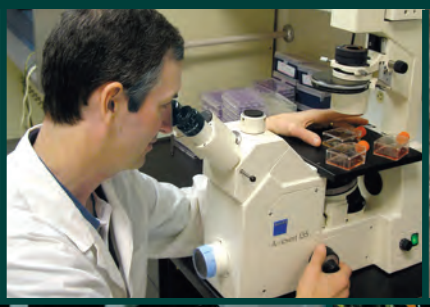
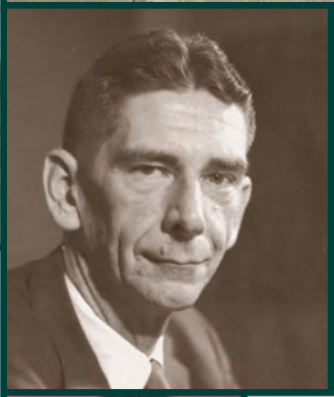
USGS
science for a changing world

Seventy-Five Years of Science—

The Story of the U.S. Geological Survey's Western Fisheries Research Center, 1935–2010











General Information Product 149

U.S. Department of the Interior
U.S. Geological Survey

Front Cover: Left to Right

Top row:
R. Rucker, G. Wedemeyer, and R. Ross measuring oxygen consumption of a fish exposed to DDT, 1966
WFRC staff photograph,1965
B. Batts using an inverted microscope, 2007
Future Center Director R. Rucker with WFRC founder F. Fish and Government car, ca. 1937

Middle row:
WFRC founder F. Fish, ca. 1934
The Center's first high-powered microscope, ca. 1962. Staff unidentified.
Parasitologist J. Uzman,1956

Lower row
The Center's histology laboratory, S. Black, technician,1964
Center Director T. Parisot,1974
Center Director R. Rucker,1958
Center Director R. Rucker with Leetown Laboratory Director S. Sniezko and a government car, 1958

Back Cover: Left to Right

First row:
1. Immunologist G. Klontz, 1964
2. R. Rucker and S. Bernier, Winthrop National Fish Hatchery, 1956
3. Ma. M. Penaranda, Visiting Scientist, Philippines, ca. 2009
4. Backpack electroshocking, Kenai River fish genetics study, ca. 1980. Unidentified staff

Second row:
1. Bacteriologist A. Ross and Virologist T. Parisot, 1958
2. Center Director F. Shipley, 1995
3. CRRL Director J. Petersen, 2005
4. Center Director A. Fox, 1978

Third row:
Virologist D. Amend, 1966
Center Director L. Thorsteinson, 2003
Lower Elwha Dam before removal, ca. 2012

Seventy-Five Years of Science—
The Story of the U.S. Geological Survey's Western Fisheries Research Center

By Gary A. Wedemeyer

General Information Product 149

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2013

Suggested citation:
Wedemeyer, G.A., 2013, Seventy-five years of science—The U.S. Geological Survey's Western Fisheries Research Center: U.S. Geological Survey General Information Product 149, 44 p.

Preface

As of January 2010, 75 years have elapsed since Dr. Frederic Fish initiated the pioneering research program that would evolve into today's Western Fisheries Research Center (WFRC). Fish began his research working alone in the basement of the recently opened Fisheries Biological Laboratory on Lake Union in Seattle, Washington. WFRC's research began under the aegis of the U.S. Fish and Wildlife Service and ends its first 75 years as part of the U.S. Geological Survey with a staff of more than 150 biologists and support personnel and a heritage of fundamental research that has made important contributions to our understanding of the biology and ecology of the economically important fish and fish populations of the Nation.

Although the current staff may rarely stop to think about it, WFRC's antecedents extend many years into the past and are intimately involved with the history of fisheries conservation in the Western United States. Thus, WFRC Director Lyman Thorsteinson asked me to write the story of this laboratory "*while there are still a few of you around who were here for some of the earlier years*" to document the rich history and culture of WFRC by recognizing its many famous scientists and their achievements. This history also would help document WFRC's research 'footprint' in the Western United States and its strategic directions. Center Director Thorsteinson concluded that WFRC's heritage told by an emeritus scientist also would add a texture of legitimacy based on personal knowledge that will all-to-soon be lost to the WFRC and to the USGS. The WFRC story is important for the future as well as for historical reasons. It describes how we got to the place we are today by documenting the origin, original mission, and our evolving role in response to the constantly changing technical information requirements of new environmental legislation and organizational decision-making.

The WFRC research program owes its existence to the policy requirements of Federal conservation legislation originating with the construction of Grand Coulee Dam in 1933. The research program was shaped by laws enacted in subsequent years such as the Federal Water Pollution Control Act (1972), National Environmental Policy Act (1973), Endangered Species Act (1974), and Northwest Power Planning Act (1980), to name only a few. The WFRC has not been constrained by direct management or regulatory responsibility for a particular fishery (such as providing sustainable catch limits data to a resource management structure). Thus, WFRC has been able to concentrate on scientific pursuits and information needs required by contemporary environmental legislation. Over the years, we have pioneered in several important areas of fisheries research including the diagnoses and control of diseases in economically important fish, effects of environmental alterations on the physiological quality and survival of Pacific salmon released from federal mitigation hatcheries, applications in biotelemetry, and the bioenergetics of predator-prey interactions in the Columbia River.

The WFRC of today is a widely distributed organization in the Western United States. Knowledge of the historical connections and accomplishments of our predecessors is important beyond the sense of pride and unity it instills in the WFRC family of today. For example, a discerning reader will note the evolution of WFRC's research from a single disciplinary focus (early era—hatchery disease problems), to multiple disciplines (middle to late era—species, populations, habitats; threatened and endangered species), to the present era (multidisciplinary

and with increasing process focus). For the benefit of the current WFRC staff, more emphasis has been placed on the early years rather than on the present day because people are quite naturally more familiar with the recent past than with the research done during the first decades of WFRC's existence.

By every rational measure, the WFRC has evolved into a fisheries research organization well positioned to provide the biological information needed to support the continued conservation and management of our Nation's living aquatic natural resources. The high standard of excellence that connects WFRC's past to our present research program provides a firm foundation on which to base the work yet to be done.

In another 75 years, WFRC will undoubtedly be a very different place than it is today, but its evolution will be forever rooted in the story of the research and of the people related here.

More about the diverse fisheries research projects WFRC scientists are conducting today is available at WFRC's website: *http://wfrc.usgs.gov/*.

Gary A. Wedemeyer
Senior Scientist Emeritus
October 2012

Contents

This page left intentionally blank

Chapter 1

1871: WFRC's Roots — The U.S. Commission of Fish and Fisheries

The year was 1871 and the Civil War only recently ended when, due to growing concerns about the declining fisheries of the east coast and Great Lakes, Congress passed legislation creating the Nation's first natural resource conservation agency, the U.S. Commission of Fish and Fisheries. War hero Ulysses S. Grant was President and he appointed Smithsonian Director Spencer Fullerton Baird[1] (a founding member of the fledgling American Fisheries Society) to head up the new agency. With a budget appropriation of $5,000, Congress directed the U.S. Fish Commission, as it soon came to be called, to:

> "*Investigate the causes of decrease in the supply of useful food-fishes of the United States, and determine and employ such measures as may seem best calculated to stock or restock the waters of the rivers, lakes and the sea.*"

As a scientist, Baird was a contemporary of Louis Agassiz, T.H. Huxley, and Charles Darwin. Like them, he was a man of great vision and his first report[2] to Congress shows how quickly he worked out the complex factors that were causing the Nation's economically important fish populations to decline. Baird listed the following.

1. Decrease or disappearance of food items of commercially important fish populations,
2. Migration of fishes to other localities,
3. Fish diseases and adverse environmental changes such as water temperature and dissolved oxygen,
4. Predation,
5. Man's activities such as pollution, overfishing, or the use of improper gear.

Today, some 140 year later, Baird's analysis remains as accurate as it was then and his vision continues to influence fisheries conservation work. The U.S. Fish and Wildlife Service recently named a Great Lakes research vessel the M/V Spencer Fullerton Baird in his honor.

During the first few years of the U.S. Fish Commission's existence, Baird and his assistant George Brown Goode did much of its research themselves. Working during the summer field season out of a small fisheries laboratory they built at Wood's Hole Massachusetts, a former New England Whaling port, Baird and Goode investigated the distribution, spawning, rate of growth, diseases, and prey of Atlantic cod (*Gadus morhua*) and other declining food fishes along the New England coast.[3] They also began work on methods for the artificial propagation of these species. Millions of eggs were collected each year, incubated in hatcheries,

[1] Madison, Mark, 2009, Spencer Fullerton Baird—Eddies—Reflections on Fisheries Conservation 2 (special issue): U.S. Fish and Wildlife Service, Washington D.C.
[2] Baird, S.F., 1873, Report of the Commissioner for 1871–1872: U.S. Commission of Fish and Fisheries—Part 1, U.S. Government Printing Office, Washington D.C.
[3] Baird died at the Woods Hole research station in 1887 at the age of 64.

and the young released in an effort to restore their former abundance. At that time, the great fisheries of the Pacific Coast, the Gulf of Mexico, and the Territory of Alaska were virtually unmapped and awaited exploration and study by U.S. Fish Commission scientists.

In 1872, in response to a resolution by the fledgling American Fisheries Society, Congress appropriated $15,000 and directed the U.S. Fish Commission to begin rebuilding declining fish populations by transplanting fish throughout the country. Prominent fish culturist Livingston Stone, one of the founders of the American Fisheries Society, was named Deputy U.S. Fish Commissioner and assigned to establish a freshwater fish hatchery in California. Stone, who had just published his classic text "Domesticated Trout", was also assigned the task of transporting fish across the continent by railroad. Large numbers of American shad (*Alosa sapidissima*) and striped bass (*Morone saxatilis*) were transported from the Atlantic to the Pacific coasts in aquarium railroad cars that Stone had designed, while Pacific salmon (*Oncorhynchus* spp.) and trout (*Salmo* spp.) were hauled from the west coast to eastern streams. Passengers were hired to crank the hand operated aeration pumps. Although these early fish transplant efforts are now considered unwise, American shad and striped bass populations adapted well to the Pacific coast and currently support a sizeable recreational and, at times, even a small commercial fishery.

In 1879, Congress directed the U.S. Fish Commission to conduct a comprehensive survey of the fish and fisheries of the Nation as part of the 1880 U.S. census.[4] Director Baird asked legendary zoologist David Starr Jordon, then president of Indiana University, to organize and head up a team of experts to conduct this pioneering national biological survey. Jordan and his graduate student Charles H. Gilbert took leave from Indiana University and personally conducted stream surveys from southern California to Vancouver Island, B.C., to document the fishes of the west coast. The inventories and reports generated by these surveys provided a wealth of information about the life histories of these species and records of their exploitation that are still used today.[5] In 1879, Congress also created the U.S. Geological Survey (USGS) to investigate the geology and mineral resources of the vast new lands added to the United States by the Louisiana Purchase and the Mexican-American War. Few would have predicted that some 90 years later, Congress would transfer the fisheries research conducted by the U.S. Fish Commission into the USGS.

In 1891, soon after the last of Jordan and Gilbert's original biological surveys had been published, Jordan was appointed President of Stanford University in Palo Alto, California, and Gilbert joined him as head of the zoology department. In 1903, the U.S. Fish Commission was renamed the U.S. Bureau of Fisheries and tasked with determining the cause of the declining Alaska salmon fishery. President Theodore Roosevelt appointed Jordan and Gilbert to head up this work and a few years later the Bureau established a Stanford Pacific Fishery Investigations (SPFI) group at Stanford University with Gilbert as Chief Scientist.[6] In subsequent years, Jordan,

[4] The 1880 census data had to be compiled by hand and it took so long (7 years) that the U.S. Census Bureau contracted inventor Herman Hollerith to build a tabulating machine to be used for the 1890 census. Hollerith designed a cardpunch machine that was so successful that the results of the 1890 census took only 1 year to tabulate. In 1896, he started "The Hollerith Tabulating Machine Company" and began marketing his invention. In 1924, the Hollerith Tabulating Machine Company was renamed the International Business Machines Corporation (IBM). The rest… is history.

[5] Jordan, D.S., and Gilbert, C., 1887, The salmon fishing and canning interests of the Pacific coast, *in* Atkinson, C., 1988, Fishery studies on the U.S. Pacific Coast 1887–1931: Marine Fisheries Review, v. 50, no. 4, p. 95–97.

[6] Gilbert died in 1928 at the age of 68. In 2008, Gilbert's grandson established the Gilbert Endowed Professorship at the University of Washington, a longtime partner of WFRC in fisheries research. The distinguished ichthyologist, Theodore Wells Pietsch III was the initial occupant.

Gilbert, and their SPFI colleagues became the first to use fish scales to determine the age of salmon, did pioneering work on tagging to study Alaska salmon migrations, and proved the 'home stream' theory of returning adults.

In 1931, the personnel and equipment of the SPFI group were transferred to the newly completed Fisheries Biological Laboratory in Seattle (popularly known as the "Montlake laboratory"). Research at the Seattle facility initially focused on fisheries issues caused by the new dams being construction on the Columbia River. At that time, Rock Island Dam had already been built and construction on Bonneville Dam and the Grand Coulee Dam was about to begin.

Due to its 550-foot height, a fish ladder was precluded at Grand Coulee Dam thus preventing several important runs of salmon from returning to their native spawning streams upstream of the dam. To mitigate this loss of habitat, salmon hatcheries were built on Columbia River tributaries such as the Methow River, the Entiat River, and Icicle Creek near Leavenworth, Washington. This so-called Grand Coulee Fish Maintenance Project (GCFMP) was the first major hatchery program designed to compensate for hydroelectric development in the Columbia River Basin. The GCFMP was destined to play a vital role in shaping the origins and future of the yet unborn Western Fisheries Research Center (WFRC).

