Biological Research at Auke Bay Laboratory

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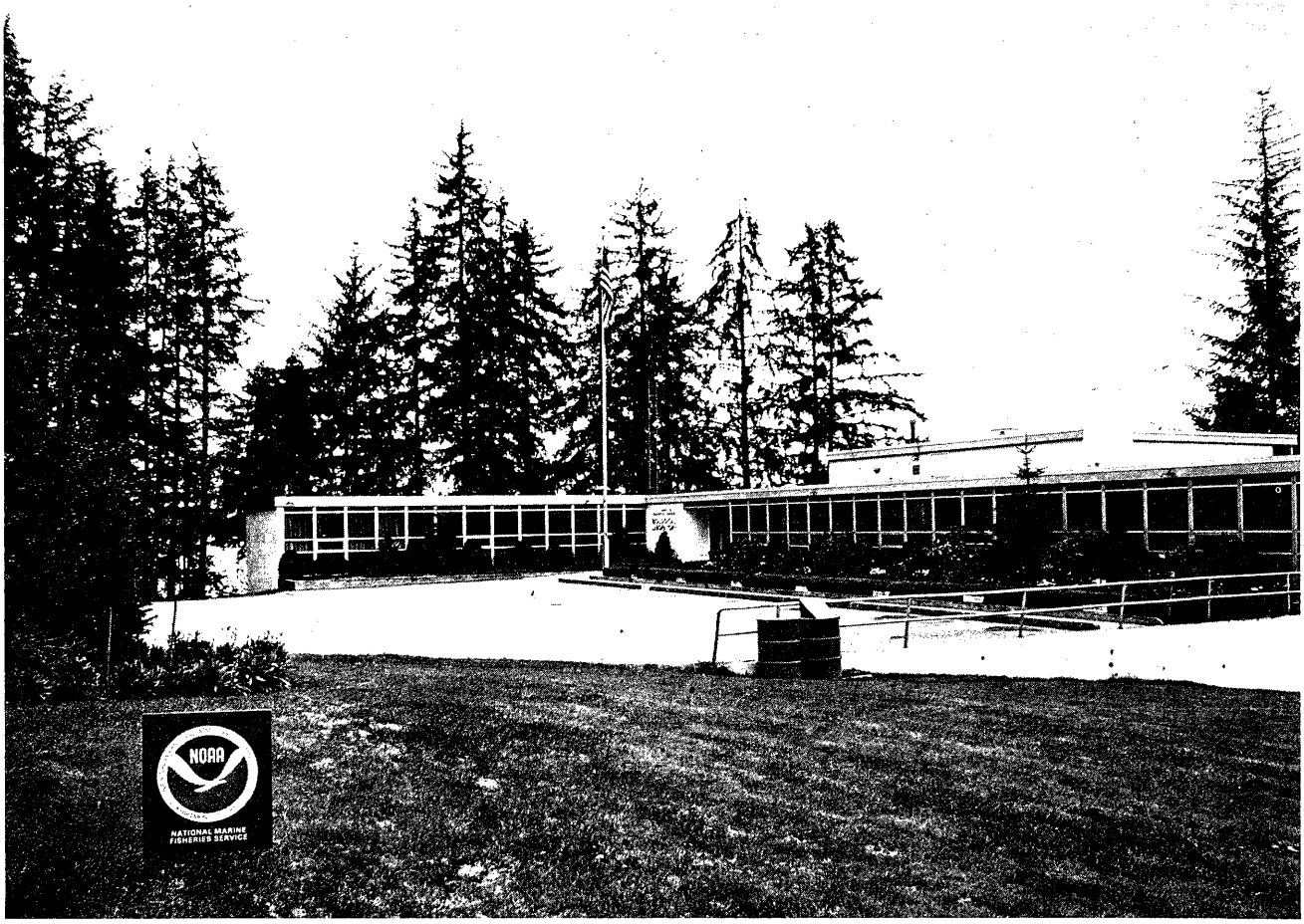

ACTIVITIES

Fisheries in the Territory of Alaska were managed by the federal government until the advent of statehood in 1959. In 1955 Secretary of the Interior Douglas McKay transferred Donald McKernan to Alaska to fill the newly established post of Alaska Fishery Administrator. Research on Alaska's commercial fisheries, which had been based at the Seattle Laboratory, was then transferred north so that "all functions concerned with the management of the commercial fisheries to the territory will be handled by a single field organization." Only two of the Seattle residents chose to move to Alaska, so a new staff of biologists had to be recruited. Dr. William Royce was appointed as the Assistant Administrator in charge of research, and in 1957 he established a new Alaska commercial fisheries group that was initially based in the Alaska-Juneau Mine Building.

