

# A RETROSPECTIVE OF THE COUNCIL'S FISH AND WILDLIFE PROGRAM, 1980 - 2022



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**March 2024**

This Retrospective is a Council staff document. Staff presented a summary of this document to the Fish and Wildlife Committee in August and September of 2022, and presented to the Council in May of 2023. Council member review and approval were not requested at the time of initial development.

The Retrospective helped Council staff better understand the relationship between the Power Act and Fish and Wildlife Program, how Programs were developed over time, and important regional context that influenced Program content. The Retrospective was also critical for helping staff identify key measures over time that the Council could track through our Categorical Assessments.

In preparing this document, staff tried to be as thorough as possible while maintaining a document that was still a reasonable length. This may mean some topics are not covered in a great degree of detail or were even excluded. Also, this is one particular perspective on that program history; others might choose to focus or emphasize different elements.



Northwest **Power** and  
**Conservation** Council

# Executive Summary

The Northwest Power and Conservation Council's Fish and Wildlife Program (hereafter Program or Programs) represents a 40-year effort to protect, mitigate, and enhance fish, wildlife, and habitat affected by the hydropower system (hydrosystem) in the Columbia Basin. The scope and investment in this Program make it one of the largest fish and wildlife mitigation efforts in the world.

To better understand what kind of progress has been made, we developed this retrospective of Program development from 1980 through 2022 as a component of assessing Program performance. In this retrospective, we briefly review the early development of the Columbia Basin and development of the modern hydropower system, including effects of hydrosystem development on fish and wildlife. We then describe events that precipitated the Northwest Power Act, its legal framework, the formation of the Council, and requirements of the Fish and Wildlife Program. Finally, we shift to reviewing the Fish and Wildlife Programs by decade. This section includes the historical context that influenced the actions called for in each Program along with a detailed description of the actions.

## Development of the Columbia Basin

Pre-development, the Columbia Basin was characterized by diverse, high-quality habitats occurring throughout the Basin. Abundant and diverse salmon and steelhead runs returned to the basin annually and contributed to a rich and interconnected ecosystem of anadromous fish, resident fish, and wildlife.

The first hydropower dam in the Columbia Basin was constructed in 1890 on the Spokane River, marking the beginning of a century of hydropower development in the basin. Major mainstem Columbia River dams were constructed between 1933 and 1971 and most Snake River dams were constructed between 1952 and 1975. Some dams included facilities for juvenile or adult fish passage and others were complete blockages to fish migration. The construction, inundation, and operation of the hydropower system affected fish and wildlife locally and regionally.

Along with development of the hydropower system, numerous other human activities (such as extractive land uses) negatively affected fish and wildlife in the basin. These changes are important to understand because the baseline of ecosystem function in the Columbia River Basin has been fundamentally altered. Moreover, mitigation for effects of the hydrosystem is occurring against a backdrop of ongoing degradation that has the potential to affect the success of mitigation efforts.

## The Power Act

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (hereafter, Power Act) was developed in response to an energy and financial crisis in the Pacific Northwest. Inaccurate power demand forecasting resulted in the development of unneeded energy facilities, with significant cost to ratepayers. In addition to forecasting issues, there were also concerns that the power planning did not take into consideration environmental concerns, lacked public involvement in the process, and was outside of BPA's direct authority. The Power Act was passed to address these multiple power planning and environmental deficiencies.

The Power Act authorized the states of Idaho, Montana, Oregon, and Washington to enter into an interstate compact, with the governors of these states each appointing up to two representatives. Collectively, they formed the Pacific Northwest Electric Power and Conservation Planning Council (hereafter Council). The Power Act specifies three responsibilities of the Council: (1) to develop a Program to protect, mitigate and enhance fish and wildlife affected by hydroelectric facilities in the Columbia River Basin; (2) to develop a power plan assuring the Pacific Northwest of an adequate, efficient, economical, and reliable power supply, consistent with the fish and wildlife Program, and (3) to inform and involve the public.

## **The Fish and Wildlife Program**

Over the last 40 years, there have been seven Fish and Wildlife Programs and ten amendments or addendums to those Programs. The Programs were based on the language in the Act that called for a combination of onsite and offsite actions to protect, mitigate, and enhance populations of fish and wildlife affected by the hydrosystem. Onsite actions involve changing the structure and operation of the hydrosystem (e.g., flow or passage) to achieve protection and improve survival for fish and wildlife. Offsite actions include all efforts not directly located in the mainstem or near a dam, for example replacement of lost natural production using hatchery production, and implementation of actions to protect and restore tributary habitat.

## **Program Development in the 1980s**

The first decade of the Fish and Wildlife Program began at the time the era of major dam construction in the Columbia and Snake Rivers was ending. Returns of wild salmon and steelhead were declining rapidly—to the lowest levels ever seen—and there was great urgency to implement actions that would rebuild stocks throughout the basin. The formation of the Council in 1981 created a forum for the region to come together and begin developing a framework for the Fish and Wildlife Program.

The content and contributions of the 1980's Programs were foundational to all subsequent Fish and Wildlife Programs. The first Programs heavily emphasized onsite mitigation of the hydrosystem given the high mortality rates of both juvenile and adult fish during passage. One key element was the water budget—a new concept for ensuring flows for juvenile fish by carving out a fixed volume of water from storage and releasing it during the juvenile migration season (April 15 – June 15). One water budget was established for Lower Granite Dam on the Snake River and another for Priest Rapids Dam on the Columbia River. Another key element was improved fish passage. Although most federally owned dams had passage routes for juvenile fish, many required improvements. The five mid-Columbia dams operated by the Public Utility Districts did not include fish passage for juvenile fish. Programs included requirements to retrofit dams with better fish passage technology and provide interim spill to aid juvenile migrants until passage facilities were constructed.

Another significant action was the designation of areas in the basin that would be protected from future hydroelectric development. Approximately 44,000 miles of stream within the area serviced by BPA were designated as protected areas and adopted into the Program. Along with these protected areas, the Council requested that FERC take the Council's hydroelectric development standards into consideration

when developing or licensing hydroelectric facilities (NPPC 1988). To date, no licenses have ever been issued by FERC within these protected areas.

In 1986, the Council produced a document compiling estimates of pre-development returns to the Columbia Basin, along with estimates of losses from all causes combined and from the hydrosystem, specifically. Pre-development returns were estimated to range from 10 to 16 million salmon and steelhead. In total, losses of salmon and steelhead *specifically* attributed to the construction, inundation, and operation of the hydropower system were estimated to range from 5 to 11 million fish each year. This compared to a total loss from all causes of 7 to 14 million salmon and steelhead per year. These hydrosystem losses also included the complete loss of salmon and steelhead runs in areas completely blocked to anadromous fish (hereafter blocked areas). Based on established losses and the estimated average run size of 2.5 million adult fish from 1976 to 1981, the Council established an interim goal to double the current returns of salmon and steelhead to achieve 5 million adult returns annually.