The U.S. Bureau of Fisheries (Bureau) Hatchery Division and Research Division (then called the Division of Scientific Inquiry) shared in the management of the GCFMP. The Hatchery Division was responsible for operating the Grand Coulee project mitigation hatcheries and for trapping returning adult salmon at the Rock Island Dam and transporting them to streams downstream of Grand Coulee Dam. The headquarters of the Hatchery Division's Western division was at the new Montlake laboratory with Al Kemmerich as superintendent. In November 1934, the U.S. Bureau of Fisheries brought in Dr. Frederic Forward Fish from its experimental hatchery at Leetown, West Virginia, to head up a newly established Consulting Fish Disease Service, which Dr. Fish himself had earlier proposed. An announcement by Chief of Research Elmer Higgins[7] in the 1935 issue of the Progressive Fish-Culturist (now the North American Journal of Aquaculture) explains:

> *The Division of Scientific Inquiry, U.S. Bureau of Fisheries, in carrying out the purposes of Congress to discover how great a diminution of food and game fishes of the United States has occurred, what the causes may be, and what remedial measures may be proposed, has established a Consulting Hatchery Disease Service. Two pathological laboratories will be maintained by the Bureau, one at Washington D.C. under the direction of Dr. H. S. Davis, and one at Seattle Washington, under Dr. Frederic F. Fish. The service will be limited to production hatcheries, federal, state, and private. The accompanying article[8] by Dr. Fish, to whom much credit is due for proposing the establishment of the Hatchery Disease Service, explains the operation, character and benefits to be derived.*

WFRC founder Frederic F. Fish, ca. 1945.

[7] Higgins was the third of David Starr Jordan's students to play an important role in the predecessors of the WFRC. The others were Willis Rich and W.F. Thompson.

[8] Fish, F.F., 1935, The Bureau of Fisheries Disease Service: The Progressive Fish-Culturist, v. 8, p. 9–12.

The WFRC research program can therefore directly trace its origins to 1935, 75 years before the time of this writing — to a man and his dream at the very depth of the Great Depression, Dr. Frederic F. Fish. Dr. Fish had done notable work for the Bureau's Division of Scientific Inquiry (Research Division) solving fish disease problems in the eastern United States, including issues with Atlantic herring disease mortality in the Gulf of Maine and ulcer disease of trout at the Bureau's Cortland, New York, hatchery. Fish convinced his superiors that he was the one to send out to Seattle to develop methods to control the hatchery disease problems that were limiting the success of the Grand Coulee Fish Maintenance Project. The consulting hatchery disease service he originated was the antecedent of the WFRC of today.

Fish's research program got off the ground in early 1935, shortly after he arrived at the Monlake laboratory in November of 1934. His first laboratory consisted of a small basement room at the Montlake facility with six aquaria where fish disease treatments could be tested under controlled conditions. Fish soon designed and built a second laboratory in another basement room and supplied it with an autoclave for bacteriological studies, sectioning equipment for histological work, and supplies and equipment for water chemistry analyses. Needing an assistant and more space, Fish hired Robert R. Rucker who built another experimental wet laboratory at the nearby University of Washington Fisheries Building and equipped it with sixteen 4-foot troughs supplied with heated or regular dechlorinated city water. Rucker then built a small satellite laboratory at the Quilcene National Fish Hatchery where mortality from fish parasite diseases had long been a chronic problem. Here, the experimental disease treatments developed at the Montlake laboratory could be tested under production conditions.

Fish and Rucker soon established a second satellite laboratory at the Leavenworth National Fish Hatchery with substations at hatcheries on the Entiat and Methow rivers. Here, new and improved methods were developed to control environmental disease problems caused by unfavorable water-quality conditions such as adverse temperature, low dissolved oxygen, and excess carbon dioxide and nitrogen gas.

During their first few years working at the Montlake laboratory, Fish and Rucker identified and characterized the bacterial pathogens that cause furunculosis and ulcer disease and they soon became recognized authorities on fish disease problems in the Western United States. Their research findings resulted in immediate improvements in the health and survival of juvenile salmon released from the federal mitigation hatcheries. For example, current treatment protocols for using formalin, salt, copper sulfate, and other chemicals to control fungi, external bacteria, and protozoan parasites in salmon hatcheries were pioneered by Fish and Rucker.


Bob Rucker & Fred Fish (his boss) with a Government vehicle. (1938)

The early years of fisheries research at the Montlake laboratory were marked by the rapid expansion of biological knowledge and the development of a staff of very talented young scientists

— Fred Fish, Robert Rucker, Richard Van Cleve, Roger Burrows and Lauren Donaldson, to name only a few. By 1939, for example, Fish and Rucker's innovative research had gained national recognition and Newsweek Magazine published an article entitled "A Hospital for Fish." The article characterized the Montlake laboratory as a fish hospital and the Quilcene Fish Hatchery Experimental Station as one of its wards.[9] The WFRC evolved from the pioneering work of some very forward-looking biologists.

In 1940, President Franklin Delano Roosevelt reorganized the government and the U.S. Bureau of Fisheries was merged with some wildlife biology work within the Department of Agriculture to form a new agency, the U.S. Fish and Wildlife Service (FWS) under Harold Ickes,[10] then Secretary of the Interior. The reorganization also established five regional offices around the United States. The Hatchery Division headquarters was moved from the Montlake laboratory to the newly established FWS Western Regional Office in Portland, Oregon.

In 1941, the United States entered World War II and the Montlake laboratory research team began to disperse. Younger biologists were drafted, and others were reassigned to the Office of the Coordination of Fisheries or similar wartime agencies. Funding was kept to a minimum, the use of vehicles was curtailed, and supplies and equipment were increasingly difficult to obtain. Despite this, however, the Grand Coulee Dam Fish Maintenance Project team continued to transplant salmon into new home streams and evaluate the results. During the early years of the war, Fish and Rucker were able to maintain their research on the practical application of promising fish-disease treatment chemicals. Formalin had proved effective for the control of some, but not all fish parasites so other chemicals such as Roccal and malachite green were tested and treatment protocols developed. The use of sulfonamides had just started and some forms proved to be effective against certain bacterial fish diseases. During this time, Rucker made significant strides in the identification and culture of the bacterium *Chondrococcus columnaris,* responsible for columnaris disease and in 1943, he and Fish became the first to obtain the organism in pure culture. In 1943, Fish and Rucker published the first report of columnaris as a disease of cold-water fishes.[11]

In 1944, Rucker transferred to the FWS fisheries technology laboratory at College Park, Maryland, where he did bacteriological food safety research until the war ended in 1945. Shortly thereafter, Rucker returned to the Montlake laboratory in Seattle where he resumed work with Fred Fish in a new research group called the Pacific Coast Fish Cultural Investigations (PCFCI). Soon after Rucker's return, Fish was transferred to PCFCI headquarters in Corvallis, Oregon, as Director. Rucker remained at the Montlake laboratory for a few more years doing pioneering work on the role of nitrogen supersaturation in gas bubble disease, using a Van Slyke blood gas apparatus he had modified for hatchery water supplies. In 1948, Rucker also was transferred to the PCFCI group in Corvallis where he was assigned to water pollution problems in the Willamette River system — effectively ending the initial era of fish disease research at the Montlake laboratory.

Remarkably, in the 13 years WFRC founder Fred Fish and his assistant Robert Rucker devoted to their fish disease/fish cultural investigations at the Montlake laboratory, they published more than 50 scientific papers. Their research findings became the basis for the

---

[9] A Hospital for Fish: Newsweek Magazine, January 2, 1939, p. 21–22.

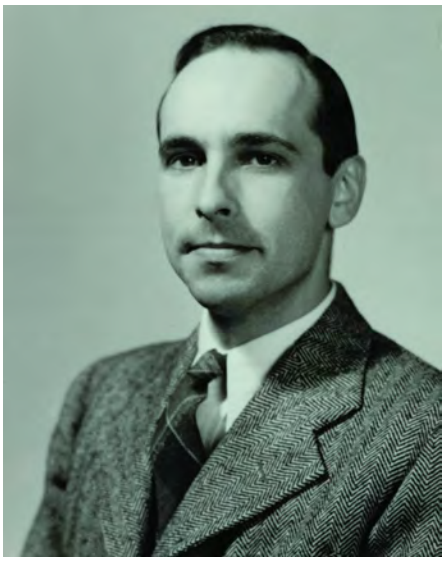
[10] Harold L. Ickes was responsible for implementing much of President Roosevelt's "New Deal" and was the father of Harold M. Ickes, Chief of Staff under President Bill Clinton, and advisor to Senator Hillary Clinton.

[11] Fish, F.F., and Rucker R.R., 1943, Columnaris as a disease of cold-water fishes: Transactions of the American Fisheries Society, v. 73, p. 32–36.

hatchery operations that were needed to ensure the continued survival of Pacific salmon populations in the United States and Canada. Some of the diagnostic and control methods Fish and Rucker developed are still in use today. A complete list of all WFRC publications from 1935, when Fish and Rucker began their work, to the present day is available at the WFRC website *http://wfrc.usgs.gov/*.

Chapter 2

1950: An Independent Laboratory



Robert R. Rucker, Center Director 1950–1973.

In 1949, Fred Fish unexpectedly resigned as Director of the PCFCI group and took a research management position with the U.S. Public Health Service in Texas.[12]

Shortly thereafter, Rucker was reassigned to Seattle with a mandate to organize and direct an expanded fish-disease research program for the Pacific Northwest to be housed at the University of Washington's College of Fisheries. The new organization was named the Western Fish Disease Laboratory (WFDL) and in 1950, it was elevated by the FWS to independent laboratory status, thus becoming the direct predecessor of the Western Fisheries Research Center of today. For his staff, Rucker selected specialists in fish parasitology (Joe Uzmann), bacteriology (A. John Ross), virology (Stanley and Margaret Watson), and histopathology (Wm. T. Yasutake). Gail R. Dryer was the first administrative officer. The space initially given to the group by the University included a large bacteriology laboratory; a wet laboratory with three large aquaria, sixteen 4-foot troughs supplied with heated and chilled dechlorinated city water; a shop; a dark room for photographic work; laboratory space for preparation of histological specimens; and 4 office/laboratory rooms for researchers in fish virology, bacteriology, parasitology, and histopathology.

The fish-virology research program was based on Rucker's 1949 discovery that a highly infectious, filterable, heat-labile agent was responsible for the severe mortalities then occurring among hatchery sockeye salmon in the Pacific Northwest. Stanley and Margaret Watson were hired to work on what was then being called the sockeye salmon virus disease. Today, we realize that these reports actually were early accounts of the virus disease now known as infectious hematopoietic necrosis (IHN). The Watson era predated by some years the availability of fish cell and tissue culture techniques. However, their immersion method of experimental infection is still widely used today and their discovery that warm water protects against IHN infections has been sustained.

Another first occurred in 1950, when Rucker and his staff identified *Ichthyosporidium* as the causative agent of mortalities among hatchery rainbow trout, and Chinook, sockeye, and

[12] The life of Dr. Fish was remarkable in many ways. Starting in 1949, he put in a second career with the U.S. Public Health Service taking early retirement in 1960. He then put in a third career with the North Carolina Wildlife Resources Commission, retiring in 1970 as Assistant Chief of the Division of Inland Fisheries. Fish died in 1978. It is quite a story.

coho salmon. Diseased stocks of fish in the western United States were subsequently destroyed. In 1950, Rucker also began work at the Winthrop National Fish Hatchery on bacterial kidney disease (BKD), to develop improved techniques for culturing the organism and methods for its control. In 1952, bacteriologist A. John Ross was hired to expand this line of inquiry with Thomas J. Parisot as his first assistant. Subsequently, Rucker, Ross, and Parisot became the first to identify the saltwater pathogen *Vibrio anguillarum* as the cause of large-scale mortality in rainbow and steelhead trout in freshwater and trace its origins to herring meal in the diet.[13] Rucker and Ross also were the first to diagnose and treat *Ichthyosporidium* infections in freshwater salmonid fishes in the United States.

In the early 1950s, Rucker had originally isolated a Gram-negative motile rod-shaped bacterium from rainbow trout with redmouth disease, a very serious problem in Idaho hatcheries. Bacteriologist A. John Ross subsequently classified this organism as a member of the *Enterobacteriaccae* and, working with the Centers for Disease Control, placed it in the genus *Yersinia,* and gave it the specific name *ruckeri*.[14]

In 1954, the Watsons left[15] WFDL and Tom Parisot took over virology research. Parisot developed tissue culture techniques and continued studies on fish viruses, which included the sockeye and Chinook salmon viruses (today known as IHNV) and a rainbow trout virus (today known as IPNV).

By 1958, the rapidly growing College of Fisheries needed the space WFDL was using, so Rucker located a vacant warehouse at the nearby Sand Point Naval Air Station. The FWS provided the materials and Navy personnel remodeled the space into a well laid out laboratory including a shop, dark room, library/conference room, and animal quarters for fish immunology research. The wet laboratory contained 15 circular tanks, twenty 4-foot stainless steel troughs and 2 water tables—all supplied with well water and heated and chilled dechlorinated city water.

In 1959, Joe Uzmann joined the staff to initiate a parasitology research program. Uzmann also collaborated with the North Pacific investigators at the Montlake laboratory in delineating the origin of salmon stocks using their parasites as geographic indicators.

In 1960, histologist Wm. T. Yasutake transferred from the FWS Western Fish Nutrition Laboratory (WFNL) at Cook, Washington,[16] to start a fish pathology diagnostic laboratory at the WFDL. His research assignment was to describe the histopathology of fish diseases of interest to the laboratory, identify etiologic agents, and confirm the provisional diagnoses of hatchery biologists. Yasutake was one of the first scientists to recognize hepatoma (liver cancer) in a population of hatchery-reared rainbow trout and he helped trace the disease to an aflatoxin produced by the mold *Aspergillus flavis* growing on fish diet ingredients during storage—another first for WFDL. Yasutake later became the first American to be awarded a doctorate by the Faculty of Fisheries, University of Tokyo. His classic "Microscopic Anatomy of Salmonids: An

[13] Rucker, R.R., 1959, Vibrio infections among marine and fresh-water fish: Progressive Fish-Culturist, v. 21, p. 22–25.