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Dr. Royce organized the salmon research into geographically separate investigations--southeastern, central, and western Alaska. Each team was responsible for studies on migration and population dynamics of the salmon stocks in its particular region. Dr. Royce also established salmon survival investigations in southeastern Alaska, Bristol Bay, and Kodiak. Marine fish investigations were established for herring and king crab studies and a biometrics unit to serve the other research activities. Other individuals involved in the new research organization included Harry Rietze, Dr. Charles DiCostanzo, Theodore Merrell, Dr. Richard Myron, Dr. Richard Straty, Chester Mattson, Fred Thorsteinson, Dr. Norman Wilimovsky, and Dr. Howard Tait. When Dr. Royce resigned in 1958 Dr. George Harry became Director of the Fisheries Research Institute (FRI) of the University of Washington, which was extensively involved with Alaska salmon research.

In 1958 and 1959, Congress appropriated $430,000 for construction of the Auke Bay Laboratory, and the new facility was occupied in 1960 under the directorship of Dr. Harry. In 1967, Dr. Harry transferred out of Alaska and Dr. William Smoker became the Auke Bay Laboratory Director and served in that capacity for 14 years. Dr. George Snyder was appointed Director of the Auke Bay Laboratory in September 1981. The Laboratory is situated on a picturesque site overlooking Auke Bay, 12 miles north of Juneau. Nearby, Auke Lake and Auke Creek supply freshwater and serve as natural experimental areas.

Auke Bay is used for estuarine studies and supplies saltwater to laboratory aquaria. The building consists of 14,000 ft^2 of office/laboratory space for 50 persons. When the Laboratory was established, its activities were geographically extended by permanent outlying field stations at King Salmon and Brooks Lake at Bristol Bay, Karluk Lake on Kodiak Island, Kasitsna Bay in lower Cook Inlet, Olsen Bay in Prince William Sound, and Traitors Cove and Little Port Walter in southeastern Alaska.

The Little Port Walter station is the longest continuously operating fisheries facility in Alaska. This station was completed in 1940 with Civilian Conservation Corps labor under the management of Sam Hutchinson and research focused on Sashin Creek pink salmon. A weir on the creek has enabled counts of adult pink salmon to be made since 1934 and fry since 1940. Pink salmon research at Little Port Walter, until 1971, had been concerned primarily with natural factors that affect production and survival of pink salmon in fresh water. In the 1970s, the station became Alaska's principal salmon ocean ranching research facility for jointly shared state and NMFS programs.

The King Salmon facility served principally as the Bristol Bay Fishery Management Center and as the logistics and maintenance base for outlying field camps where research activities were undertaken. This facility was most active during the latter period of federal management of Alaska's fisheries, and during 1956-60, it supported the seasonal activities of nearly 100 full time permanent and temporary personnel. For several years the King Salmon base had been in caretaker status but, since 1978, the U.S. Fish and Wildlife Service has been using the base as a logistics center and headquarters for the Bechanof National Wildlife Reserve.

The Brooks Lake field station at Bristol Bay was established in 1940, enlarged in 1958 and 1960, and abandoned in 1973 because of severe bear predation and budget constraints. The station was used for intensive ecological studies of spawning grounds and nursery areas of the Naknek River system from 1957 through 1968. These studies culminated in numerous scientific publications on the population dynamics of sockeye salmon in the Naknek system. In 1978, the Brooks Lake Field Station was turned over to the Katmai National Park and Preserve of the National Park Service as a logistical-maintenance center.

The Olsen Bay field station, located at Prince William Sound, was operational between 1960 and 1969 for studies on the intertidal spawning and survival of pink and chum salmon. In the Sound's streams, from 50% to 75% of salmon spawning occurs in the intertidal areas. This station's usefulness was given considerable re-emphasis during the latter part of the 1960s for determining the effects of the Alaska earthquake on production of pink salmon in Prince William Sound. In 1981, the Alaska Pacific University began using the station for an environmental studies program and for teaching and training students.

Although Karluk Lake on Kodiak Island has been a site for intermittent federal sockeye salmon research since 1921, the program was expanded in 1956, and the main field laboratory and living facilities were constructed in 1960. Research objectives were to estimate the reproductive potential and optimum numbers of spawners occupying Karluk River and the separate tributaries of the lake. Budgetary restrictions forced abandonment of Karluk Lake studies in 1968. Some small programs involving monitoring of adult escapements and smolt migrations have been continued by the Alaska Department of Fish and Game. In 1978, the facilities at Karluk were transferred to the Kodiak National Wildlife Refuge of the U.S. Fish and Wildlife Service.