## Program Development in the 1990s

During the 1990s, six evolutionarily significant units of salmon and eight distinct population segments of steelhead, Kootenai River white sturgeon, bull trout, and Oregon chub were listed under the Endangered Species Act (ESA). These listings required the agencies operating and utilizing the dams (action agencies) to consult with either the National Marine Fisheries Service (NMFS) or the US Fish and Wildlife Service (USFWS) to determine whether operation of the hydrosystem would cause harm to listed species. These consultations resulted in a series of biological opinions (BiOps) along with reasonable and prudent alternatives (RPAs), actions to be taken to reduce impacts on listed species. The actions called for in the BiOps were reflected *in* the Programs or incorporated measures *from* the Programs.

In the 1990s, Programs became far more detailed and complex and represented a huge expansion from the Programs of the 1980s. The 1991-1993 Program was developed in four parts. The first part was released concurrent with the first ESA listings and encompassed the highest priority production and habitat actions for salmon and steelhead meant to be implemented immediately while further development of the Program was underway. The second and third parts, called the strategy for salmon, focused on mainstem survival and harvest and system integration. The fourth part addressed resident fish and wildlife. In 1994, the Program was redeveloped, greatly expanded and largely dedicated to measures associated with salmon and steelhead, while the 1995 amendment focused on resident fish and wildlife.

Changes to the operation of the hydrosystem remained a major part of the Program in the 1990s. The concept of the water budget developed in the Council's Program was incorporated in biological opinions and evolved from specific target volumes to a combination of volume and flow targets. Because of increasing concern about effects of flow operations on resident fish, the 1995 amendment included requirements for managing reservoir levels at Libby and Hungry Horse Dams and new operations at these dams to allow resident fish to complete their life cycle (e.g., necessary flows for spawning or for egg development). Flow measures at Libby Dam were also proposed to improve spawning conditions for

endangered Kootenai River white sturgeon. These programs also included significant measures for addressing water quality concerns at the dams and in the rivers.

There was a growing emphasis on habitat restoration and protection in the 1990 Programs. Protection measures included calls for land conservation in riparian zones and water conservation. The Program also called for near-term screening at water withdrawal facilities (diversions). In the 1990s, there was a continued call for assessing and adopting wildlife losses related to construction, inundation, and operation. Several long-term wildlife agreements were in place (e.g., Libby Dam, Hungry Horse Dam, Dworshak Dam), and a short-term agreement was in place in Washington. The Programs called for additional settlement agreements with the states of Oregon and Idaho.

Predator management efforts increased and expanded in the 1990s and addressed predation by both non-native and native species. Hatchery mitigation continued in the 1990's. Although most hatchery production occurred outside of the Program, one exception was of a set of hatcheries that were operated by the tribes with the objective of supplementing the remaining natural origin runs or to reintroducing fish to areas from which they were extirpated. During the 1990s resident fish losses at Libby and Hungry Horse Dams were described in mitigation plans, which were approved by the Council and adopted into the Program (NPPC 1995a).

The 1990s were also a time of development of information management and science review tools and processes. Programs in the 1990s supported development of the Coordinated Information System, which included databases, scientific summaries and accounting of project expenditures. In 1996, Congress amended the Power Act to create a process for scientific review of Program implementation (Section 4(h)10(D)) including the creation of the eleven-member Independent Scientific Review Panel (ISRP) to review projects and their results. Additionally in 1996, the Council and NMFS created the Independent Scientific Advisory Board to review the science supporting their respective programs.

## **Program Development in the 2000s**

In 2000, the Fish and Wildlife Program was fundamentally restructured while retaining the major provisions that had been implemented for the previous 20 years. A newly proposed scientific framework connected an overarching vision to goals, objectives, strategies, principles, and measures. There was a new emphasis on ecosystem function and better approximation of natural conditions, along with an emphasis that the natural environment was meant to serve as a baseline. The intention of the 2000 Program was for the Fish and Wildlife Program to be implemented through subbasin plans so that regional limiting factors or conditions could govern the kinds of actions implemented throughout the basin.

The 2003 Program focused on mainstem amendments, including specific hydrosystem operations, inclusion of BiOp measures, Montana amendments for storage reservoir protections for listed and non-listed species, measures for upriver and unlisted species, and mainstem habitat. In 2004 and 2005, subbasin plans were adopted and all offsite mitigation measures were listed in these plans. They included a technical assessment of limiting factors and a management plan linked to those limiting factors. Between 2004 and 2011, plans were adopted for 59 subbasins.

In 2009, the Council adopted a new Program. This Program incorporated the framework from 2000, the mainstem plan from 2003, and the subbasin plans from 2004 and 2005. It also recognized the 2008 accords. The organization of this Program reflected the new framework, with basinwide strategies, province-scale strategies (e.g., ocean and mainstem), and a discussion of elements required in subbasin plans and the procedure for implementing those plans.

To encourage more rapid progress on wildlife settlement agreements, the 1994/95 Program had called for interim agreements to be completed within 90 days of adoption of the Program and long-term agreements to be completed within 3 years. Many of those agreements were still incomplete at the time of the 2000 Program, so the Program set a deadline for developing those agreements as April 1, 2001. After that date, any losses not yet part of a settlement agreement and not yet mitigated would be doubled (2:1 crediting), thus requiring twice as much mitigation. The 2009 Program also called for a Wildlife Mitigation Advisory Committee to establish a ledger of habitat units acquired, address accounting issues around habitat units, and create a database to track acquisition and assign to projects.

Other efforts included developing interim goals. Goals included (1) halting declining trends (no target year), (2) improving smolt-to-adult returns (SARs) to achieve survival in the range of 2-6%; (3) continuing to restore lamprey; (4) restoring the widest possible set of healthy populations in each province (no target year); (5) increasing total adult salmon and steelhead runs above Bonneville to an average of 5 million by 2025 and within 100 years achieving full mitigation for losses of anadromous fish; (6) achieving within 100 years full mitigation for losses of resident fish; (7) restoring native resident fish species to near historical abundance wherever possible; and (8) reintroducing anadromous fish into blocked areas, where feasible.

Several research themes were explored in the 2000s. On the topic of the ocean, the Program called for research to separate marine mortality from freshwater mortality in the salmon life cycle. The estuary was a new focus of research in the 2000s. The Program recognized a need to better understand processes affecting the estuary and opportunities for restoration, along with better understanding salmon and steelhead survival rates through the estuary.

## Program Development in the 2010s

In the current decade, significant climatic events have impacted Columbia Basin fish and wildlife. From late 2013 – 2016, a marine heat wave, termed ‘the blob’ formed over the North Pacific. The affected region was characterized by exceptionally warm surface water temperatures and low productivity. This widespread low productivity resulted in extremely poor ocean survival rates of Columbia Basin salmon and steelhead. Additional marine heatwaves occurred in 2019, 2020, and 2021. Other climatic impacts included widespread fires throughout the basin, prolonged drought, and extreme temperature events. Each of these events demonstrates the vulnerability of the region to climate change events, particularly when multiple events within and outside the region occur simultaneously. In this decade, litigation on the FCRPS BiOp has continued and resulted in completion of an Environmental Impact Statement for the Columbia River Hydrosystem, as well as a new Biological Opinions. During this time, a new [2018 spill agreement](#) was developed and incorporated into the regulatory documents.