[14] Ewing, W.H., Ross, A.J., Brenner, D.J., and Fanning, G.R., 1978, *Yersinia ruckeri* sp. nov., the redmouth (RM) bacterium: International Journal of Systematic Bacteriology, v. 28, p. 37–44.

[15] Stan Watson joined the staff of the Woods Hole Oceanographic Institute in 1957 and in 1974, he founded a successful biologics company to market his patented *Limulus* amebocyte lysate assay (LAL) to detect bacterial endotoxins in pharmaceuticals required to be pyrogen free. Watson died in 1995.

[16] The WFNL was closed in 1975 and the facility currently is occupied by WFRC's Columbia River Research Laboratory.

Atlas" was published in 1983 and quickly became a standard reference work that is still in use today.[17]

Additionally, 1960 was also the year Rucker organized a small round-table discussion in the laboratory conference room to exchange ideas about fish disease problems of mutual interest to hatchery biologists and fish disease researchers in the western United States. About 10 state and federal biologists attended the initial meeting including the late Jim Wood and Dick Westgard (Washington Department of Fisheries), Joe Wales (Oregon Fish Commission), Harold Wolf and Bob Toth (California Fish and Game), and the WFDL staff. This meeting turned out to be a significant event that was subsequently recognized as the first working session of the Western Fish Disease Conference. Today, this conference is convened annually and attracts hundreds of fishery professionals.

In 1963, veterinary pathologist G.W. Klontz joined the WFDL research team to initiate much needed work on fish immunology and develop vaccines against diseases such as furunculosis in rainbow trout. Klontz, assisted first by Dennis Crouch and then by Douglas Anderson, also collaborated with A.J. Ross in conducting bacteriological research on enteric redmouth disease (ERM), caused by the gram-negative bacterium *Yersinia ruckeri*. At the time, this disease was a very serious factor limiting the success of the Idaho commercial aquaculture industry. Klontz and Ross were the first scientists to develop an effective experimental vaccine against this agent. Klontz and Anderson also did much of the original work on the unique immune system of salmonids and were the first to describe precipitating antibody in rainbow trout. The fact that these cold-blooded animals could produce large amounts of a circulating tetrameric, IgM antibody was an important milestone in fish immunology. Klontz and Anderson also made the first application of immunoflourescence in fish disease research using rabbit antibodies against the pathogens in the assay. In the 1960s, few fishery scientists were willing or capable of drawing clean heart blood and processing the sera for the valuable antibody needed for diagnostic assays.

By the early 1960s, pesticides had become a serious national environmental concern and, in the Pacific Northwest, an issue that connected fish to forests and agriculture. Fish toxicity problems were caused by aerial spraying of farms, orchards, and forests; disposal of excess material; and equipment washing. However, water samples collected after a fish kill had occurred sometimes showed no evidence of the suspected pesticide. To address such problems, Gary A. Wedemeyer was stationed at WFDL, in 1965, as a field representative of the FWS Fish Pesticide Research Laboratory in Denver, Colorado. He was tasked with developing the methods, concepts, and standards needed to identify and quantify biological effects of pesticides on west coast fishery resources, and to establish safe exposure limits to protect the aquatic environment. Wedemeyer's research was among the first to document the limited metabolic pathways available for the biodegradation of DDT in the aquatic environment.

The Western Fisheries Research Center, ca. August 1965.

[17] Yasutake, W.T., and Wales, J.H., 1983, Microscopic anatomy of salmonids—An Atlas: U.S. Fish and Wildlife Service Resource Publication 150, Washington D.C.

During 1960s, organic mercurials were often used to control external bacterial infections in hatchery salmonids and questions were being raised about their safety. Accordingly, Rucker hired Donald F. Amend in 1965 to evaluate mercury uptake by hatchery fish treated with these compounds. The effect of Amend's research was immediate and lead to the abandonment of mercury compounds for treating fish diseases.

R.R. Rucker, Gary Wedemeyer, and A.J. Ross, ca. 1968, measuring effects of DDT exposure on the oxygen consumption of coho salmon. Seattle Times photograph, used by permission.

In 1968, WFDL virologist Tom Parisot was appointed assistant director of the new Fish Pesticide Research Laboratory then under construction by the FWS in Columbia, Missouri. Having completed his mercury uptake work, Don Amend then assumed Parisot's research projects on the Oregon Sockeye Virus (OSV) and the Sacramento River Chinook Disease Virus (SRCDV). Amend compared these agents with the previously isolated sockeye and Chinook salmon viruses and determined that all three produced similar pathologic changes in tissue culture cells, and that the diseases had certain other features in common as well. Because the renal blood-forming tissues were the specific target, Amend, Yasutake, and Meade proposed the name 'infectious hematopoietic necrosis' in their 1969 seminal publication.[18] The viruses of Oregon sockeye disease, Chinook salmon virus disease, and IHN soon became recognized as one entity and the name IHN stuck. Amend's subsequent research findings on preventing transmission of the IHNV by iodophor disinfection are still in use today as a standard hatchery practice.

Parisot's departure also brought about Gary Wedemeyer's reassignment to the WFDL staff. Wedemeyer was tasked with broadening his pesticide toxicology research to include developing concepts, methods, and standards for determining the physiological tolerance limits of fish and fish populations to the stress of environmental alterations in general. These experiments were of a landmark nature because they led to a new understanding of the physical, chemical, and biological conditions during freshwater rearing required to improve the health, physiological quality, and early marine survival of juvenile salmonids released from federal mitigation hatcheries. Wedemeyer's research findings on the physiological stress of hatchery rearing conditions also soon became an important consideration for the fish disease diagnostician.[19]

In 1972, Klontz[20] left WFDL for a position at Texas A&M University and Anderson assumed his research assignment, assisted by Kathy Stannes as his laboratory technician. That year Anderson also began work on his classic textbook "Fish Immunology," part of the 6-volume series on fish diseases being edited by S.F. Snieszko and H.W. Axelrod. Anderson's seminal

[18] Amend, D.F., Yasutake, W.T., and Mead, R.W., 1969, A hematopoietic virus disease of rainbow trout and sockeye salmon: Transactions of the American Fisheries Society, v. 98, p. 796–804.

[19] Mitchell, A.J., 2001, Finfish health in the United States (1690–1969)—Historical perspective, pioneering researchers, and annotated bibliography: Aquaculture 196:347-438.

[20] Dr. Klontz later joined the faculty of the University of Idaho where he finished out a distinguished career. He received the American Fisheries Society S.F. Snieszko Award in 1994 and died in 2000.

volume was published in 1974 just before he transferred to the FWS Eastern Fish Disease Laboratory in Leetown, West Virginia, where he finished out a distinguished career as Chief of Immunology and Biologics.[21]

After Andersen's departure, Don Amend took over the WFDL immunology research program and, in cooperation with the biologics company Wildlife Vaccines, developed the first commercial vaccines for vibriosis and ERM.

In 1973, Rucker retired[22] and Wedemeyer was appointed interim acting Director.

The years from 1950, when the WFDL was established as an independent laboratory, until Director Bob Rucker retired were very exciting in the history of the WFRC. They were marked by a very rapid expansion of new ideas critical to the continued survival of hatchery propagated anadromous and non-anadromous salmonid populations of the United States, Canada, Russia, Japan, and Europe. The accomplishments of this small research team earned them the respect and friendship of the international fishery biology research community.

With an annual appropriation averaging less than $250,000, and a staff of five principal investigators, the Center produced more than 200 technical publications during the Rucker era. These papers are catalogued in the Center's master publication list posted on the WFRC web site *http://wfrc.usgs.gov/products/*.

The 'WFRC' Staff in 1966. From left: Tom Parisot, virologist; Robert R. Rucker, Director; Nell Nichols, clerk/typist; Don Amend, virology; Norma Busby, histology; Gary Wedemeyer, field representative, Fish Pesticide Laboratory, Denver, Colorado; Wm. T. Yasutake, histopathology; A. John Ross, bacteriology, G. Wm. Klontz, immunology; Reg. Morgan, fish culturist; Gail Dryer, office manager; Doug Anderson, immunology; and Jan Martin, bacteriology.

[21] Dr. Anderson received the American Fisheries Society S.F. Snieszko Distinguished Service Award in 1989 and retired in 1994.

[22] Rucker received the American Fisheries Society S.F. Snieszko Distinguished Service Award in 1980. Rucker died in 1998 and was inducted into the AFS Fish Culture Hall of Fame posthumously in 2011.

Chapter 3

1974 – 1977: The Transitional Years

Thomas J. Parisot, Center Director 1974–77.

The Fish/Rucker years were truly the end of an era in that the early 1970s were marked by the passage of landmark environmental legislation such as the Clean Water Act, National Environmental Policy Act, and the Endangered Species Act that greatly expanded the technical information needed by the FWS for natural resource management. The mission of the WFDL was therefore broadened to include a wider range of fisheries and aquatic science and the laboratory was renamed the National Fisheries Research Center (NFRC). In late 1974, Thomas J. Parisot, a member of the FWS Directorate in Washington D.C., was appointed Center Director. Parisot immediately initiated a comprehensive review of the NFRC research program and initiated innovative new biological research programs while retaining the historic core competencies in fish disease research that had made NFRC's predecessor, the WFDL, a world leader. Parisot's work thus laid the organizational and scientific foundation for what the WFRC has become today.

Marrowstone Marine Field Station

Parisot's first initiative was to provide a seawater research capability — the Marrowstone Marine Field Station (MMFS) added in 1974. Here for the first time, biologists were able to study young salmon under controlled conditions during their critical first few months after seawater entry and identify environmental stress factors during freshwater rearing that limited early marine survival.

The Marrowstone Marine Field Station, ca. 1973.

The MMFS was originally established in 1972, on 5 acres of a surplus U.S. Coast Guard light house station at the northern end of Marrowstone Island, Washington, by Dr. John E. Halver, Director of the (then) FWS Western Fish Nutrition Laboratory at Cook, Washington. At that time, the MMFS facility consisted of an 1896 light keeper's residence (converted into laboratory and office space), a garage (converted into a wet laboratory) and a boathouse (converted into a shop).

Clarence C. Johnson was the Biologist-in-Charge. Seawater initially was obtained from a slant-well drilled into the sand above the shoreline. The MMFS property and the staff were transferred to the NFRC in 1974; in 1975, Johnson designed and installed an improved seawater intake with an additional 3,200 square feet of wet laboratory space.

Parisot's second initiative was to develop new research programs in fish genetics/population biology, and physiological ecology. John D. McIntyre and Gerald R. Bouck were hired as project leaders in 1974–75, and in 1977, Stan Smith was hired to assist with Bouck's physiological ecology research. Smith soon transferred to MMFS to replace Clarence Johnson who had relocated to NFRC-Seattle to work with Wedemeyer in solving a smolt physiology problem that was limiting the survival of downstream migrants at the new FWS Dworshak National Fish Hatchery in Idaho.

Alaska Research Field Station[23]

Parisot's third initiative was to establish an Alaska Research Field Station. By 1976, impending oil and gas energy development had provided an impetus for an expanded FWS research presence in Alaska, and NFRC Section Chief John D. McIntyre was dispatched to the FWS Area Office in Anchorage to lay plans for the new facility and for the research to be conducted. Carl V. Burger, who was just finishing a tour of duty as a federal field monitor for the Trans-Alaska Pipeline Project, was hired in spring 1976 as the field station's first employee. By late summer of 1976, McIntyre had selected fish geneticist Richard L. Wilmot, then at the FWS Ecological Services office in Olympia, Washington, as field station chief. Wilmot's expertise in fish genetics was key to filling a niche in Arctic and sub-Arctic fishery research—a niche where not much genetics research was being done except for a limited Alaska Department of Fish and Game effort in genetic policies for hatchery egg takes.

In late 1976, the NFRC Alaska Field Station opened shop in a small office with an adjoining one-room laboratory on Northern Lights Boulevard in Anchorage with a secretary and two biologists—Burger and Wilmot. The station's first project was a genetic survey of fishes (coregonids and grayling) on Naval Petroleum Reserve #4, near Barrow. There were plans for an oil extraction facility near Barrow and the FWS needed baseline information to assess potential environmental impacts. The Area Office provided the fly-outs from Barrow for field sampling as well as required field support (with FWS biologists Norval Netsch and Ed Crateau as float plane pilots). Over time, NFRC and Alaska Area Office biologists would conduct pioneering genetics and telemetry studies of Kodiak Island, Kenai River, and other salmon populations.

Seattle Laboratory

In 1975, NFRC-Seattle microbiologist A.J. Ross retired[24] and Rowan W. Gould was hired to carry on and expand Ross's work on bacterial kidney disease (BKD) and other economically important bacterial diseases of fish. Gould's work was innovative for its application of the "next-generation" research techniques of the emerging field of molecular biology being developed at that time.

[23] Condensed from material originally written by Carl V. Burger, U.S. Fish and Wildlife Service (Ret.).

[24] Deceased, 2003.

In 1976, research virologist Don Amend left the NFRC to direct fish vaccine development for Johnson & Johnson Pharmaceuticals[25] and Dan Mulcahy[26] was hired to continue Amend's pioneering work on the isolation and quantification of IHN virus in hatchery salmonids. Mulcahy immediately recruited Ronald J. Pascho[27] as his assistant and together, they conducted a series of innovative studies on waterborne transmission of the infectious hematopoietic necrosis virus and its pathogenesis in sockeye salmon (*Oncorhynchus nerka*).