The Kasitsna Bay Station, located at lower Cook Inlet across Kachemak Bay from Homer, was constructed in 1957 and has been operational since then as a year-round field facility for shellfish research. Studies at this station have been concerned with the life history of Alaska shrimp and crab species, population dynamics leading to derivation of regulated annual harvest levels of Kachemak Bay shrimp as well as description of Alaska shrimp and crab larvae and of oceanic properties in Kachemak Bay affecting their distribution and abundance. In September 1977 the station was transferred to the Northwest and Alaska Fisheries Center's Kodiak facility. In 1981 the University of Alaska began using the station for shellfish research.

In contrast to the typical high seas activities by NMFS laboratories studying fish populations, the activities at the Auke Bay Laboratory for the most part have been landbased. Exceptions to this were the following short-lived, vessel-based studies: 1) Bering Sea king crab population studies 1965-72; 2) foreign fishery observer program and Pacific ocean perch study 1964-69; and 3) study of survival of juvenile salmon transiting from Bristol Bay, 1969-72.

During the more recent history of the Auke Bay Laboratory, the trend has been for a general shift from studies within watershed environments to studies in estuarine environments and from the field into the laboratory.

Fresh and saltwater systems and wet laboratory facilities were installed in the laboratory, and a chemistry and physiology laboratory was converted from office space. Experimental hatchery facilities were installed at Auke Creek, and a massive freshwater pipeline serving the new hatchery and rearing facilities at Little Port Walter were all installed with substantial assistance and funding from the State of Alaska.

By the 1970s the activities of the Auke Bay Laboratory focused on research and development of salmon ocean ranching, studies of the impacts of petroleum development and other disturbances on fish populations and habitats, and on assessment of shrimp and herring populations.

All federal biological research in the North Pacific areas under the National Marine Fisheries Service, except for that at Auke Bay, became a part of the Northwest Fisheries Center when it was formed in 1971. The Auke Bay Laboratory became a part of what was then renamed the Northwest and Alaska Fisheries Center in 1976.

Beginning in 1978 as a result of intensive planning, a major part of the Laboratory's activities was reoriented. Increased effort was placed in the Center's MARMAP program, which had national emphasis in NMFS. The collective activities of the laboratory focused on causes underlying recruitment variability in marine ecosystems. Research efforts were directed primarily at the egg-through-early-juvenile life of commercially important species that included pink and coho salmon, herring, walleye pollock, and rockfish. Also in 1978, the Auke Bay Laboratory was assigned responsibility for all biostatistical support for salmon research within NMFS for the U.S. Section to the INPFC. Coupled with this assignment was the responsibility for monitoring the Japanese high-seas salmon fishery, instituting the foreign salmon fishery observer program, and for the analyses to estimate the numbers of North American salmon being intercepted by the Japanese fishery. New program changes are being considered to bring other aspects of ABL research into closer alignment with fishery management issues of the Magnuson Fishery Conservation and Management Act of 1976.

ACCOMPLISHMENTS

A number of notable accomplishments have brought regional recognition and credit to the Auke Bay Laboratory. This recognition is indicated by a multitude of close alliances that have been evolving between the laboratory and agencies of the Alaskan and the federal government and with industry and community groups. In some cases, state and federal agencies have sought assistance and formally sponsored laboratory research. In the Alaska and ABL salmon restoration programs, where objectives are parallel, memoranda of agreement have been issued for sharing facilities, personnel, logistics, and other program costs. Members of the laboratory serve on the Governor's Fishery Council, constituted to develop legislation and attune state institutional mechanisms to the state-of-the-art of salmon ocean ranching. The petroleum industry financed laboratory bioassay studies concerned with the effects of crude oil on Alaskan fish. The U.S. Fish and Wildlife Service sponsored and repeatedly renewed a contract with ABL between 1969 and 1979 to monitor the

chronic effects of petroleum at the trans-Alaska pipeline terminal at Port Valdez. Research at Auke Bay to support management of salmon, herring, shrimp, and crab resources has been accomplished in harmony with efforts of the Alaska Department of Fish and Game (ADFG).

Following is a list of some of the laboratory's research accomplishments and actions that provide bases and support for dealing with fisheries management, protection of fish habitat, and restoration of salmon resources.