The 2014/2020 Program is a compilation of the types of work implemented since 1982 and the innovations and research that have contributed to new topics or scientific advances. For example, the

growing frequency of natural disasters and observations of temperature increases, changing precipitation patterns, and sea level rise have highlighted the need to consider the effects of the climate on the many efforts of the Fish and Wildlife Program. There has also been growing recognition of the effects of hydrosystem on sturgeon, lamprey, eulachon, burbot. Additionally, the 2014/2020 Program recognizes that the volume of work implemented in the blocked areas has been insufficient, leading to further recommendations for increased mitigation effort and funding.

In the 2014 Program, the wildlife strategy called for a recommendation on how to determine operational losses and set a deadline of 2015 to complete this effort. The 2014 Program also called for mitigation agreements for construction and inundation to be completed by 2016. The 2014 Program also included numerous measures on predator management both of native species (sea lions, seals, northern pikeminnow, double-crested cormorants, Caspian terns, white pelicans) and non-native species (northern pike, brook trout, other game fish). This was re-emphasized in 2020 with a near-term priority of sustaining and supporting ongoing efforts to reduce predation by northern pike.

A major issue in the current decade has been invasive zebra and quagga mussels. The Columbia Basin is the only major river basin in the U.S. that has not been impacted by zebra and quagga mussels. The Council highlighted this as an emerging priority in 2014, urging the Corps of Engineers to help fund detection and response actions. The 2014 program also outlined a set of principles related to integrating guidance from the Hatchery Science Review Group (HSRG 2009) and best management practices, along with calling for comprehensive RM&E on hatchery effectiveness.

In 2020, the Council highlighted as a near term priority that the Corps and Bureau implement additional operational changes at Libby and Hungry Horse Dams. Operational changes included slower ramp rates, altered draft and refill targets, integrating VarQ flood management with sturgeon flows, and altered operations during drought years. The Program continued to call for an adaptive management approach to all flow and passage measures. In the 2014 Program and 2020 addendum, specific measures called for a phased approach to evaluating reintroduction of anadromous fish above Chief Joseph and Grand Coulee dams. In 2020, there was further emphasis on increasing investment in blocked areas mitigation.

In recognition of the long-term investment of time and money in mitigation work, the 2014 Program and the 2020 Addendum emphasized assessing the performance of the Program. A major effort was undertaken in the 2014 Program to develop quantitative objectives for the existing Program goals. These were re-organized, reformulated, and supplemented where necessary in the 2020 addendum to allow for improved tracking and evaluation of Program performance. While the concept of performance has existed in some form in every program, the 2020 addendum introduced the concept of Strategy Performance Indicators (SPIs) to help track status and trends of conditions in the basin and evaluate program performance. The reporting of the SPI data occurs through the [Program Tracker](#).

Two other key research topics were the ocean and climate change. As part of this enhanced focus on the ocean, a new forum was created to discuss issues in the plume and ocean—the Ocean and Plume Science and Management Forum. As funding shifted throughout the decade, the ocean projects operated on decreased budgets, impacting the array of monitoring and analytical products that could be offered to the region. As such, the 2020 addendum identified a near term priority of restoring and sustaining funding for ocean monitoring and research.



## Connecting the Retrospective to Performance Assessments

The Retrospective provided an understanding of Program history and key events. The historical context provides information on why different elements have been included in the Program over time, what kind of changes were expected to occur, where those changes could occur, and when they could occur. This functions as sideboards for assessing Program performance. This retrospective of Program history is the basis for a more detailed assessment of Program performance, organized according to the main categories in the Program (Hydrosystem, Habitat, Artificial production, and Program adaptive management). These categories are implemented collectively to achieve mitigation. Assessing performance of the entire Program requires understanding each of these pieces and how they contribute to mitigation, and tracking what has been called for over time relative to any benchmarks in the Program, along with established Program objectives and goals.

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# Purpose and Scope

The Northwest Power and Conservation Council's Fish and Wildlife Program (hereafter Program or Programs) represents a 40-year effort to protect, mitigate, and enhance fish, wildlife, and habitat affected by the hydropower system in the Columbia Basin. The scope and investment in this Program make it one of the largest fish and wildlife mitigation efforts in the world and a significant part of the tapestry of mitigation efforts in the Columbia Basin. Through the collective efforts over the last 40 years, a substantial amount of work has been called for and implemented.

To better understand what kind of progress has been made, we developed this retrospective of Program development from 1980 through 2022 as a component of overall Program performance. In this retrospective, we describe the background of the Program, including the legal framework and co-occurring events that precipitated the formation of the Council and development of the Programs. We then describe in greater detail the actions called for in the Programs, by decade, and specifically identify major actions called for over time. Examples of implementation are included in these descriptions when they are specifically adopted into the Program or when that implementation influenced measures adopted into subsequent Programs. This information provides the basis for evaluating the status of fish and wildlife protection, mitigation, and enhancement through the 40-year history of the Program.

Following this retrospective, a separate set of assessments will describe the relationship between what has been called for in the Programs (inputs), what has been implemented (outputs), and what biological or ecological changes have occurred over time (outcomes) in the U.S. portion of the Columbia River Basin. Those assessments will be organized using a common set of categories: Hydrosystem, Habitat, Artificial Production, and Program adaptive management. Together, this retrospective and the categorical assessments constitute a thorough evaluation of Program performance that will lead into a prospective look at Program efforts into the future.

## The Columbia River Basin

### Basin Description

The Columbia Basin drains an area of 668,000 km<sup>2</sup> encompassing parts of Washington, Oregon, Idaho, Montana, Nevada, Utah, and Wyoming in the U.S., and parts of British Columbia in Canada (Figure 1). The dramatic geological history of earthquakes, volcanoes, glaciation, and epic floods in the basin has shaped the unique geography and created a diversity of habitat types across elevations ranging from sea level to greater than 4,000 m. Climactic differences throughout the basin further contribute to this variation by shaping hydrology. In the northern and eastern portions of the basin, the landscape is mountainous, and the hydrology of rivers is dominated by snowmelt. The central portion of the basin is characterized by mid-elevation, arid conditions on the Columbia Plateau. In the southern portion of the basin in Idaho and along the Oregon border, the landscape is arid, and the hydrograph is dominated by snowmelt. The Cascades mark a rain/snow transition zone; on the west slopes of the Cascades, hydrographs of some tributaries are influenced by snow-melt runoff from the Cascade Range, whereas lower elevation tributaries are primarily influenced by rainfall. Further to the west, the rivers in the low-

lying Coast Range are primarily influenced by rainfall. Across this landscape, precipitation ranges from < 30 cm/year of rain in the Columbia Plateau, to > 13.5 m of snow in Canada at the headwaters of the Columbia River, to > 200 cm of rain at Astoria, Oregon, in the Columbia River Estuary.



Figure 1. Major rivers of the Columbia River Basin. Map created in ArcGIS Pro. © 2020 ESRI. All rights reserved.