In 1977, the Parisot[28] era ended with his transfer to a research management position in the FWS Central Office in Washington D.C. Once again, Wedemeyer was appointed Acting Director, serving until late 1978.

The 4 years of Parisot's tenure were significant in the evolution of what would become the WFRC. The innovative new research areas Parisot developed and the research findings of his scientific staff provided much needed technical information to resource managers responding to the legislative mandates of the new environmental laws that were then being enacted.

[25] Tavolek Inc., was founded by Johnson & Johnson Pharmaceuticals. Amend later served as professor of fish pathology at the University of California–Davis and finished out a very productive career as Director of the Southeast Aquaculture Association in Ketchikan, Alaska. He retired in 1988.

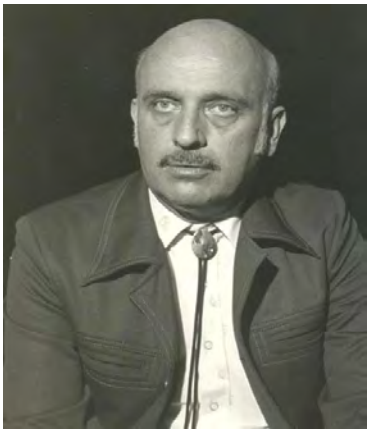
[26] Mulcahy transferred to the FWS National Wildlife Health Laboratory in Madison, Wisconsin in 1986.

[27] Retired, 2003.

[28] Parisot retired in 1986 after holding several increasingly responsible positions in the FWS Central Office.

Chapter 4

1978 – 1994: Expansion and a State-of-the-Art Facility



Alfred C. Fox, Center Director, 1978–1994.

In 1978 Alfred C. Fox, then Chief of the FWS Ecological Services Division, was appointed Center Director.[29] After evaluating the center's research program, Fox selected Clarence M. Johnson as his deputy. Once again, the mission of the NFRC was broadened and new field stations were established. A major feature of the Center's work during the Fox years involved expanded cooperation with other public fisheries agencies, universities, and non-governmental organizations. The Cooperative Fish and Wildlife Research Units at the University of Washington and University of Idaho became especially valuable partners, with NFRC scientists supervising graduate student dissertation research, giving guest lectures and seminars, and teaching courses.

Seattle Laboratory

In 1980, John D. McIntyre,[30] the laboratory's first Section Chief for fish ecology, hired Reginald R. Reisenbichler from the FWS Fisheries Assistance Office in Red Bluff, California. Working with Ted Bjornn,[31] Idaho Cooperative Fisheries Research Unit, Reisenbichler and McIntyre quickly developed studies to determine the effects of hatchery supplementation on Idaho steelhead populations and other native species such as bull trout and cutthroat trout. In 1999, University of Idaho students Alan Bryne and Steve Rubin were hired to collaborate on Reisenbichler's classic work on the genetic population structure of Olympic National Park and Columbia River salmonids. With the assistance of Kim Larsen, Steve Rubin, Mike Hayes, and Lisa Wetzel, Reisenbichler

Reginald Reisenbichler, ca. 2010.

[29] Fox had previously served for many years as FWS Cooperative Unit Leader at Montana State University and the University of Georgia. He retired from the NFRC in 1994 and died in 2011.

[30] McIntyre transferred to the U.S. Forest Service (Boise) in 1990 where he finished out his career, retiring in 1994 and died in 2012.

[31] Deceased, 2001.

established an otolith laboratory and began long-term studies of hatchery-wild fish interactions including effects on stock productivity. In later years, during the Thorsteinson era, Reisenbichler[32] and his research team would do innovative research on the ecology of eelgrass habitats in Puget Sound and its estuaries as well as important work on the life history of the anadromous bull trout.

In 1983, Microbiologist Rowan W. Gould ended his innovative fish disease research work at the Center to become Director of the FWS Wellsboro, Pennsylvania Research Laboratory. Gould later went on to become Deputy Director of the FWS Pacific Region, Director of the Alaska Region, and in 2008, Deputy Director of the FWS.

Diane G. Elliott was hired in 1985 to continue Gould's seminal research on BKD in hatchery fish. Elliott collaborated with Ron Pascho and expanded these studies into pioneering work on the effects of stress factors such as transporting downstream migrant smolts around the dams on the Columbia River on BKD infection rates. Lynn (Chip) Applegate joined the Elliott/Pascho BKD research team in 1985, Connie McKibbon was hired in 1989, and Dorothy Chase joined in 1993. In addition to their pioneering work on BKD in downstream migrant Columbia River smolts and in the Great Lakes, Pascho and Elliott made a series of lasting contributions to the detection and control of BKD by developing an enzyme-linked immunosorbant assay (ELISA) diagnostic test to replace the traditional method of isolation and culture, and the broodstock segregation method of controlling BKD by preventing its vertical transmission. Today, the ELISA and a new polymerase chain reaction (PCR) assay Pascho and Elliott developed are considered standard practice. Their chapter in the book "Molecular Diagnosis of Salmonid Diseases" has become a classic reference.[33]

Diane Elliott with one of her Ikebana flower arrangement she often made for the WFRC staff to enjoy.

After making significant contributions to the improvement of the seawater survival of anadromous salmonids released from federal mitigation hatcheries, Gerald Bouck[34] left the Center in 1983 to take a Senior Fisheries Scientist position with the Bonneville Power Administration. Bouck was replaced by Percy Washington who transferred from the National Marine Fisheries Service (NMFS) Seattle Montlake laboratory.

[32] Reisenbichler retired in 2008 and is currently a WFRC scientist emeritus.

[33] Pascho, R.J., Elliott, D.G., and Chase, D.M., 2002, Comparison of traditional and molecular methods for detection of *Renibacterium salmoninarumin* Cunningham, C.O., (ed.), Molecular diagnosis of salmonid disease: Kluwer Academic Publishers, Dordrecht, p. 157–209.

[34] Received the American Fisheries Society Meritorious Service Award in 1997.

In 1983, Seattle Laboratory virologist Dan Mulcahy hired William N. Batts to aid in the isolation and quantification of IHNV in hatchery samples. In 1986, Mulcahy[35] transferred to a virologist position at the FWS National Wildlife Health Laboratory and James R. Winton, then at Oregon State University, was hired to replace him. In 1988, when viral hemorrhagic septicemia (VHS) was first detected in North America, Winton and Batts were on the forefront of the diagnosis and performed many studies into rapid detection procedures involving DNA probes and PCR. Winton went on to build up a strong interactive team of principal investigators who not only maintained the already excellent fish disease research capability of the WFRC, but also improved it. The accomplishments of the fish disease research section are too many to list here, but they include pioneering work on the molecular biology of the infectious hematopoietic necrosis virus (IHNV), the viral hemorrhagic septicemia virus, *Piscirickettsia salmonis*, the first Gram-negative, intracellular bacterial pathogen isolated from fish and a significant cause of mortality in salmonids, BKD, and VHS in the Great Lakes, whirling disease (*Myxobolus cerebralis*), and infectious salmonid anemia virus (ISAV) in west coast anadromous fish populations. Winton went on to earn the AFS Snieszko Distinguished Service Award, and the Department of the Interior Meritorious Service Award and Distinguished Service Award—the only WFRC scientist ever to be so recognized.

William (Bill) Batts, ca. 2005.

James R. Winton, ca. 2010.

In 1985, ecologist John M. Emlen, then Director of the U.S. Environmental Protection Agency (EPA) Risk Assessment Division in Corvallis, Oregon, was hired to replace Percy Washington who had left to start a private consulting firm. Emlen soon became a leader in developing the theoretical underpinnings of developmental stability, a phenomenon based on the symmetry of organisms and how this symmetry can break down when organisms experience environmental or genetic impacts. He also did pioneering research on a new field-based methodology for studying populations called Interaction Assessment and wrote specialized software and field techniques for its implementation.[36]

In 1985, Assistant Director Clarence Johnson[37] transferred to the FWS Washington Office and Stan Smith came to Seattle from the MMFS to replace him.

[35] Mulcahy retired in 2003.

[36] Emlen retired in 2005.

[37] Johnson finished out a notable career as FWS Biologist-In-Charge of chemical and drug registration activities with Federal Drug Administration, U.S. Environmental Protection Agency, and U.S. Department of Agriculture. Johnson retired in 1997 and died in 2010.

In 1986, Wm. T. Yasutake's[38] landmark book, *The Microscopic Anatomy of Salmonids: An Atlas,* was published. In preparation for more than 20 years, this atlas of fish histology quickly became a classic reference text. It was reprinted in 2005 and still is in use today.

Gael Kurath, Senior Research Virologist, ca. 2005.

In 1988, the Reagan administration appropriated initial funding for the design and construction of a modern laboratory building to replace the aging WWII warehouse that had housed the Seattle Center since 1958 and in 1990, Center Director Fox hired Allen Marmelstein from the FWS Hawaii Area Office to assist with the design preparations for this project.

In 1992, Fish Health Research Team Leader Jim Winton hired Gael Kurath to begin research on the molecular biology of fish viruses and in 1994 Kurath hired Eveline Emmenegger as her research associate. The Kurath-Emmenegger collaboration continued through 2007 with accomplishments such as a patent for a DNA vaccine against spring viremia of carp (SVC) and a virus isolate genetics database for IHNV, VHSV, and SVCV.

Columbia River Field Station

Lance Beckman with his "Lab" assistant, ca. 1964

Among the most significant new research efforts initiated by Center Director Fox was the establishment in 1978 of a field station on the Columbia River. Earlier that year, the FWS reorganized the National Reservoir Research Program (NRRP) and biologists William R. Nelson and Lance G. Beckman, then at the NRRP field station at Pierre, South Dakota, were reassigned to the NFRC and stationed at the FWS Fisheries Assistance Office in Vancouver, Washington.

Fox tasked Nelson and Beckman with developing a research program to provide information needed by resource managers on fish populations in the impoundments behind the 11 major dams on the Columbia River. Nelson and Beckman were quickly successful in obtaining Bureau of Reclamation funding to study the distribution and abundance of fish populations in Lake Roosevelt, the reservoir behind Grand Coulee dam. Dennis Rondorf was the first biologist hired followed by Gerry Gray Anthony Nigro, and Richard Harper. Gray and Harper were stationed at Grand Coulee to begin the Lake Roosevelt research program under the supervision of Lance Beckman. Dennis Rondorf was stationed at the McNary National Wildlife Refuge (NWR) to conduct a related study on juvenile fall Chinook salmon in the reservoir behind McNary Dam.

Dennis Rondorf, first biologist hired by the CRRL, with a Columbia River shad, ca. 2011.

[38] Yasutake retired in 1988 and is currently a Senior Scientist Emeritus at the Center.

In 1980, Congress enacted the Northwest Electric Power Planning and Conservation Act. In response, the major emphasis of the Columbia River Field Station (CRFS) shifted to providing natural resource managers and regulators with an improved understanding of how hydropower systems affect the growth and survival of anadromous salmonids in the various freshwater habitats they use for spawning, rearing, and migration in the Columbia and Snake River basins. Although the research targeted hydropower related problems, the research also was designed to be applicable to fish passage and other issues in regulated rivers throughout the United States. Other environmental stress factors, such as fishing, agriculture, and hatchery practices also were studied to determine their effects on efforts to sustain native runs of salmon. This research began in 1981 with pioneering work by Dennis Rondorf on the bioenergetics of downstream migrant smolts and Gerry Gray on predator-prey relationships. Other early researchers on the predation project were Jean Beyer Rogers, Mike Faler, Hal Hansel, Doug Palmer, and Gary Sonnevil.

The CRFS research program grew rapidly and in 1982, the staff moved to the former FWS Western Fish Nutrition Laboratory at Cook, Washington, in the Columbia River Gorge east of Portland, Oregon. Soon after the move, the CRFS was renamed the Columbia River Research Laboratory (CRRL) and the research program continued to progress.

Mike Parsley, CRRL project leader for sturgeon and shad ecology, ca. 2005.

In 1984, Gerry Gray transferred from CRRL to the FWS Alaska Regional Office and Tom Poe[39] was later hired from the FWS Great Lakes Fisheries Research Laboratory to succeed him. Poe and his research team (Mike Parsley, Matt Mesa, Craig Barfoot, Rip Shively, Steve Vigg, and Roger Tabor) continued CRRL's now classic work on predator-prey relationships throughout the Columbia and lower Snake River basins with emphasis on the survival of salmon smolts. Today, the team's research findings are considered the baseline for predator-prey studies throughout the country.

In 1985, John Beeman was hired to work with Jerry Novotny on a Bonneville Power Administration (BPA) funded study rearing juvenile fall Chinook salmon in net pens in backwaters of the Columbia River to increase the number of adults returning to the John Day Reservoir. This research progressed into physiological measurements of smoltification, stress, and disease. Beeman's research team currently is using radio and acoustic telemetry to monitor fish movements and describe factors affecting in-river mortality and dam passage of juvenile salmonids in several rivers in Washington and Oregon as part of a series of studies to improve downstream passage success.

In 1987, Mike Parsley moved from the predator-prey project to the Columbia River white sturgeon project led by Lance Beckman. These pioneering biologists were the first to

- Delineate the early life history of the Columbia River white sturgeon,
- Find white sturgeon eggs in the reservoirs,
- Capture age-0 white sturgeon in reservoirs,
- Document predation on white sturgeon eggs by other fish, and
- Publish a paper in which a geographic information system (GIS) was used to quantify habitat for fish.

[39] Poe retired in 1999 and served as a consultant for BioAnalysts Inc. for several years. He has been a member of the Northwest Power and Conservation Council and their Independent Scientific Advisory Board since 2003.