FISHERIES MANAGEMENT

Salmon

1. Described ranges of optimum escapements for sockeye salmon in major Bristol Bay river systems.
2. Correlated migration routes of adult Bristol Bay sockeye salmon from major river systems with oceanic currents and water masses.
3. Developed a new model that allocates salmon catches taken in a multistock common estuary Bristol Bay fishery to their appropriate rivers of origin.
4. Studied the oceanic nature of the routes of seaward migrating juvenile sockeye salmon in broad Bristol Bay estuaries and their growth and food habits to obtain measures of survival and to explain some hitherto unknown causes of fluctuating magnitude of returning sockeye salmon runs.
5. Determined the rivers of origin and the migration routes of pink, chum, and sockeye salmon taken in the Alaska Peninsula purse seine fishery.
6. Established boundaries of subdistricts for managing the Bristol Bay salmon fishery through information from a tagging study in the late 1950s.
7. Surveyed chum salmon resources in rivers of the subarctic and arctic regions of Alaska.
8. Surveyed abundance of Yukon River salmon and their use for subsistence.
9. Developed methodologies for measuring the timing and escapement of sockeye salmon in the Copper River.
10. Determined optimum pink salmon spawning densities under different stream conditions of southeastern Alaska and determined the survival rate of eggs and alevins over the winter.
11. Derived basic knowledge about the success, intensity, and extent of intertidal spawning by pink salmon in Prince William Sound where more than 50% of all spawning is intertidal.
12. Developed a technique, refined and used by the ADFG, to successfully predict the magnitude of pink and chum salmon runs in Prince William Sound.
13. Contracted with the University of Washington to catalog information on salmon streams in southeastern Alaska and for research in Bristol Bay to determine impacts of predation and lake fertilization on sockeye salmon smolts to: 1) develop a description of lake environment supporting sockeye salmon and 2) derive indices of smolt migrations.
14. Developed statistical estimators and measures of their precision to evaluate composition of stock mixtures. This technique is now used by ADFG for in-season management of Cook Inlet and Bristol Bay salmon, by the Fisheries Research Institute in ascertaining continent of origin of salmon taken on the high seas, and by the International Pacific Halibut Commission in estimating the sex composition of historical halibut landings from otolith collections.
15. Improved predictions of abundance of chum salmon runs by

quantifying the influence of marine environment on age and size at maturity and growth.

16. Derived new basic knowledge useful to fishery management and treaty negotiations on oceanic migration and distribution of different chinook salmon stocks in southeastern Alaska and their contributions to different fisheries.

Shellfish

1. Developed methodology used by the state of Alaska to forecast the annual productive capacity of shrimp stocks and to establish stable harvest levels in Kachemak Bay.

2. Conducted large-scale tagging of Gulf of Alaska king crab stocks to study biology, migration, and stock boundaries. For a number of years, annually assessed the status of Bering Sea king and snow (Tanner) crab stocks being harvested in the multinational fisheries. Developed a yield-per-recruit model used for establishing annual harvest levels of Bering Sea king crab.

3. Developed and published keys and complete descriptions of larval stages of major pandalid shrimp species and crab species in the North Pacific Ocean.

Marine Fishes

1. Analyzed impact of foreign fishing on Alaska Pacific ocean perch stocks and correctly forecast their decline.

2. Operated a groundfish observer program, for a number of years, by placing U.S. specialists aboard Japanese trawlers to estimate the levels of incidental halibut catches taken off Alaska.

3. Documented precise homing behavior of some rockfishes and the presence of juvenile Pacific ocean perch in fjords of southeastern Alaska.

4. Described dynamics of herring populations, schooling ecology, seasonal distribution; determined rates of growth and mortality; estimated sizes of spring spawning populations; in recent years, allied with the state to assess wintering stocks harvested in new food herring fisheries; and perfected a method of tagging herring.

5. Described the movements and feeding of walleye pollock during their first year of life in southeastern Alaska.

6. Defined coastal nursery grounds of Pacific rockfish of southeastern Alaska.

7. Described the food habits of Pacific cod, flathead and yellowfin sole, and of juvenile and young adult pollock in southeastern Alaska.

8. Collaborated with scientists at the Center's Seattle Laboratory in determining the effect of temperature on the rate of development of walleye pollock embryos and developing predictive equations for estimating spawning and hatching time of the embryos.

9. Determined the peak spawning period of walleye pollock in northern southeastern Alaska.

10. Described the stomach contents of two beached humpback whales and determined the major fish items in their diets.

General

Assisted in the creation of a comprehensive State of Alaska Fisheries Management Policy--that lays out the Department of Fish and Game posture on several controversial issues--by detailing an ABL member to that organization under the provisions of the Intergovernmental Personnel Act.

Protection of Fish Habitat

1. Developed SCUBA capability to study shallow-water marine ecology and built perhaps the best-trained team of diver-ecologists in cold-water areas.