Prior to development in the Columbia Basin, abundant and diverse salmon and steelhead runs returned to the basin annually (NPCC 1986). These runs were integral to the culture and diet of the Native American Tribes in the basin and contributed to a rich and interconnected ecosystem of anadromous fish, resident fish, and wildlife. Diverse, high-quality habitats occurred throughout the Columbia Basin, connected by intact riverine or terrestrial corridors. Fish and wildlife exhibited many life-history strategies, connecting seasonal or life-stage specific habitats throughout the basin with movements or migrations of different distances. Migrations were timed in relation to seasonally predictable environmental conditions, such as the timing of runoff (Poff et al. 1997). Because populations inhabited different environments at different times, the risk of extirpation following a natural disturbance was reduced (termed risk-spreading; Den Boer 1968). Likewise, the diversity of behavioral strategies exhibited meant that regardless of the prevailing environmental conditions (ocean conditions, annual hydrograph, drought, etc.), some set of behaviors was well-suited to the environment, allowing those individuals to successfully reproduce (termed bet-hedging; Murphy 1968; Stearns 1989).

## Development of the Columbia Basin

Rapid development of the Columbia Basin began in the mid to late 1800s. At that time, salmon were so abundant that they were considered a limitless resource (*Washington v. Fishing Vessel Association 1979*). With the advent of more efficient techniques, gear, and the ability to preserve salmon and send it to other markets, commercial harvest rapidly increased (ODFW and WDF 2002; Smith 1979; Figure 2) and stayed elevated through the 1930s (Smith 1979). Overharvest led to precipitous declines in salmon and steelhead abundance. As stocks declined, regulations were imposed to limit the types of gear that could be used (e.g., banning fish wheels in 1928 (Oregon) and 1935 (Washington)). Tighter restrictions were also set around seasons and exploitation rates in an effort to reverse harvest-related declines (ODFW and WDFW 2002), although enforcement of these early restrictions was inconsistent.

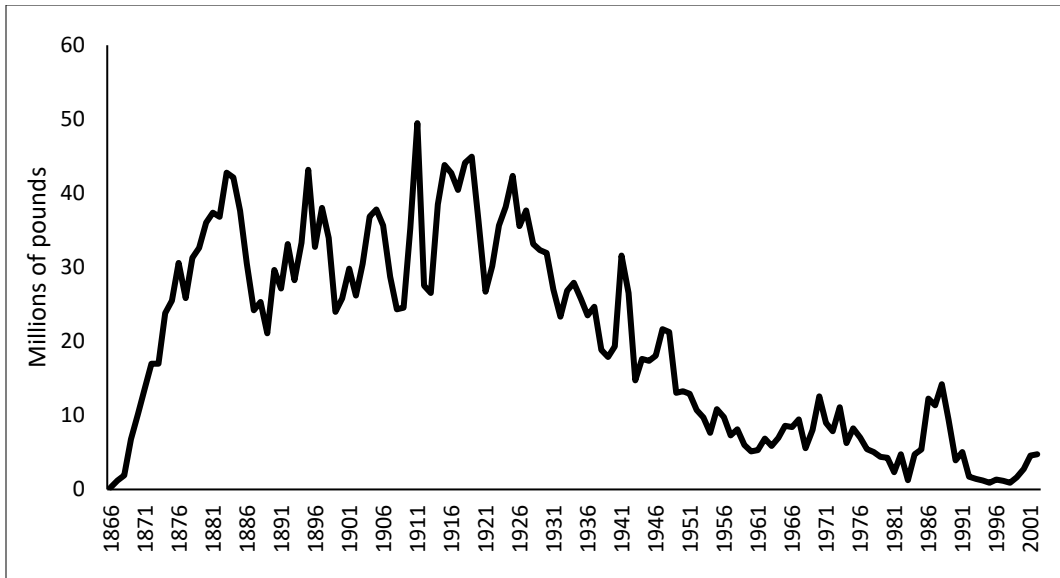


Figure 2. Commercial landings (in millions of pounds) of Columbia River Salmon, 1866-2001. Data from ODFW and WDFW 2002 and references contained therein. Recent data have not been compiled in a similar fashion.

At the same time, there were other changes to land use including commercial forestry, mining, ranching, and irrigated farming, development of transportation and the railroad, and new human population centers (NPPC 1986; ISAB 2011; Figure 3). Each of these factors impacted habitat or negatively affected the survival or reproduction of fish and wildlife in the basin. They also formed the backdrop against which the development of the hydrosystem, and its additional impacts to fish, wildlife, and ecosystem function, occurred.



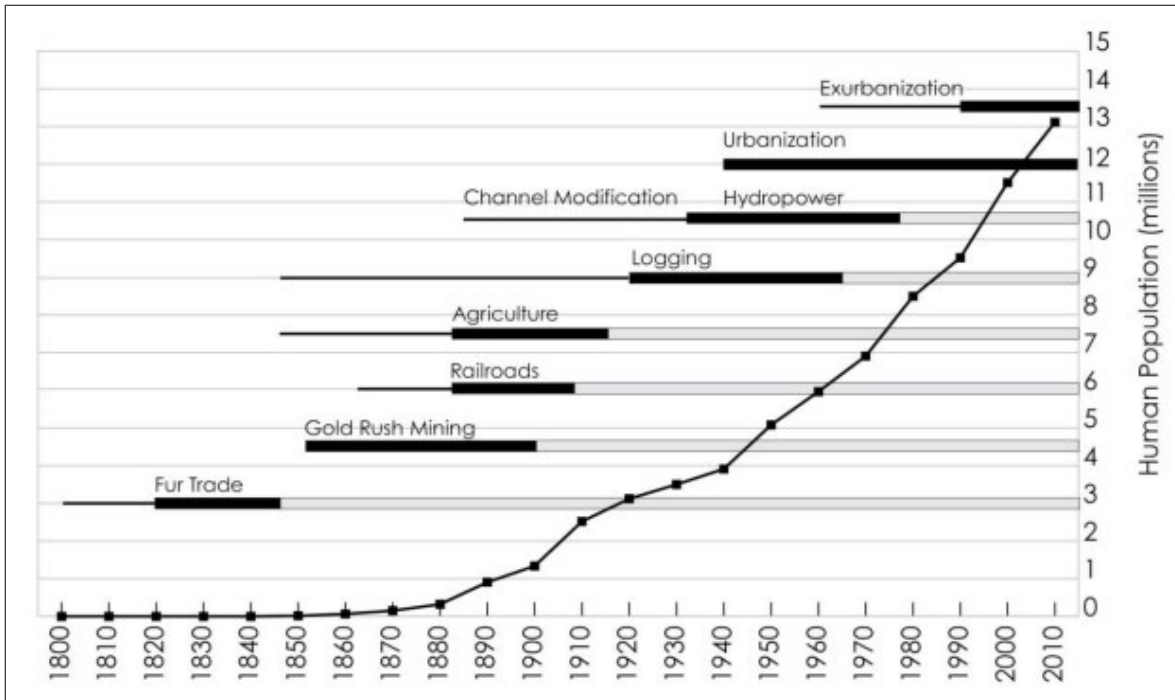


Figure 3. Sequential development of activities driving landscape change in the Northwest and concurrent changes in human population size. (U.S. Census data for Oregon, Idaho, Montana, and Washington). Wide dark bars indicate the period of peak development and rapid habitat conversion, and wide light bars indicate continued effects following the development period. Figure from ISAB 2011.