In 1991, Stan Smith[40] transferred to the CRRL to assist Director Bill Nelson with his work on facilities expansion and to begin his own research on hatchery rearing practices. Dennis Rondorf also started his Snake River fall Chinook project in 1991 and Alec G. Maule was hired to continue the smolt condition for travel-time analysis project that Rondorf had initiated in 1987. Maule expanded Rondorf's pioneering work on smolt physiology and in 1996 began his own classic gas bubble disease research and monitoring project.

CRRL's Alec Maule, ca. 2005.

During Director Bill Nelson's era (1978–94), CRRL fisheries science in the Columbia River Basin steadily expanded to address the information needs of the Army Corps of Engineers, Bonneville Power Administration, and other client agencies willing to support well-regarded USGS science. In 1988 for example, Nelson hired James H. Peterson to mathematically model predation as a factor limiting smolt survival in the Columbia River Basin. Peterson's innovative research lead to bioenergetics and individual-based models of predation in a "normalized" Columbia River. Peterson was also a key driver in establishing the stream ecology research program, which since has become a mainstay of the laboratory. After Nelson[41] retired in 1994, Jim Peterson was appointed Acting Director. After Beckman retired in 1994, Parsley became project leader and later the WFRC's geospatial technology coordinator for the Biological Resources Division of the U.S. Geological Survey. His "Digital Atlas of John Day Reservoir," has become a classic reference work.

Alaska Research Field Station[42]

Research at the Alaska Research Field Station also was growing in importance in the late 1970s. In 1978, the staff moved into larger quarters in the FWS Regional Office building in Anchorage. This new laboratory and office space provided a unique set of research capabilities including an isolation room, genetics laboratory, and fish rearing tanks. The group branched out to research areas on Karluk Lake and the Kenai Peninsula and Dick Wilmot's genetic analyses took on new relevance in the world of fisheries management and coast-wide stock assessment. Sockeye and Chinook samples were collected from Kenai Peninsula streams such as the Russian River, where there was a suspected remnant population of steelhead. Corky Hunger was detailed from the MMFS to help assemble the new laboratory and to assist with the genetic sampling effort in the field.

In 1979, Dave Wangaard and Aldo Palmisano were hired to provide the improved biological information needed on Chinook salmon spawning and rearing areas in the Kenai River, one of the most heavily used recreation areas in the State. Palmisano was given the responsibility of overseeing a population estimate of Chinook salmon in an upper Kenai River tributary (the Killey River). His innovative use of a portable electric weir led to some valuable scientific results and garnered high praise among Alaska Department of Fish and Game resource managers.[43]

---

[40] Retired, 1997

[41] Deceased, 2007

[42] Written by Carl Burger, January 2010.

[43] Palmisano, A.N., and Burger, C.V., 1988, Use of a portable electric barrier to estimate Chinook salmon escapement in a turbid Alaskan river: North American Journal of Fisheries Management, v. 8, p. 475–480.

In these early days (1979–80), Carl Burger developed radio-tagging techniques for Kenai River Chinook and coho salmon as a method to find their main stem spawning areas, pioneering the use of radio telemetry to track fish movements in Alaska. Burger's[44] finding that two distinct runs occurred, coupled with spatial, temporal, and genetic distinctness, led to widely recognized publications on thermal adaptation and post-glaciation colonization strategies.

In the mid-1980s, a collaborative project was developed with the FWS Refuge Division to study the declining sockeye salmon run at Karluk Lake. Sockeye salmon are an important food source for the Kodiak Island brown bear population. Rowan Gould and Dan Mulcahy took tissue samples from migrating salmon in the Karluk River to determine the incidence of virus and bacterial diseases, Reg Reisenbichler designed a weir to evaluate the role of stickleback competition on sockeye growth rates, and Terry Terrell did core sampling to discern the role of marine-derived nutrients in lake productivity. Dick Wilmot ruled out genetics issues.

From Karluk, Dick Wilmot's coast-wide genetics program advanced, along with some other research efforts for the National Park Service involving rainbow and sockeye salmon studies in Katmai National Park and Wrangell-St. Elias National Park.

The Center's direct role in Alaska ended in 1988 when all FWS studies were consolidated under a new research group in Anchorage with Angelo W. (Bill) Palmisano as Director. Cooperation with NFRC continued, however. For example, Wedemeyer maintained an active working relationship with the Cooperative Fisheries Research Unit-Fairbanks (Dr. Jim Reynolds, Unit Leader) on the tolerance of fish to the environmental impacts of placer mining, and the redesign of highway culverts that were blocking the upstream migration of returning adult salmon.

Reno Field Station

In 1985, the Center established an endangered species-recovery research field station in Reno, Nevada, under the leadership of G. Gayton (Gary) Scoppettone. Located within 400 miles of about one-half of the Nation's Endangered Species Act (ESA)-listed fishes, the mission of the station was to provide biological information needed for the recovery of threatened and endangered "desert fish" populations in the Great Basin and Mojave Desert area of the western United States. Scoppettone, then at the FWS Reno Fisheries Assistance Office, had been working with the Center since 1981 on the life history requirements of the endangered cui-ui *(Chasmistes cujus)* of Pyramid Lake, Nevada. This information was needed to provide legally defensible water flow and temperature regimes to ensure the continued natural reproduction of this unique species in the Truckee River. After transferring to the NFRC staff, Scoppettone continued this work and, with the assistance of Howard Burge, began his pioneering recovery plan research that lead to the successful establishment of self-sustaining endangered Moapa Dace (*Moapa coriacea*) populations in the Moapa National Wildlife Refuge, Nevada, the first wildlife refuge acquired by the FWS for a fish species.

Reno Field Station Chief Gary Scoppettone, ca. 2005.

[44] Carl Burger departed Alaska in 1996 to head up the FWS Abernathy Fish Technology Development Center. Burger served as president of the American Fisheries Society in 2000 and afterward appointed Director of the FWS Maine Fisheries Program Complex Office. He retired in 2006 and is presently a senior scientist with Smith-Root Inc.

The definition of spawning and rearing habitat requirements of the Pyramid Lake cui-ui by Scoppettone and Mark Coleman (then at the FWS Fisheries Assistance Office) led to the important discovery that cui-ui (and larger suckers in the west such as the Lost River, shortnose, and June sucker) were much longer lived than previously believed—surviving in some cases as long as 50 years.[45] The Reno Station's pioneering work with the Nevada Department of Wildlife is widely credited with preventing the extinction of the white river springfish, which had declined to only 20 individuals. Today, this species numbers more than 1,000. In 1988, Scoppettone hired Peter Rissler and Mark Coleman who began the endangered Klamath Lake sucker project that eventually evolved into the Center's Klamath Falls Field Station.

Since its founding in 1985, the Reno Field Station, under Scoppettone's leadership, has continued to provide badly needed status surveys and critical information on the life history, population dynamics, and interspecific interactions of threatened and endangered species. To date, these surveys have been used for biological opinions, water management strategies, invasive species control measures, and the listing and recovery plans of more than 30 threatened and endangered fishes in the desert aquatic ecosystems of the Great Basin.

Marrowstone Marine Field Station

In 1980, under the leadership of Stan Smith and Gerald Bouck, the Marrowstone Marine Field Station (MMFS) was enlarged to enable the laboratory to pump as much as 200 gallons per minute of seawater from a depth of 40 feet. This allowed large-scale studies to be carried out under controlled conditions on the effects of environmental alterations during freshwater rearing on the parr-smolt transformation and subsequent seawater survival of anadromous salmonids. A series of such studies were later conducted with the BPA, EPA, NMFS, Washington Department of Fish and Wildlife (WDFW) and the University of Idaho. In 1981, Ted Bjornn and Christine Moffitt of the University of Idaho began their groundbreaking 8-year study at MMFS to determine how feeding juvenile salmonids erythromycin to control BKD during hatchery rearing affected their subsequent smoltification and early marine survival. A small travel trailer brought from Idaho served as living quarters.

From 1982 to 1992, pioneering work on the culture of Pacific halibut (*Hippoglossus stenolepis*) was conducted at MMFS in cooperation with University of Washington School of Fisheries director Robert Stickney, the International Pacific Halibut Commission, and MMFS Biologist-in-Charge, Stan Smith. In 1984, Smith transferred to the Seattle laboratory to replace Clarence Johnson as Director Fox's Deputy and Aldo Palmisano[46] transferred from the Alaska Field Station as MMFS Field Station Chief. In 1987, Robin Schrock[47] was hired as his principal biologist.

In 1988, Palmisano hired Nancy Elder, then a University of Idaho research associate working with Christine Moffitt and Ted Bjornn on the eythromycin project at MMFS. Elder's first project was the WDFW collaboration with the Center on the effects of Chehalis River pulp mill and sewage treatment plant effluents on the smoltification and early seawater survival of juvenile spring Chinook salmon.

---

[45] Scoppettone, G.G., 1988, Growth and longevity of the cui-ui and other *catostomids* and *cyprinids* in western North America: Transactions of the American Fisheries Society, v. 117, p. 301–307.

[46] Deceased, 2002

[47] Schrock transferred to CRRL in 1991 where she managed several fisheries and water-quality studies. She later transferred to USGS in Reston, Virginia and in 2003, became the Assistant Fisheries and Aquatic Resources Program Coordinator. She is presently the Executive Director of the US Bureau of Reclamation Trinity River Restoration Project, Weaverville, California.

In 1991–92, the MMFS laboratory underwent an extensive ($4,000,000) renovation. Laboratory space and seawater pumping capacity were more than doubled and the water quality improved by installing a still deeper intake structure and an ultraviolet light (UV) treatment system. New equipment also provided temperature control of the freshwater and saltwater supplies.

In 1996, MMFS began cooperative work with Richard Kocan and Paul Hershberger at the University of Washington to characterize the effects of contaminants on marine species and life stages, in particular the effects of the Exxon Valdez oil spill on the susceptibility of Pacific herring (*Clupea pallasii*) exposed to the VHS virus, a potentially deadly pathogen of these fish. Subsequent work involved an investigation of diseases affecting populations of Puget Sound forage fish such as Pacific herring and Pacific sand lance (*Ammodytes hexapterus*)—important food sources for Pacific salmon, seabirds, and marine mammals.

A State-of-the-Art Laboratory Facility

In 1988, funding for the design and construction of a new Seattle laboratory facility (and further renovation of the MMFS) sought by Congressman Norm Dicks (D-Washington) was approved by the Reagan administration. In 1990, Al Marmelstein transferred from the FWS Pacific Regional Office to assist Director Al Fox with the work required to finish planning and building the new Seattle and MMFS facilities. Research team leader Jim Winton took the lead in the design of the new laboratory, the second such facility Winton had developed. The facility included six artificial streams and an aquatic biosafety level 3 disease-containment facility with airlock entry.

Center Director Al Fox and WFRC founder Robert R. Rucker (Ret.) preparing to turn the first shovel of dirt at the groundbreaking ceremony for the new laboratory, ca. 1992.

Actual construction of the new Seattle Laboratory facility began in 1992. In 1993, while construction was still in progress, a new agency, the National Biological Survey (NBS), was established by the Clinton administration within the Department of the Interior (DOI; appendix 1). In the resulting reorganization, the research divisions of the FWS, National Park Service, Bureau of Reclamation, and several other entities within the DOI were merged into the NBS. Under the NBS, the Center was renamed the Northwest Biological Science Center (NWBSC) and its mission was again broadened—this time to include all biological science disciplines with an emphasis on ecosystems research.

Construction of the new WFRC headquarters and Seattle laboratory, with its state-of-the-art research capability, was completed in 1994. The Seattle facility was designed to support the research needs of the FWS, and, after the USGS merger, still serves that agency as its primary partner.

Shown here is an artist conception of the new facility. Director Al Fox[48] retired in 1994 shortly after the facility was completed, as did long-time Administrative Officer Peggy Dixon. Deputy Director Al Marmelstein became Acting Director until he transferred to the NBS Regional Office in 1994. Gary Wedemeyer[49] was given a temporary promotion to Center Director while a search was, once more, conducted for a permanent replacement.

[48] Fox died in 2011.

[49] Wedemeyer retired in 1998 and currently (2012) serves as Senior Scientist Emeritus. He received the American Fisheries Society Snieszko Distinguished Service Award in 1997 and the Department of the Interior Meritorious Service Award in 1998 for making lasting contributions to science. He was elected to the Northwest Fish Cultural Conference Hall of Fame in 2012 for his contributions to fisheries biology.

Chapter 5

1995 – 2003: Reorganization and the USGS Era Begins

Frank S. Shipley, Center Director, 1995–2003.

In early 1995, Frank S. Shipley[50] was selected as the new NWBSC Director and almost immediately, he and his staff were caught up in a major agency reorganization. In late 1995, DOI Secretary, Bruce Babbitt issued Secretarial Order 3185, which changed the name of NWBSCs parent agency, the politically troubled National Biological Survey, to the National Biological Service (NBS), based on the reasoning that the title "Survey" unnecessarily conjured up an image of government biologists searching for threatened and endangered species on private lands. Secretarial Order 3185 also instructed NBS employees not to work on private land without the owner's permission. By early 1996, NBS's political difficulties were taking their toll and the Wildlife Management Institute joined with five other conservation organizations in urging Congress to return NBS research biologists to their original agencies.

The issue finally was resolved by compromise. In 1996, 3 years after its birth, Congress abolished the NBS, and transferred its employees into the U.S. Geological Survey (USGS). The former stand-alone agency would now become a division—the Biological Resources Division (BRD)—within the USGS. NBS Director Ronald Pulliam became Secretary Babbitt's Science Advisor for a few months and then returned to his former position at the University of Georgia's Institute of Ecology. Assistant Director James Reichman had already resigned to become the Director of the new National Center for Ecological Analysis and Synthesis at the University of California, Santa Barbara. NBS Deputy Director Gene Hester retired.