2. Assisted the Atomic Energy Commission in evaluating effects of nuclear testing on marine organisms near Amchitka Island.

3. Surveyed estuarine bottom at a site used for log dumping and raft storing and found that dumping logs caused the substrate to be buried under masses of woody debris, making it nearly devoid of bottom organisms. Criteria for recommending permitting of sites for log dumping to minimize effects of fishery resources are based on these surveys.

4. Tested effects of aerial spraying of DDT on fish and aquatic insects in forest streams and achieved a local moratorium before use of DDT was forbidden by federal laws. Determined critical toxicity levels of various concentrations of a herbicide (2-4-D) on salmonids in Alaskan watersheds. Pinpointed residual DDT accumulations in freshwater fishes throughout Alaska.

5. Provided key information on the Kachemak Bay shrimp and crab nursery area used as an important basis for the state to buy back a $25-million oil lease from an oil company.

6. Published extensively quoted argument on the statistical difficulty of measuring the effects of logging on salmon through use of catch and escapement data.

7. Provided a comprehensive analysis of forest management practices and needs of the Alaska Department of Environmental Conservation.

8. Responded to major petroleum developments and corresponding national needs for information on potential impact on fisheries and habitat through expanded field studies of marine community dynamics coupled with laboratory bioassay and physiology studies. Oil effects research by ABL has extended over a 10-year period and has resulted in 22 papers published in national or international journals. Some notable conclusions have been included

   a. The relative sensitivity of Alaskan marine species to petroleum hydrocarbon.
   b. Some early life stages of shrimp and crab are more sensitive to oil than others.
   c. Early life stages of marine species are generally more sensitive to oil than older stages, and adults are generally less affected by oil than juveniles.
   d. Pelagic marine species of fish and invertebrates are generally more sensitive to oil than intertidal species.
   e. Salmon eggs are tolerant of petroleum hydrocarbons in short-term exposures, but long-term exposures result in high mortality at hatching.
   f. Some fry are much more sensitive to petroleum hydrocarbon during the transition from freshwater to the marine environment than at other life stages.
   g. Pioneered use of the macoma clam as an indicator of environmental stresses used to ascertain measures of oil pollution in Prince William Sound.

9. Surveyed the entire Alaska coastline from Yakutat to the Bering Strait and published an atlas that provides qualitative physical descriptions of this stretch of beach line.

10. Determined the effects of the 1964 Alaska earthquake and resultant land elevation changes on the

production of pink and chum salmon in Prince William Sound.

11. Provided testimony as expert witnesses before the state legislature on such matters as tanker, logging, and hatchery legislation.

12. Assessed the fishery resources encountered by the 800-mile trans-Alaskan pipeline and recommended procedures to minimize damage at stream crossings.

13. Defined oceanic conditions in several areas that were considered for development for transport of timber, pulp, or oil.

14. Made numerous recommendations on water-use construction projects to protect or enhance salmon runs. For example, laboratory experiments were performed to simulate the cold-water conditions at the Grace Creek dam site on salmon egg development.

Restoration of Salmon Resources

In recent years the Auke Bay Laboratory developed a regionally recognized leadership role in ocean ranching research as well as technology and development of Alaska salmon species together with a concomitant alliance with the ADFG and with the Governor's Council for restoration of salmon resources. Among the Laboratory's accomplishments are

1. Published the very popular Salmon Ranchers Manual that translated findings in salmon hatchery and rearing research into a practical format.

2. Established a viable run of pink salmon in a natural stream by transporting and transplanting adults to replace an extinct run in southeastern Alaska. This technique was adapted as a management tool in Prince William Sound.

3. Developed a technology for producing high-quality fry in naturalized artificial environments with use of incubation boxes in wild streams and rearing pens in estuaries.

4. Worked with fishery managers to arrange management of a special open fishery on surplus coho salmon returning to the NMFS research station at Little Port Walter.

5. Developed and tested methodology of planting coho salmon fry in unutilized lakes, as minimal cost nurseries, for producing high quality smolts and increase in adult returns.

6. Coordinated development of a statewide plankton watch concept that strategically correlates release timing of hatchery fry with estuarine conditions to maximize adult returns.

7. Developed a comprehensive historic summary and analysis of early-day hatcheries in Alaska from 1891 to statehood in 1959.

8. Developed a rearing program utilizing a unique system of floating raceways that permit precisely controlled fresh water, intermediate saline, and saltwater culture to optimize salmonid growth and survival.

9. Tested new criteria for chinook salmon brood stock development and enhancement technology in Alaska for use in developing hatchery programs and rehabilitating depressed natural runs.