## Development of the Hydrosystem

The first hydropower dam in the Columbia Basin was constructed in 1890 on the Spokane River (Figure 4), marking the beginning of a century of hydropower development in the basin (data on construction dates and nameplate capacity collected from NPCC database on Columbia Basin hydropower). Major mainstem Columbia River dams were constructed between 1933 and 1971 (Figures 4 - 6). Dam construction on the mainstem Snake River occurred between 1901 and 1992, although most Snake River dams were constructed between 1952 and 1975 (Figures 4 - 6). Following disastrous flooding in the lower Columbia in 1948, the Columbia River Treaty was ratified between the U.S. and Canada (1964) and authorized the construction of major storage dams in Canada (Hugh Keenleyside, Mica, Duncan) and one in the U.S. (Libby Dam). These dams were completed between 1967 and 1977. Numerically speaking, construction of hydropower dams of any size accelerated most rapidly during the 1980s (Figure 4). During that decade, the number of dams in the basin almost doubled. However, construction after 1980 was mostly of small hydroelectric facilities that primarily serve other purposes such as irrigation. In total, approximately 272 hydroelectric dams were constructed in the U.S. portion of the Columbia Basin; 23 of those dams were eventually removed.

In its current configuration, the hydrosystem includes major hydropower producers on the mainstem Columbia River, Snake River, and tributaries, along with dams that produce minimal hydropower, often for local purposes (e.g., diversions or canals). A total of 29 dams in the Columbia Basin (and two dams outside the basin) comprise the Federal Columbia River Power System (FCRPS). The largest eight dams in

the basin have the capacity to produce over 50% of the total power generated by the hydrosystem (Grand Coulee, Chief Joseph, John Day, The Dalles, Rocky Reach, Wanapum, Bonneville, and Boundary). Of the 249 dams currently in the basin, only 114 have a maximum rated output (nameplate capacity) greater than 5 megawatts.

Major hydropower dams were authorized for multiple purposes in addition to power generation, including flood control, irrigation, municipal water, navigation, and recreation. To meet these various needs, some dams were constructed as storage dams (capable of altering the timing and volume of river flows and power generation seasonally) and others were constructed as run-of-the-river dams (minimal capacity to shape flows). Mainstem dams were also constructed with locks to allow for barging upstream as far as Lewiston Idaho, an inland seaport located 748 km from the ocean.

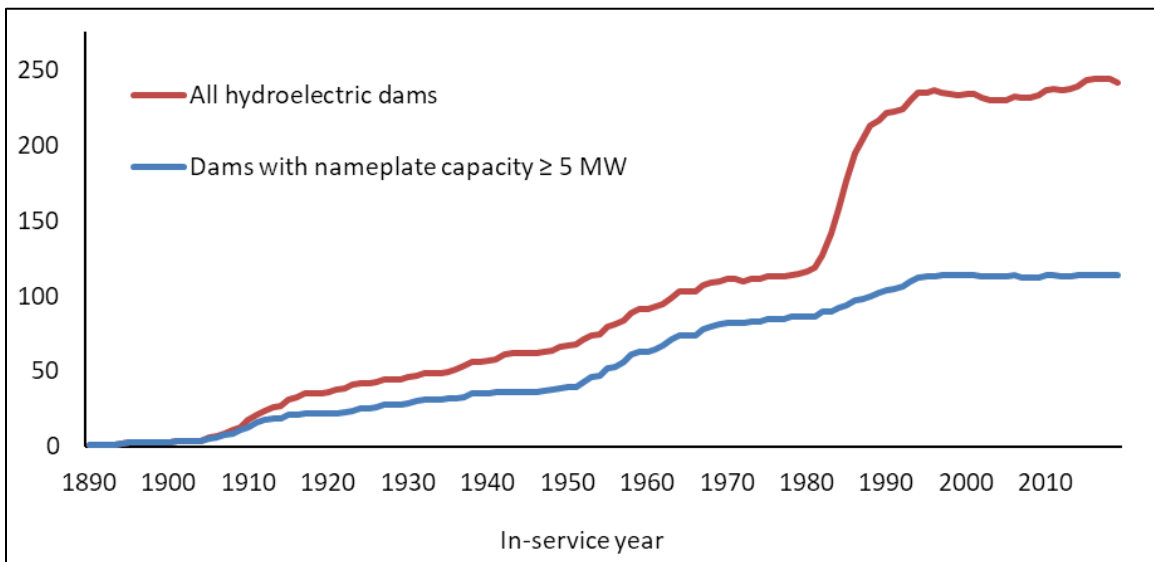


Figure 4. Cumulative count of hydropower dams and dams with a nameplate capacity  $\geq 5$  in the U.S. portion of the Columbia Basin using the Northwest Power and Conservation Council hydropower database. Dams are added to the count the year they are placed in service and dams are removed from the count on their retirement date. This figure excludes eight dams for which no in-service dates were available and includes three dams known to have been retired but for which no retirement dates were available. It also excludes nine database entries where additional turbines were added to an existing hydroelectric facility.