Dennis Fenn became the first BRD Director in October 1996. Fenn was a veteran employee of the National Park Service and had served as the first Director of the NBS Western Regional Office in Seattle, Washington. After 3 years of almost continuous administrative turmoil, a BRD Director experienced in, and sensitive to agency cultures and procedures, together with a secure home in a veteran DOI agency, greatly assisted Center Director Shipley in his work to maintain the NWBSC at a high level of morale and productivity.

Director Shipley quickly focused on the Center's new role within the USGS, long renowned as the scientific arm of the Department of the Interior. In this new role, the Center's

[50] A true renaissance man, Frank was also a talented musician, well remembered for his guitar playing and singing in the WFRC combo "Close Enough for Government Work." Other members included Gael Kurath keyboard/vocals, and founders Lynn (Chip) Applegate guitar/vocals and Stewart Alcorn, drums.

mission was realigned to fisheries and aquatic resources in the Western United States and in 1997, Shipley gave the NWBSC its current name, the Western Fisheries Research Center (WFRC). Under Shipley's leadership, the Center's research was broadened to encompass larger ecosystem implications influencing fish and their habitats, and realigned to better focus on emerging environmental issues such as marine invasive species. In 2001, Shipley hired Lyman Thorsteinson, then at the USGS Western Regional Office, as his Deputy to assist with these efforts. Thorsteinson had conducted or managed marine ecological and fishery research in Alaska and along the Pacific coast for many years.

Several major environmental trends helped shape WFRC research during Shipley's tenure. Climate change, invasive species, and water availability emerged as major environmental influences on fish and their habitats. The Clinton administration's Pacific Salmon initiative influenced USGS strategic science planning and thus furthered interagency coordination efforts by the Shipley/Thorsteinson team.

In addition to his Deputy Director duties, Thorsteinson also led the Seattle Laboratory Fish Ecology research team and he tasked WFRC scientist Russell J. Rodriguez with developing DNA markers to detect live invasive organisms being transported in marine ballast water tanks. These data were needed to enable state and federal regulators to determine if ballast water could be safely discharged from ships docked in coastal ports of the Pacific Northwest and elsewhere.

Klamath Falls Field Station

Water allocation, especially in dry years, in the Klamath River Basin, Oregon, has long been a challenge that had gained national attention in federal and state natural resource planning. In 1988, the Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*) were listed as endangered species and water quality, quantity, and availability (influenced by human use and climate) were identified as major factors limiting their survival. However, the basin's scarce water resources also were in demand by agriculture, municipalities, and recreationists and unbiased technical information needed by the Bureau of Reclamation, the FWS, and other agencies in the Klamath River Basin was lacking.

WFRC biologists Gary Scoppettone and Mark Coleman (Reno Field Station), and Mike Saiki (Dixon Duty Station) had been monitoring the endangered populations of Lost River and short nose suckers in Klamath Lake and surrounding tributaries on a part-time basis since the late 1980s. In 1999, WFRC Director Shipley decided it was time to establish a permanent field station at Klamath Falls and selected Rip Shively from the CRRL to direct the new station. In 2001, a FWS Biological Opinion on factors affecting the survival of two threatened sucker species in Upper Klamath Lake made the intensive collection of data on fish behavior, movements, and water quality a lasting requirement. In response, Scott VanderKooi transferred from the CRRL to determine patterns of habitat use and the effects of poor water quality on these populations.

Under the leadership of Rip Shively, many of the projects on the life history, population dynamics, and behavioral ecology of fishes in lentic and lotic habitats within the Klamath Basin were conducted jointly with other federal and state agencies and tribes and the Klamath Falls Field Station soon became the exemplar of research groups conducting such studies.

Dixon Duty Station

Dixon Duty Station Chief, Mike Saiki, ca 2005.

Originally established in 1978 as a field station of the FWS Columbia National Fisheries Research Center, the Dixon laboratory became part of the California Water Science Center in 1993 when the NBS was created by the Clinton administration. In 1997, after the NBS had been abolished and its staff transferred into the USGS, all USGS fisheries expertise on the West Coast was consolidated under the WFRC and the Dixon Duty Station, under chief biologist Michael Saiki, became part of the WFRC. This new research capability gave the WFRC expertise in aquatic contaminants and added to its portfolio on desert fishes. The station's close proximity to the rivers of the California central valley and the San Francisco Bay-Delta, and its working relationship with the California Cooperative Fishery Research Unit at Humboldt State University were added advantages. In turn, the affiliation with WFRC broadened the duty station's mission to include research on the ecology and life history of threatened and endangered and other native species in California, the selenium problem at Kesterson National Wildlife Refuge, heavy metal pollution in the upper Sacramento River from acid-mine drainage, and assessing the tolerance of endangered suckers in Upper Klamath Lake to high pH and ammonia and low dissolved oxygen.

In 2001, Barbara Martin joined Saiki at the Dixon Duty Station. Working with the FWS and NPS, Saiki and Martin researched threatened and endangered species such as the Santa Ana sucker, the California freshwater shrimp, and the desert pupfish. They also conducted surveys of poorly documented fish communities in small lagoons along the California coast and in former salt ponds in San Francisco Bay. Long-term monitoring of the Salton Sea to evaluate effects of selenium on fish populations also was done. In 2011, Saiki retired, Barbra Martin transferred to the Klamath Falls Field Station, and the Dixon Duty Station was closed.

Seattle Laboratory

In the late 1990s, Center Director Frank Shipley initiated cooperative studies with investigators from the Russian Academy of Sciences to address Pacific salmonid conservation interests in both nations. This research was part of an ongoing USGS collaboration with the Russian Academy of Sciences and Moscow State University to develop genetic techniques needed for an improved understanding of life history and geographic distribution of Pacific salmonids in the Russian Far East and the U.S. Pacific Northwest. Originally, the collaboration focused on the development of genetic marks for steelhead in Kamchatka Peninsula, Russia. Later, the WFRC and Moscow State University worked together to determine the genetic diversity of Dolly Varden char morphotypes (*Salvelinus malma*) in Kamchatka's Kronotsky Biosphere State Reserve. Both resident and ocean going forms of these char occur in Kamchatka Rivers, such as the Zhypanova River, that are free from hatchery and watershed development. The natural setting of the Kamchatka Peninsula was ideally suited to provide environmental contrast to char in North American habitats that, except for Alaska, are not free of human influences.

In 2001, Shipley conducted field research in Kamchatka with Russian scientists working on the genetics and life histories of Kamchatka Peninsula rainbow trout and steelhead (O. *mykiss*), and char (S. *malma*, S. *leucomaensis*). Anadromous and resident forms of these genera

occur in Kamchatka Peninsula rivers where there are no hatchery and watershed development influences and provide research opportunities pertaining to natural patterns in genetic diversity that do not exist in the United States. In 2003, Moscow State University biologist Serge Pavlov traveled to the WFRC to work with Shipley, Assistant Director Lyman Thorsteinson, and biologists Rusty Rodriguez and Carl Ostberg in genetic analyses of the samples collected. In 2001, IHN virus was detected for the first time in Kamchatka sockeye salmon leading to an ongoing collaboration between WFRC researchers led by Gael Kurath, and Dr. Svetlana Rudakova, virologist for the Kamchatka Science Research Institutes on Fisheries and Oceanography. Genetic typing will be used to understand IHN epidemiology as it continues to emerge in Kamchatka.

During the Shipley years, the WFRC Fish Health Research Section also made important contributions to the management of severe outbreaks of IHNV that had been decimating Atlantic salmon reared in sea pen sites off British Columbia, Canada. In 2001–02, groundbreaking research by the Center's fish disease research group showed that IHNV isolates from sites off the east coast of Vancouver Island were closely related to a common IHNV type that was widespread in Alaska, British Columbia, and Washington. This indicates that the IHN outbreaks in Atlantic salmon sea pens were caused by IHNV from local marine sources endemic to British Columbia.

In 2001-02, WFRC's Charlotte Rasmussen, Alison Colwell, and Jim Winton of the Fish Health Research Section also made considerable progress on methods for the control of whirling disease caused by the myxosporean protozoan *Myxobolus cerebralis*. This parasite infects both salmonid fish and a ubiquitous aquatic oligochaete worm, *Tubifex tubifex* and the complex host-parasite relationship has greatly hindered efforts to develop control strategies to prevent the spread of whirling disease. Determining size and the genetic composition of *T. tubifex* populations inhabiting streams and river systems provided a predictive tool for managers to assess the potential for *M. cerebralis* infection of worms, the levels of parasite proliferation from infected worms, and thus the severity of whirling disease in a watershed. These researchers also discovered that *M. cerebralis* is not likely to be passed directly from worm host to worm host without an intervening fish host stage. This supposition had long been assumed but never explicitly tested.

Veterinary Medical Officer George Sanders, ca. 2010

In 2001, George E. Sanders, DVM, joined the Fish Health Section to serve as WFRC's Veterinary Medical Officer in a split appointment with the School of Medicine, University of Washington. Sanders immediately began development of an infectious disease model at the Seattle Laboratory using zebra fish (*Danio rerio)* and conducted research at the MMFS on disease ecology and the role of *Ichthyophonus* in the decline of Chinook salmon in the Yukon River, Alaska.

In 2002, the National Science Foundation provided funding for MMFS staff scientist Russell J. Rodriguez and University of Washington collaborator Regina Redman to join an international team of scientists researching microbial ecology in the Antarctic at the McMurdo International Research Station. Although microbial ecology is of paramount importance to the health and dynamics of fish and wildlife communities, little is known about the roles of most microbial organisms in soil food webs. Through this work, the USGS obtained critical expertise in microbial ecology and soil chemistry. Additionally, the USGS began research in connecting soil activities with habitat restoration efforts, the spread of invasive plant species, and species

adaptation to climate change. The work also advanced aquatic research projects at WFRC that focused on plant adaptation, habitat restoration, food web integrity, and species interactions.

Marrowstone Marine Field Station

In 1998, the water system at MMFS was upgraded by the addition of sand filters, which, in conjunction with the existing UV system, provided premium quality pathogen-free seawater. The old lighthouse building was renovated as housing for visiting scientists conducting research on forage fish, rockfish, marine fish diseases, and the treatment of marine ballast water to inactivate invasive species. In 2001, WFRC received the first installment of Congressional funding for the research and development of treatment systems to inactivate invasive species carried in the ballast water of commercial ships. In response, cooperative research was initiated between WFRC and its partners to make the MMFS a ballast water treatment, testing, and certification center. Important progress also was made at MMFS on the role of disease factors such as *Ichthyophonus* and viral hemorrhagic septicemia in the decline of Pacific herring populations in Prince William Sound, Alaska (Exxon Valdez oil spill) and in Puget Sound.

Columbia River Research Laboratory

In 1995, James G. Seelye, then Chief of the Hammond Bay Field Station of the FWS Great Lakes Laboratory in Ann Arbor, Michigan, was appointed Director of the Columbia River Research Laboratory (CRRL). In 1999, Seelye hired Jim Hutton, WFRCs first geographer, to run CRRL's GIS/Geospatial Section full-time.

In 2000, Alec Maule began his research to determine how natural physiological processes interact with climate driven changes in the aquatic environment to affect the survival of individuals and thus, populations. In 2002, Maule began his classic work on the physiological effects of polychlorinated biphenyls (PCBs) on Arctic char (*Salvelinus alpinus*) with Norway's Kårvik Research Station and support from the National Science Foundation. Arctic char in high northern latitudes migrate to the ocean in the spring to feed and grow. This results in accumulation of PCBs in their visceral fat. During the winter, the char reside in freshwater lakes where they do not feed, but mobilize lipids from adipose tissue for energy. This process results in the distribution of toxic PCBs to the brain, spleen, and heart that decrease the overall physiological health of these populations.

In 2003, as the Western Fisheries Research Center neared its seventh decade, Director Frank Shipley transferred to the USGS Western Regional Office as Deputy Regional Biologist overseeing all six western regional science centers. During Shipley's 8 years as Director, the WFRC produced more than 600 peer-reviewed scientific publications together with hundreds more contract research reports, many of which formed the basis for administrative action by natural resource managers. The unprecedented growth in contract work related to the ESA listing of several Columbia River salmon runs and the increasing demands for biological research on other riverine species such as white sturgeon and Pacific lampreys had resulted in a total WFRC staff numbering nearly 200 employees, including students and contractors.

Overall, the Shipley years at WFRC were marked by high productivity and spirited cooperation between the Center, the fisheries research community worldwide, academia, the aquaculture industry, and state governmental agencies with similar legislative responsibilities.

Chapter 6

2003 – 2010: The WFRC Today

Lyman K. Thorsteinson, Center Director. Photograph ca. 2003.

In 2003, Lyman K. Thorsteinson, who had been Deputy Center Director since 2001, was selected as Frank Shipley's replacement. Thorsteinson had recently published his epic reference texts *Fishes of Alaska*[51] and *The Rockfishes of the Northeast Pacific*,[52] and had recently served a term as Acting Center Director of the USGS Great Lakes Fishery Science Center. In 2004, Thorsteinson selected W. David Woodson, then a staff biologist at the Western Regional Office, as his Deputy Director. Woodson would go on to play a key role in helping to establish research priorities, and in managing, planning, and evaluating all phases of the Center's activities.

Thorsteinson and Woodson's first act was to update and implement a new strategic 5-year Strategic Plan[53] for the Center that placed high value on USGS integrated science, on inter-Center research collaborations in the Western United States, and on upgrading laboratory facilities to meet the changing science missions of the WFRC. A team approach was used for strategic planning to identify and describe the science needs and relevance to managers across the Western United States. Thorsteinson's strategic 5-year plan was a positive step forward in making the WFRC and its field stations into a more cohesive working organization.

Thorsteinson also involved the Center in USGS integrated science planning for the restoration of ecological processes in the nearshore waters of Puget Sound. Such processes have become an ongoing focus in WFRC's pioneering research on restoration of the Elwha River (dam removal), and in Skagit and Liberty bays (wetlands and coastal restoration; effects of urbanization).

