Fishery Management Plans for the various species and to become the principal research agency for the Councils.

The first State fishery laboratory was established in California in 1919 although studies were made as early as 1911, probably influenced by Jordan and his group of fishery scientists at Stanford. Similar state research laboratories were established in Washington and Oregon during the 1930's.

Since the States are responsible for managing their own fisheries, their research programs are generally focused on salmon and trout in their fresh and coastal waters, marine fisheries (e.g., herring, cod, pollock, shrimp, etc.) along their coasts, shellfish and the culture of salmon and other species. Much effort goes towards the maintenance of the fishery resource and their environment. Management and the associated research programs for the highly migratory species for California, Oregon, Washington and Alaska are coordinated by an interstate Commission, The Pacific Marine

Fisheries Commission, that meets regularly to review the status of the fisheries and take joint action to regulate the shared fishery resources.

Finally, the Universities in the four Pacific coast States have been a constant source of trained fishery scientists and basic research. As mentioned earlier, Stanford University was the first, then the College of Fisheries at the University of Washington (1919) have been especially prominent. Scripps (U of California) is famous for its work in Oceanography including fishery-related research. Oregon State University with its program in Fisheries Economics is now known world-wide. In addition to these, we now find fishery curricula and research established at almost all of the other State universities along the Pacific. All of the major universities have Marine Laboratories available for faculty and graduate research.

### **International Commissions**

No attempt will be made to review the various Commissions in any detail. Some have been amended and re-negotiated but the basic objectives have remained the same. They have contributed much to the management of the designated species and in creating cooperation and exchange between the scientists of the four countries.

The Russian Japanese Fisheries Convention (1907-1928) between Russia and Japan to control Japanese salmon fisheries at selected sites along the Russian coast.

North Pacific Fur Seal Convention (1911-1941, 1957-1963, 1966- ) between the United States, Great Britain (for Canada), Russia and Japan to manage the fur seal populations of the North Pacific, including the Bering and Okhotsk Seas.

The International Fisheries Commission/International Pacific Halibut Commission (1924- ) between Canada and the United States to manage the Halibut fisheries off the Pacific coast of North America.

The International Pacific Salmon Fisheries Commission (1937-1985) between Canada and the United States) to restore the sockeye and pink salmon runs to the Fraser river.

The Northwest Pacific Fisheries Commission (1956- ) between Russia and Japan to manage the Japanese Fisheries on Russian salmon stocks.

The North Pacific Fisheries Commission (1952-1992) between Canada, Japan and the United States to protect salmon, halibut and herring of North American origin and fully utilized by the country of origin from exploitation by Japanese high-seas fisheries.

Pacific Salmon Commission (1985- ) between Canada and the United States to jointly manage the salmon of the Fraser and other rivers.

North Pacific Anadromous Fish Commission (1993- ) between Canada, Japan, Russia, and the United States to protect the taking of anadromous fish within the 200 mile zones except by the States of origin.

### **Literature Cited**

This is not a complete list of the many of references used in the preparation of this paper but instead, is limited to only those that have been cited in the text. Some, such as the papers by Parsons and by Yamamoto are excellent sources for further studies.

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