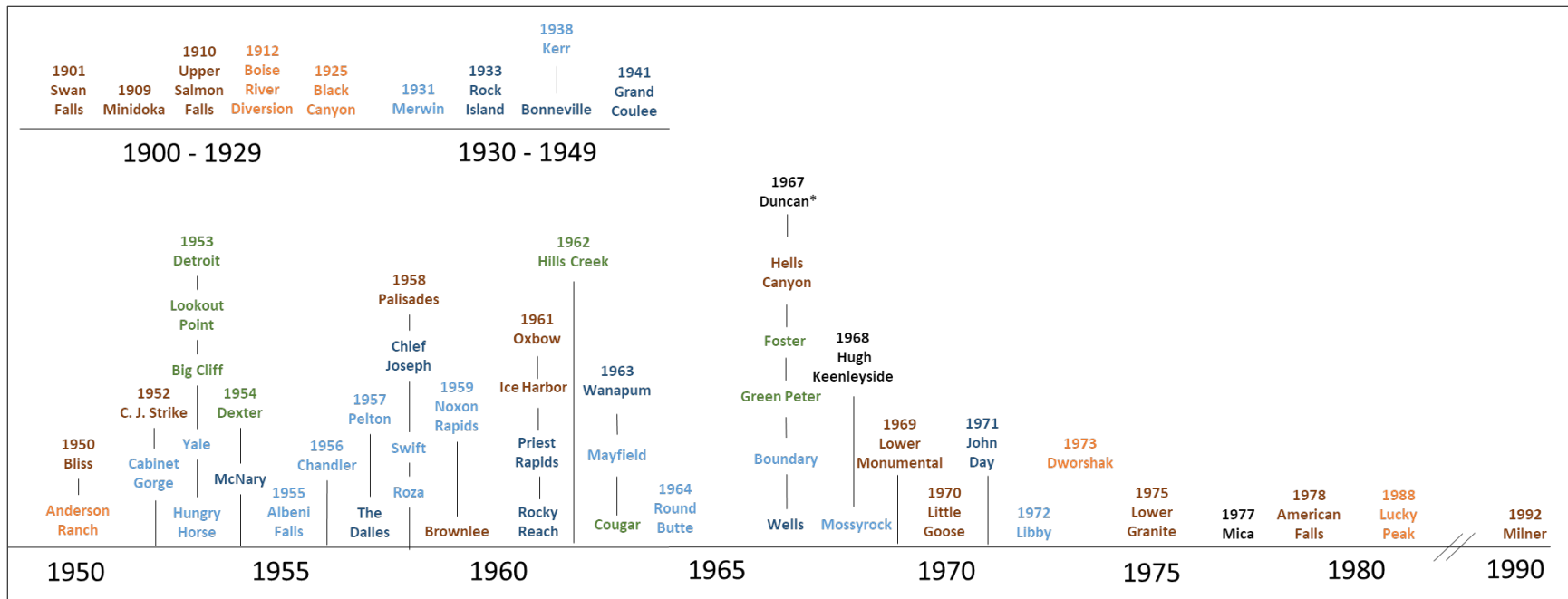


Figure 6. Construction timeline of major federally and non-federally owned hydroelectric dams (n = 55) in the Columbia River Basin. Dams are listed in the year construction was finished and power generation began unless power was retrofit to an existing dam. In that case, dams are listed in the year construction was finished. Names are color-coded by general location (dark blue = mainstem Columbia River, light blue = tributary to Columbia River, black = Canadian portion of Columbia River, brown = mainstem Snake River, light orange = tributary to Snake River, green = Willamette River subbasin). Timeline includes all dams in the Federal Columbia River Power System (FCRPS; n = 29), Hells Canyon Complex (n = 3), mid-Columbia River Public Utility Districts (PUD; n = 5), Columbia River Treaty (n = 3 in Canada; \*dam operated for storage only), along with other privately-owned, major dams (n = 18).

## Effects of Hydrosystem Development on Fish, Wildlife, and Habitat

The construction, inundation, and operation of the hydropower system has affected fish and wildlife locally and regionally. In general, effects accrue as the hydrosystem is developed and vary depending on where the dam is in the basin, what kind of dam it is, how it is operated, and how long it has been in place (Petts 1987; Poff and Hart 2002). Ecological effects include altered hydrology (Poff et al. 1997), altered sediment transport, altered temperature, habitat loss, degradation and fragmentation, and an altered ecosystem (e.g., species composition, species interactions, and nutrient sources; Ward and Stanford 1979; Fraley and Graham 1982; Ward and Stanford 1983; Wootton et al. 1996). Biological effects include passage mortality, altered behavioral cues, and altered migration patterns. These various effects have been thoroughly described in the literature (Weitkamp 1994; ISG 1996; ISAB 2000; Bottom et al. 2005; Williams et al. 2005; Ferguson et al. 2006; Waples et al. 2007) and are not the subject of this review. Rather, a brief overview is provided of the types of effects observed from the construction, inundation, and operation of the hydrosystem as context for the types of protection, mitigation, and enhancement actions called for in the Program.

### Construction and Inundation

As the hydrosystem was being developed, certain dams included facilities for juvenile or adult fish passage and others were complete blockages to fish migration. In total, the hydrosystem blocked access to approximately 4,600 stream miles out of the previously accessible 14,700 miles of salmon and steelhead habitat; this represents a loss of approximately 31% of stream miles previously accessible to anadromous fish (NPPC 1986; Figure 7). Of the miles lost, approximately 4,100 were in the basin above Bonneville Dam. Fragmentation of the river system also affected freshwater migratory (potamodromous) species such as sturgeon, bull trout, and cutthroat trout. These species exhibit certain life-history strategies that require migrating between distant life-stage specific habitats or connecting unique habitats locally (e.g., rivers, tributaries, or lakes). Fragmentation of these habitats affected the diversity of life-history forms that could be expressed, resulting in a decreased ability to successfully reproduce and survive during variable environmental conditions or survive and recolonize following local disturbances (e.g., wildfire). Fragmentation also altered sediment and nutrient transport throughout the basin, affecting habitat-forming processes and the productivity of the food web.

The development of the hydrosystem in Canada and the U.S. resulted in inundation of riverine habitat, wetlands, riparian zones, and some upland habitat, along with altering levels of some lakes. This inundated land had previously functioned as habitat for a diversity of fish and wildlife species. It also functioned as a source of nutrients supporting the ecosystem function of the riverine environment. Although some inundation occurs upstream of all dams, storage dams cause unique inundation impacts. Sections (called reaches) of the river immediately upstream of storage dams are constantly inundated (except during deep drawdown or drought), and river reaches or lakes further upstream may be seasonally inundated, depending on the specific way in which the dam is operated. Even seasonal inundation can cause substantial alterations to habitat function, including increasing bank erosion and altered nutrient inputs.