WFRC Deputy Director W. David Woodson (right) with Secretary of the Interior Kempthorne, ca. 2007.

[51] Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: American Fisheries Society, Bethesda, Maryland, 1037 p.

[52] Love, M.S., Yoklavich, M., and Thorsteinson, L., 2002, The rockfishes of the northeast Pacific: Berkeley, University of California Press, 404 p.

[53] Thorsteinson, L., 2005, Strategic Plan Western Fisheries Research Center: U.S. Geological Survey, accessed November 29, 2012, at *http:/wfrc.usgs.gov/about/centerstratplan100705.pdf*.

Elsewhere, the WFRC took a leadership role in developing next generation tools for instream flows and for ecosystem and water-resource management analysis in the West. One example is a joint venture with the USGS National Biological Information Infrastructure program (NBII) to conduct an estuarine GAP analysis for Puget Sound.

This also was a time of great transition for USGS Research Centers because of the creation and implementation of common business practices, computer-based project management tools, and fundamental science practices such as peer and policy reviews. Working together, Thorsteinson and Woodson gradually created opportunities for joint planning of research projects for constituents, and introduced a strategic planning system and project review planning and budgeting system, that relied on interactive participation and involvement of the WFRC staff for the development of the objectives, plans, and budgets for each project.

Seattle Laboratory

Microbiologist Eveline Emmenegger, ca. 2010.

During the Thorsteinson years, the WFRC Fish Health Research Section increased their efforts toward evaluating the effects of diseases as ecosystem process. Study areas included both freshwater and marine wild fish populations in Alaska, the Great Lakes, Chesapeake Bay watershed, the Mississippi River, and throughout the American West. Specific geographic hotspots included the Yukon River and Prince William Sound, Alaska, Great Lakes, Columbia River and Klamath Falls, Washington and Oregon. Much of their research was and is performed in WFRC's aquatic biosafety level 3 laboratory (BSL-3), under the management of Eveline J. Emmenegger. The WFRC BSL-3 is one of a few such facilities in the United States built for the testing of fish pathogens and invasive species that pose a high risk to the environment.

Gael Kurath and collaborators continued their focus on the regional and global phylogenies of the IHNV and DNA vaccines for fish. Highlights include developing genetic typing methods for IHN field isolates, large-scale phylogenetic studies that revealed the major North American IHN subgroups of IHN, IHNV, and VHSV, and the online databases Molecular Epidemiology of Aquatic Pathogens-IHNV (MEAP-IHNV), and AquaPathogen X, a template database for tracking field isolates of aquatic pathogens. The MEAP-IHNV database[54] is based on isolates collected throughout western North America from 1996 to the present (2012) and includes some virus isolates from Eastern Russia. The database generates tables and maps to assist fish-culture facility managers, fish health professionals, and academic researchers in developing and testing hypothesis about how IHNV moves across landscapes and changes over time.

Fish Geneticist John D. Hansen, ca. 2004.

[54] The IHNV database is available online at *http://gis.nacse.org/ihnv* or from the WFRC website *http://wfrc.usgs.gov/*.

John D. Hansen was hired in 2004 to expand and strengthen WFRC's research effort to define the basic mechanisms of the piscine immune system and the application of this knowledge to the control of infectious fish diseases. A particular research emphasis was to determine the effects of multiple environmental stress factors on the health and physiological condition of aquatic organisms. Functional genomic approaches with leading immunologists and virologists were pursued. To strengthen this work, microbiologist Maureen Purcell was hired in 2005 to further characterize the innate resistance of rainbow trout to the IHN virus and other bacterial and parasite pathogens. Together with the comparative immunology and genetics of disease resistance, research also is focused on important finfish pathogens such as bacterial kidney disease, IHN, VHSV, *Ichthyophonus hoferi* and *Nucleospora salmonis*. A zebra fish colony has been established at the Seattle Laboratory to facilitate investigations of the genetic basis of disease.

Microbiologist Maureen Purcell, ca. 2010.

Elwha River Restoration Project

In 2004, Jeff Duda began research and monitoring of the short- and the long-term effects of removing the Elwha and Glines Canyon Dams that have blocked salmon and sediment passage on the Elwha River, Washington, for almost 100 years. Following dam removal in 2012, salmon will be able to spawn in pristine river habitats of the Olympic National Park, and sediment will once again flow down the river and enrich the eroding shoreline.

WFRC Project Leader Jeff Duda holding an adult Chinook salmon captured in the Elwha River weir, ca. 2010. Photograph taken by John McMillan, NOAA.

In the initial stages, WFRC primarily was concerned with documenting baseline levels of vitally important components of the river and nearshore ecosystems that are expected to change once salmon return to their ancestral breeding grounds. The dynamics of recolonization are complex and few predictions about the status of the fish community 5, 10, and 50 years post-dam removal currently exist. Duda worked collaboratively with partners (NPS, NOAA, USFWS, and the Elwha Klallam Tribe) to conduct one of the largest whole river surveys ever done in a wilderness river. The goal of this undertaking was to describe the distribution and abundance patterns of adult fish in the main stem and major side channels of the river. Steve Rubin joined in the extensive fieldwork on the Elwha River to enumerate rainbow and bull trout populations within index reaches that will be sampled into the future. The riverscape changes due to recolonization of anadromous salmonids are being surveyed following dam removal. Duda[55] also developed baseline data about patterns of macroinvertebrate and periphyton communities above, between, and below the dams, and collected samples of bugs, algae, and fish to analyze for the

[55] Duda received the Department of the Interior Superior Service Award in 2011 for this project.

Lower Elwha Dam, ca. 2010.

stable isotope levels of carbon and nitrogen used to determine the relative contribution of salmon carcass energy to the aquatic ecosystem. The story of the Elwha River dam removals will be told for generations to come as an example of a dramatic step taken to restore salmon, a cultural and socio-political icon of the Pacific Northwest.

In 2005, noted WFRC ecologist John Emlen retired and was replaced by Reg Reisenbichler[56] as Chief of the Fish Ecology Section. Work began on a new USGS initiative, the multidisciplinary Coastal Habitats in Puget Sound (CHIPS) project, with a goal of gathering scientists from water, biology, and geology disciplines to work on estuarine food webs. An Elwha River project was funded to study the coastal nearshore marine ecosystem, the estuary, and the lower Elwha River prior to dam removal. Led by Jeff Duda, WFRC scientists Kim Larsen, Steve Rubin, and Nancy Elder worked with CHIPS funding to study the marine benthic invertebrate, algae, kelp, and fish communities. Sampling was based on habitat maps produced from sonar and video surveys by the USGS Coastal and Marine Geology program. Additional work was done to describe the ecological conditions of the Elwha River estuary, with a focus on juvenile salmon use, growth, and diet, coupled with hydrological and geological data sets collected by other USGS science centers. In 2010, the CHIPS project was recognized with a "Science Success Story" award “For advancing the goals of the USGS Science Strategy by tackling complex ecological issues and finding solutions to environmental problems.”

Invasive Species

Invasive Species Section Chief Scott S. Smith, ca. 2006.

As aquatic invasive species began receiving more attention as a special threat to the habitat of native animals and the ecosystems upon which they depend, the potential for species introductions from marine ballast water transport and discharge by the commercial shipping industry in Puget Sound emerged as a critical issue. The development and testing of ballast water treatment technologies begun by Paul Hershberger and his collaborators during Director Frank Shipley’s era had evolved into a unique research, development, and testing facility at WFRC’s Marrowstone Marine Field Station. Accordingly, in 2006, Center Director Thorsteinson created an independent Invasive Species Research Section and hired Scott S. Smith as Section Chief. Smith, formerly State Coordinator for Aquatic Invasive Species with the Washington Department of Fisheries, had been working with WFRC’s Russell Rodriquez and Paul Hershberger (MMFS) for several years to develop DNA-based diagnostic tools to detect the presence of non-indigenous species in complex samples of soils, plants, and wood. Later in 2006, Deborah A. Reusser, at the Hatfield Marine Science Center (HMSC) in Newport, Oregon, was hired as a research geographer to begin developing database templates for the collection of invasive species information for Pacific Rim countries, regional benthic indicator development, modeling global distributions and range shifts of aquatic invasive species in a changing climate, and to conduct risk assessments for non-indigenous species.

[56] Retired, 2008.

In 2009, WFRC received a special Congressional appropriation for aquatic invasive species planning and risk assessment work in the Columbia River Basin. As of this writing (2012) WFRC has expanded its involvement in the problems caused by invasive marine and other aquatic species introduced into northwest coastal waters via discharges of ballast water from ships. Cooperators on this project are from many agencies including the University of Washington, the Ecosystems Projects Northeast-Midwest Institute, Purdue University, Washington Department of Fish and Wildlife, and the University of California-Davis. The emphasis is on prevention research, to determine the technologies and methods best suited to address ballast water issues in the Pacific Northwest including Puget Sound, other coastal habitats, and the lower Columbia River. Invasive species such as zebra mussels in the Columbia and lower Colorado Rivers are of great management concern. The work by Eviline Emmenegger on the introduction of spring viremia of carp into North America and the viral hemorrhagic septicemia virus into the Great Lakes has added a unique dimension to the Center's invasive species research effort.

In 2010, WFRC created the Newport Duty Station at the HMSC. Led by Deborah Reusser, a staff of three has intensified the research and the development of models used to estimate effects of climate change on the distribution and abundance of native and non-native estuarine species at spatial and temporal scales.

Marrowstone Marine Field Station

After several decades of the MMFS serving primarily as a service laboratory for visiting researchers, in 2003 a commitment was made by WFRC Center Director Lyman Thorsteinson and Fish Health Section Chief Jim Winton to develop an independent research program at the MMFS. Paul K. Hershberger was subsequently hired to carry out this mission and bring a vision of disease ecology to the facility. Hershberger immediately began developing an internal research program to improve the current understanding of disease processes that operate in populations of wild marine fishes. The program uses techniques from science disciplines such as epidemiology, disease ecology, virology, parasitology, bacteriology, immunology, and molecular biology to address applied disease issues in fisheries ecology affecting fisheries management.

MMFS Chief Paul Hershberger, ca. 2007

During the initial years of Hershberger's leadership at Marrowstone, coastal investigations in Puget Sound began receiving special attention. In 2004, Jacob Gregg was hired to establish rearing methods for specific pathogen free (SPF) Pacific herring. At this writing, Gregg and Hershberger maintain five age classes of SPF Pacific herring and colonies of SPF rockfishes and ling cod at the facility, the only colonies of SPF and immunologically naïve marine fish known to exist. Development of these colonies for use as experimental animals resulted in immediate advancements in the field of disease ecology. As a result, active disease ecology projects at the Marrowstone Marine Field Station began to extend throughout Oregon, Washington, British Columbia, and Alaska. One important new project was the evaluation of the pathological effects of *Ichthyophonus* on the survival and reproductive success of Yukon River Chinook salmon by WFRC's Jim Winton and collaborators George Sanders, Paul Hershberger, Jacob Gregg, and the University of Washington's Richard Kocan. Researchers worldwide have visited the station each year to use the SPF fish colonies for their research projects.

Research at the MMFS by Hershberger, longtime associate Nancy Elder, and cooperators currently emphasizes marine ecosystem health, ballast water treatment technologies, and the ecology of invasive species. As of this writing (2012), the research staff at Marrowstone has grown to include 10 scientists, students, and post-doctoral associates.

Reno Field Station

At this writing (2012), Gary Scoppettone, longtime associate Peter Rissler, and the Reno Field Station (RFS), Nevada, research team remain the preeminent USGS biologists determining the effects of water allocation, habitat modification, and non-indigenous fish introductions on threatened/endangered native fish populations of the Great Basin and Mojave deserts. Their efforts over the last 30 years have provided a critical link between research and on-the-ground management actions. Their work with the FWS to recover the endangered Moapa dace (*Moapa coriacea*), and with the Pyramid Lake Paiute Tribe to recover the endangered cui-ui (*Chasmistes cujus*) are only two examples of their long history of success. Scoppettone and his research team have played a leadership role on numerous endangered species recovery teams and facilitated the cooperation of private and public partners. By conservative estimate, the RFS has been instrumental in hiring, training, and mentoring dozens of research and agency biologists, many of whom are now running their own conservation programs throughout the United States. In 2008, RFS Chief Gary Scoppettone was one of only 18 biologists in the United States recognized with the Endangered Species Recovery Champion Award from the U.S. Fish and Wildlife Service.

Columbia River Research Laboratory

In 2003, CRRL Director Jim Seelye retired and was succeeded by James H. Peterson. Peterson served as Director until his premature death in 2007 at the age of 53. Alec Maule and then Dennis Rondorf stepped into the void as acting Directors until a permanent replacement for Peterson could be found. Since 2008, the CRRL has been under the leadership of Stephen M. Waste. With years of practical experience in the commercial fishing industry, a doctoral dissertation on the role of science in natural resource decision making, and additional years of administrative experience at the Bonneville Power Administration and the Northwest Power and Conservation Council, Waste has proved a valuable addition to the WFRC Research Management Team.

Stephen M. Waste, CRRL Director, ca. 2010.

Under the leadership of Waste, his predecessors, and lead scientists such as Noah Adams, John Beeman, Patrick Connolly, Theresa Liedke, Alec Maule, Matt Mesa, Michael Parsley, Russell Perry, and Dennis Rondorf, the CRRL has become WFRC's largest field station. Contract research is conducted for, and in collaboration with the U.S. Army Corps of Engineers, Bonneville Power Administration, Bureau of Reclamation, the U.S. Fish and Wildlife Service, Public Utility Districts, Tribes, and several state agencies. As of this writing (2012), CRRL work includes fish biology, large river ecology, environmental physiology, fish behavior, invasive species, and mathematical modeling research projects throughout the Columbia River basin in five Western United States. Research Geographer James Hatten provides GIS predictive modeling and remote sensing capability. The CRRL also has become a national leader in the research, development, and use of biotelemetry and hydroacoustics such as Doppler water

velocity profiling technologies. With a year-round staff of about 70 biologists and administrative support personnel with another 70 staff members hired during the field season, the CRRL is one of the largest employers in Skamania County, Washington, and one of the largest USGS research units in the Western United States.