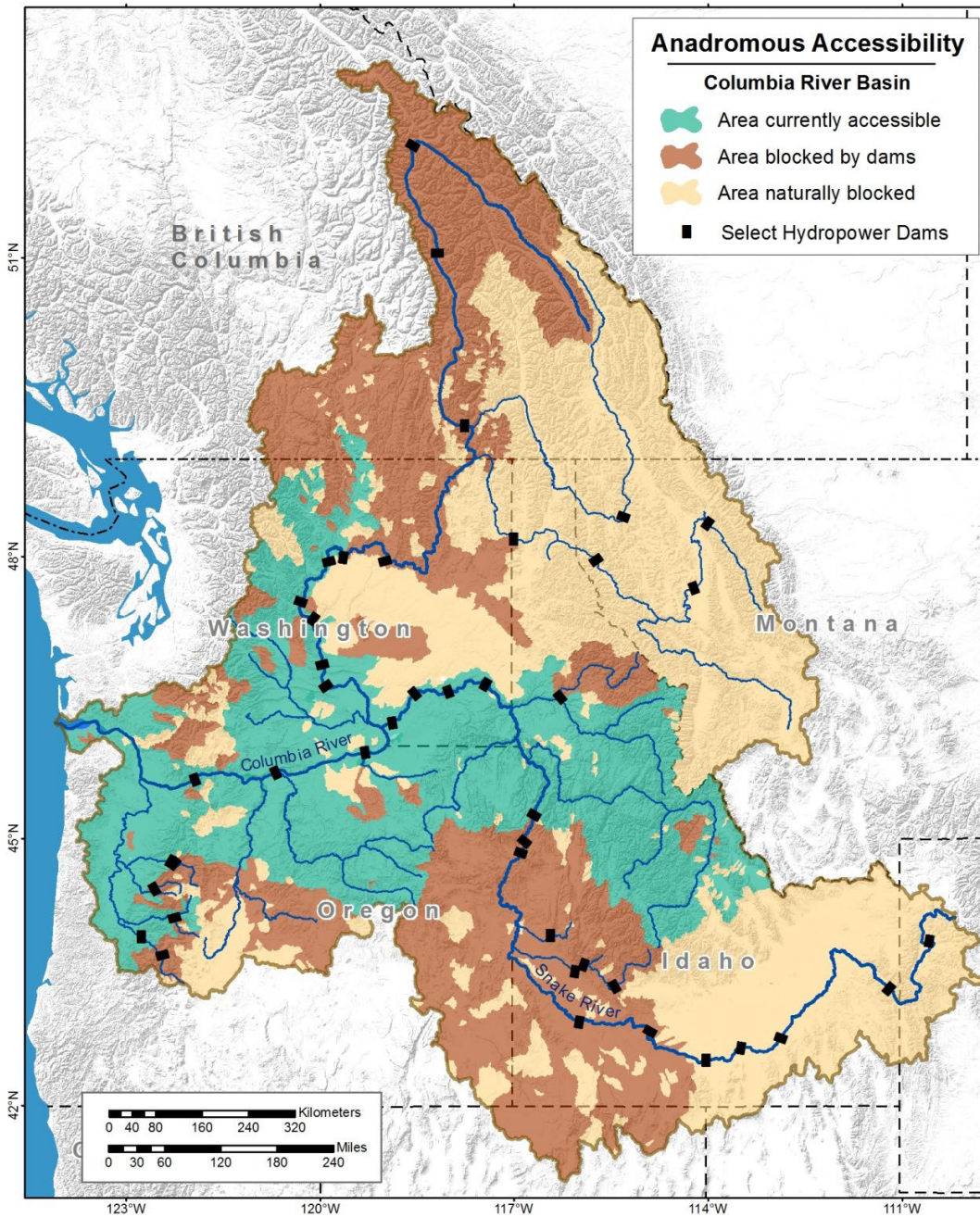


Figure 7. Regions of the Columbia River Basin that are currently accessible to salmon and steelhead, that were historically accessible but are now blocked by dams, or that were never accessible. Figure produced by Van Hare, PSMFC and published in ISAB 2015.

## Operation

The seasonal timing, duration, magnitude, frequency, and variation of flow levels constitute the hydrograph. Hydrosystem operations have changed the natural hydrograph, including seasonality and

volume of flows (Figure 8), rate of flow change, and water velocity. As Canadian storage projects were completed (1967-1977), the changes became much more pronounced (Cohen et al. 2000). Additional operational impacts included alterations to water temperature and water quality, creation of habitat conditions favorable to non-native and invasive species and native predators, changing patterns of predation throughout the mainstem and estuary, and changes to the ecological function of rivers, lakes, the estuary, and the nearshore plume. Drawdown and refill rates and volumes in reservoirs can exert a substantial impact on the food web in reservoirs, free-flowing reaches of rivers, and lakes. Examples of these impacts can be found in the river or river-lake ecosystems in Montana (e.g., Flathead and Kootenai systems; Beattie et al. 1988; Muhlfeld et al. 2011; FWP et al. 2017), and in northern Idaho (Lake Pend Oreille; Whitlock 2013).

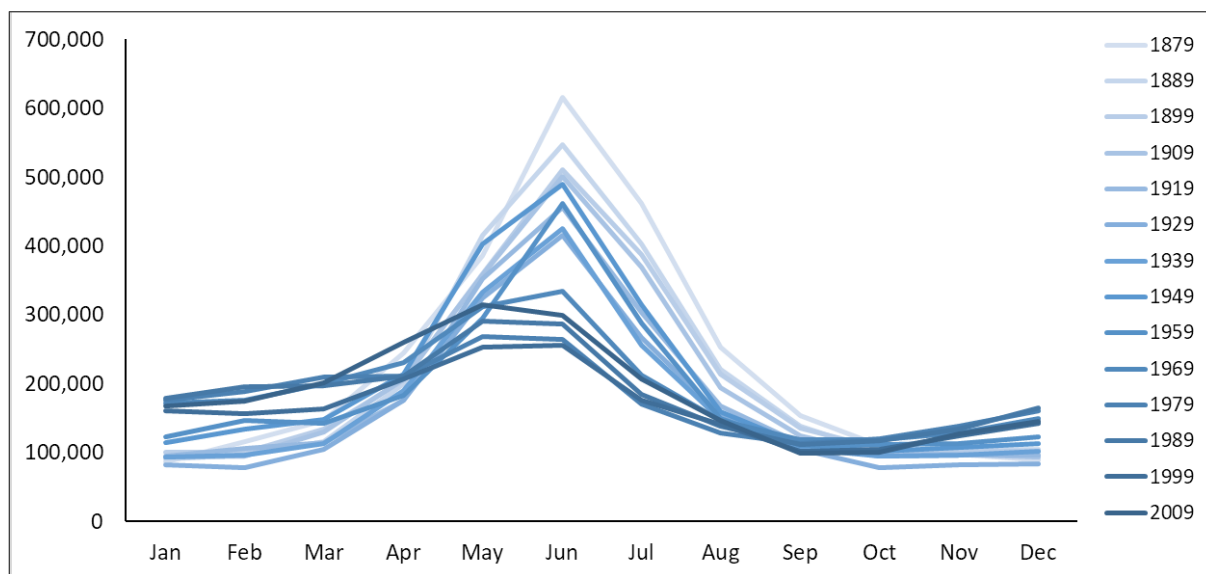


Figure 8. Average monthly discharge (CFS) at The Dalles Dam, by decade. Year labels for each line represent the beginning of the decade.

## Ongoing Impacts to Fish and Wildlife

The construction and operation of the hydrosystem was the largest source of losses to salmon and steelhead (NPPC 1986), in part because those losses were complete in the areas of the basin blocked to anadromy by dams. While historical losses from overharvest and other factors were significant, subsequent restrictions on harvest rates and methods have lessened those impacts over time. Today, the hydrosystem is one of many human-caused impacts to fish and wildlife and their habitats (NPPC 1986). Land use, continued development of the basin, and other impacts all contribute to fundamentally altering the function of the Columbia Basin ecosystem. Mitigation for effects of the hydrosystem is occurring against this backdrop of ongoing degradation, which has the potential to affect the success of mitigation efforts.

For example, because of previous fire management strategies and climate change, wildfire occurrences are extensive throughout the basin (Figure 9), and fires are larger and more intense. These conditions are exacerbated by more intense and prolonged droughts, which affect water supply. Likewise, warmer

temperatures in the Columbia and Snake rivers, along with many tributaries, exceed thresholds for salmonids during portions of the year (Figure 10). While detrimental to native species, these novel conditions can allow for faster spread of invasive species. Increased human development, in general, results in a greater footprint on the landscape with respect to factors like impermeable surface area, heat islands, introductions of non-native species, or pollution. These continued or increasing impacts must be taken into consideration when assessing Program performance.