Klamath Falls Field Station

Under the leadership of its first Director, Rip Shively, the Klamath Falls Field Station (KFFS) became part of an interdisciplinary USGS effort to develop new tools that could be used to address science and management needs related to water allocations in the Klamath River Basin. Upon Shively's departure in 2008, Scott VanderKooi was appointed Chief Biologist. VanderKooi continued the development of this and other collaborative approaches among hydrologists, geomorphologists, limnologists, and fisheries biologists. In 2011, VanderKooi, the last of the founding members of the KFFS, took a position with the USGS Southwest Biological Science Center and was succeeded by Eric Janney, the present Chief Biologist. Currently (2012), the KFFS staff consists of 14 biologists and support personnel who are providing needed new insights into lake ecosystem dynamics in the Upper Klamath Basin. Their research findings have long been considered authoritative by land use managers and water users in this area and will be crucial to future USGS watershed research and modeling in the basin. Under Janney's leadership, and that of KFFS biologists such as Greta Blackwood, Summer Burdick, Dave Hewitt, and Barbara Martin, the KFFS is well poised to respond to new opportunities associated with the Klamath Basin Restoration Agreement such as the prospective removal of four dams on the Klamath River.

Eric Janney, Chief, Klamath Falls Field Station with assistant fishery biologist Chris, ca. 2009.

Conclusion

At the close 2010, the WFRC ended its first 75 years of existence with a heritage of accomplishment and dedication that sets a very high standard for future generations to follow. The Center originated with the consulting hatchery disease service pioneered by Frederic F. Fish in 1935 as part of the Grand Coulee Fish Maintenance Project (GCFMP), the first federal hatchery program designed to compensate for hydroelectric development in the Columbia River Basin. In 1938, the Mitchell Act was passed followed by a succession of other conservation legislation that tasked Fish and his successors with providing a constant supply of new and improved technical information in response to the continuing natural resource challenges of the DOI and the Nation—challenges that each year grew ever more complex. The WFRC of today evolved over time to meet these challenges and at this writing (2012) employs a staff of nearly 200 biologists and support personnel with unique capabilities in fish health and disease, genetics and molecular biology, biotelemetry, invasive species, bioenergetics, population dynamics, fish physiology, immunology, biogeography, ecosystem informatics, fish ecology, and the population analysis of threatened and endangered species.

By the end of its first 75 years, Center scientists had communicated their actionable research findings to natural resource managers, academia, and the fishery research community worldwide through the publication of more than 2,000 peer-reviewed technical papers, chapters

in books, and textbooks that have become standard reference works. Person-to-person contact, workshops, college teaching, professional society work, and presentations at scientific meetings were a high-priority as well. In recent years, research findings have been increasingly communicated through web-based delivery systems that support visualization technology and GIS products that deliver scientific information over multiple spatial scales and enable the synthesis of scientific information by the public as well as by resource managers. More information about the diverse fisheries research projects WFRC scientists are conducting is available on the WFRC website: http://wfrc.usgs.gov.

Over the next 75 years, with the health of Earth's aquatic and terrestrial ecosystems increasingly threatened by stressors such as accelerating climate change, population growth, and intensive water and energy development, the need for the work of the WFRC can only increase. Although the Center likely will be a very different place at the end of its next 75 years, its evolution will be firmly rooted in the story of the research and of the people that has been related here. The 75-year heritage of their dedication and accomplishments provides a firm foundation on which to build our future.

Epilogue

In October of 2011, Center Director Thorsteinson accepted a new position in the USGS with the Office of the Regional Executive—Alaska Area and moved on to new responsibilities. When Thorsteinson came to the WFRC, the Center was doing excellent research. When he left, the research program had been improved over even that level with a staff numbering 153 permanent FTEs and an annual budget of $16.2 million including appropriated funds, grants, and contracts. Thorsteinson's team building approach to strategic planning significantly increased the sense of community between the Seattle headquarters and its widely distributed field stations. The new people hired during his era considerably enhanced the depth of the Center's research programs. Nearly 600 peer-reviewed scientific papers were published under Thorsteinson's leadership.

The current (2012) Center Director, Dr. Jill B. Rolland, assumed her duties in October 2012. In 2002, Rolland completed her doctoral research at the WFRC on a new virus disease of salmonids and subsequently became head of the Aquaculture, Swine, Equine, and Poultry Health Programs of the U.S. Department of Agriculture. It has been 35 years (Tom Parisot, 1974–77) since the WFRC has had a Director who is a fish health specialist. Rolland brings a long absent perspective in fisheries research back to the position of Center Director and is the first female Director in WFRC history. Rolland's vision is of a forward agenda, but she intends that her leadership will build on the high standard of excellence that connects WFRC's past to the present day, and the present day to the work yet to be done.

Dr. Jill Rolland, WFRC Director 2012 —.

Acknowledgments

Writing this history of the biological research of the Western Fisheries Research Center would not have been possible without the help of a number of emeritus scientists and colleagues who have recounted and documented events that occurred at the Center during the early years. Among these, Donald F. Amend, Douglas P. Anderson, Carl Burger, Dennis Crouch, Stan Smith, Wm. T. Yasutake, Christine Moffit. Former Center Directors Thomas J. Parisot and Lyman Thorsteinson were particularly helpful.

I am especially grateful for the assistance of the families of the late Frederic F. Fish and Robert R. Rucker for sharing personal records and recollections of WFRC's founder and his chief assistant.

Appendix 1

Center Research Managers and Administrative Support Staff

Table 1. WFRC Directors through the years.

Director	Term
Frederic F. Fish[57]	1934–1950
Robert R. Rucker[58]	1950–1973
Gary A. Wedemeyer, Acting	1973–1974
Thomas Parisot	1974–1977
Gary A. Wedemeyer, Acting	1977–1978
Alfred C. Fox[59]	1978–1994
Al Marmelstein, Acting	1994
Gary A. Wedemeyer, Temp. Promotion	1994–1995
Frank Shipley	1995–2003
Lyman Thorsteinson	2003–2011
Jill B. Rolland	2012–

Table 2. WFRC administrative support staff, Seattle Laboratory.

Administrative Officers	Facilities Managers	Computer Specialists
Margaret "Peggy" Dixon, 1979–1994	Richard A. Rosser 1980–1994	Gregg Konkel, 1984–1992
Elizabeth Turpin, Acting 1994–1995	Ronald L. Wilson, 1994–1998	Jeff Baker, 1994–1996
Cyndee Matus, 1995–1997	Lynn Hinton, 1998	Cyril Ward, 1997
Joyce Jones, 1997–2003	Kyle Sato 1998–	Carl Griffis, 1997–1999
Debra Becker, Acting, 2003		Robin Salling 1999–
Dirk Van Dyk, Acting, 2003		Mary Dunning 2006–
Elizabeth A. Turpin, 2003–2008		
Bonnie Dotson, Acting, 2009–2010		
Elizabeth Turpin, 2010–		

[57] Deceased, 1978.
[58] Deceased, 1998.
[59] Deceased, 2011.

WFRC administrative staff, ca. 2008. Back Row: Rod Polintan (CRRL), Jennifer McLean (CRRL), Bonnie Dotson (Seattle), Robin Salling (Seattle), Cheryll Trammel (CRRL), Henry Higgins (CRRL), Mary Dunning (Seattle), Michele Beeman (CRRL), Barry Egenes (Seattle). Middle: Cindy Hansen (KFFS), Rosalyn Lehner (Seattle), Judy Maule (CRRL), Barbara Gee (CRRL), Loretta Slusher (Seattle). Front: Elizabeth Gordon (CRRL), Lynne Casal (CRRL), Elizabeth Turpin (Seattle), Linda Hazen (CRRL). Not pictured: Mimi Kouretchian and Gael Sauer (Seattle).

Table 3. Columbia River Research Laboratory Directors.

Director	Term
William R. Nelson[60]	1978–1994
James H. Petersen, Acting	1994–1995
James G. Seelye[61]	1995–2003
James H Petersen, Acting	2003
Mark K. Sogge, Acting	2003
James H. Petersen[62]	2003–2007
Dennis W. Rondorf, Acting	2007
Alec G. Maule, Acting	2007–2008
Stephen P. Waste	2008–

Table 4. Columbia River Research Laboratory Administrative Section Leaders.

Administrative leader	Term
Daphne Erickson Faler	1983–1986
Sue Neece	1987–1991
Michele Beeman	1991–2009
Elizabeth Gordon	2009–2010
Elizabeth Gordon/Michele Beeman[63]	2010–

Table 5. WFRC names through the years.

Center or laboratory name	Years
Hatchery Consulting Disease Service, Fisheries Biological Laboratory Seattle[64]	1935–1945
Pacific Coast Fish Cultural Investigations, Fisheries Biological Laboratory	1945–1950
Western Fish Disease Laboratory	1950–1974
National Fisheries Research Center	1974–1993
Northwest Biological Science Center	1993–1997
Western Fisheries Research Center	1997–present

Table 6. WFRC organizational components (as of 2010).

Headquarters and Seattle Laboratory, Seattle, Washington
Columbia River Research Laboratory, Cook, Washington
Dixon Duty Station, Dixon, California
Klamath Falls Field Station, Klamath Falls, Oregon
Marrowstone Marine Field Station, Nordland, Washington
Newport Duty Station, Newport, Oregon
Reno Field Station, Reno, Nevada

[60] Retired, 1994, deceased 2011.

[61] Retired, 2003

[62] Deceased, 2007.

[63] Shared duties until 2012 when Michele Beeman retired.

[64] Now the Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration.

Appendix 2

The NBS Era — A Biological Survey for the Nation[65]

The original idea for a National Biological Survey (NBS) dates back to 1896 when Congress established the Division of Biological Survey within the U.S. Department of Agriculture (USDA) to map the geographic distribution of plants and animals in the United States. In 1935, the Division of Biological Survey became the Bureau of Biological Survey and the legendary naturalist J. "Ding" Darling was appointed Chief Biologist. In 1940, the Roosevelt administration merged the USDA Biological Survey with the Bureau of Fisheries in the Department of the Interior (DOI) to form the U.S. Fish and Wildlife Service.

By 1977, the merits of reestablishing a National Biological Survey were being discussed anew among conservation agencies and scientific societies. In 1982, The Association of Systematics Collections (ASC) endorsed the concept with the publication *Foundations for a National Biological Survey*. Meetings were held with federal agency representatives and members of Congress between 1986 and 1992 and legislation to establish a National Biological Survey was drafted, but never went forward. However, with the election of President Clinton and the appointment of Bruce Babbitt as Secretary of the Interior, the idea rapidly gained momentum.

Secretary Babbit reasoned that if incipient threatened and endangered species could be identified and their habitats improved or saved, many legal disputes could be avoided. However, such an effort would require both a concerted survey of biota in the United States to identify such species and an independent agency within the DOI to conduct the survey. Secretary Babbitt asked the National Research Council (NRC) to consider the organization and direction that a national biological survey should take and in October 1993, the NRC issued its report, *A Biological Survey for the Nation*. Secretary Babbitt immediately issued a secretarial order creating the National Biological Survey (NBS) as a new research agency within the DOI.

The NBS was staffed by transferring 1,200 scientists and 600 support personnel from the 7 existing DOI agencies—most of them coming from the U.S. Fish and Wildlife Service and National Park Service. Ronald Pulliam, director of the University of Georgia Institute of Ecology, was appointed Director of NBS. F. Eugene Hester, a career DOI employee, then assistant director for science in the National Park Service (NPS), was appointed deputy director. James Reichman, an ecologist with prior faculty appointments at Northern Arizona University and Kansas State University, and a stint as program director with the National Science Foundation was appointed assistant director. Pulliam and Reichman were selected for their academic experience; Gene Hester provided agency administrative expertise.

The NBS was controversial by the time it had been in existence for less than 1 year and was at risk for elimination. In response, Secretary Babbitt issued Secretarial Order 3185 in 1995,

[65]After, Wagner, F.H., 1999, Whatever happened to the National Biological Survey?: BioScience, v. 49, p. 219–222.

which changed the agency's name to the National Biological Service, based on the reasoning that the title “Survey” unnecessarily conjured up an image of biologists searching for threatened and endangered species. Order 3185 also instructed NBS employees not to work on private land unless the owner or lessee gave permission. However, the turmoil continued.

In 1996, 3 years after it was established, Congress abolished the NBS, and transferred its employees into DOI's U.S. Geological Survey, as the Biological Resources Division (BRD). Director Pulliam returned to his former position at the Institute of Ecology. Assistant Director Reichman had already resigned to become the director of the new National Center for Ecological Analysis and Synthesis in Santa Barbara, California. Deputy Director Gene Hester retired.

The first BRD Director, Dennis Fenn, was installed in October 1996. Fenn was a veteran employee of NPS, and had held several administrative posts. After 3 years of continuous administrative turmoil, Fenn’s experience and sensitivity to agency cultures and procedures, together with a secure home in a veteran DOI agency enabled BRD biologists to regain their previous levels of morale and productivity.

This page left intentionally blank

Publishing support provided by the U.S. Geological Survey
Publishing Network, Tacoma Publishing Service Center

For more information concerning the research in this report, contact the
Director, Western Fisheries Research Center
U.S. Geological Survey
6505 NE 65th Street
Seattle, WA 98115
http://wfrc.usgs.gov/