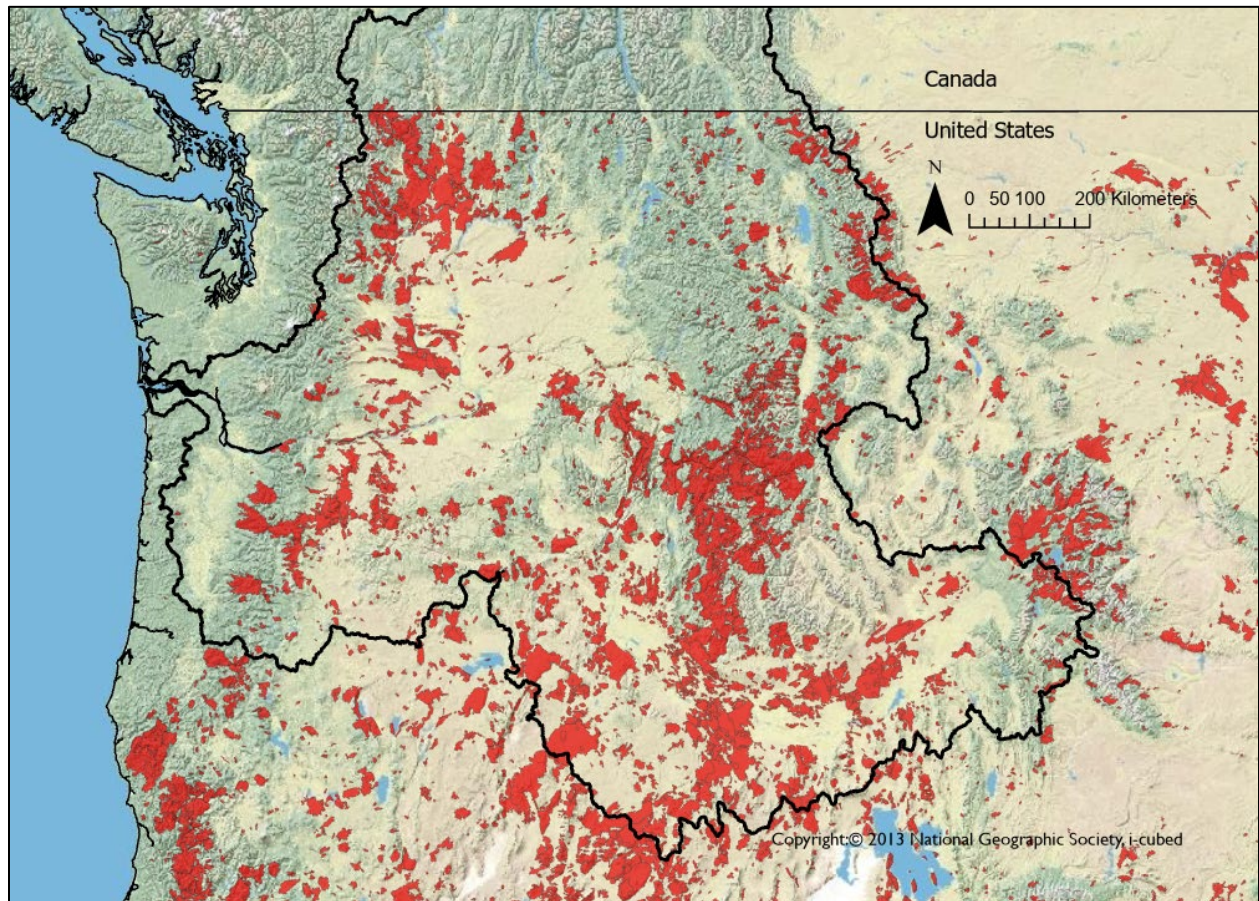


Figure 9. Annual wildfire extent in the Pacific Northwest, 1984 to 2020. Wildfire GIS layer acquired from mtbs.gov (monitoring trends in burn severity). Map created in ArcGIS Pro © 2020 ESRI. All rights reserved.



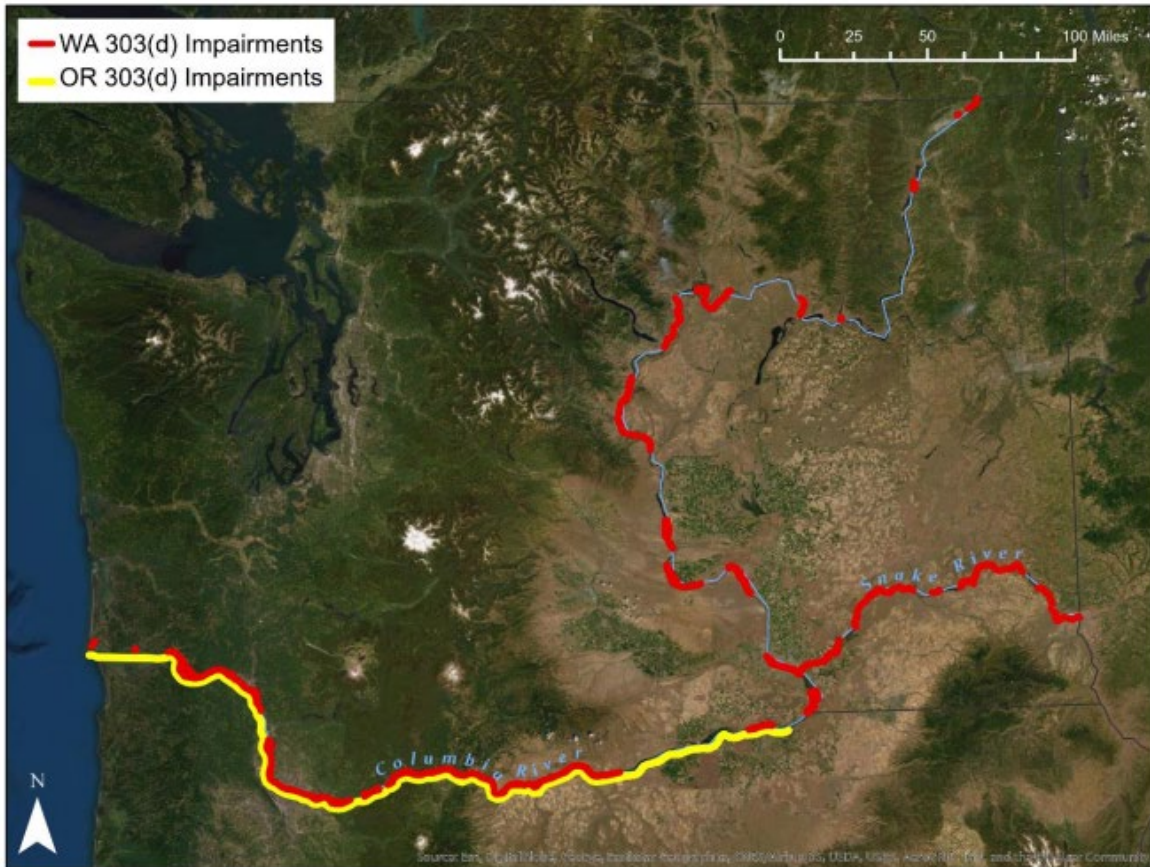


Figure 10. Reaches of the Columbia and lower Snake Rivers identified as impaired for temperature according to standards in the Clean Water Act section 303d. (Source)

## Development of the Northwest Power Act

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (hereafter, Power Act) was developed in response to an energy and financial crisis in the Pacific Northwest. Demand forecasts in the 1960s and 1970s inaccurately predicted a significant and unmet future power demand. As a companion to hydroelectric power, efforts were underway to explore adding thermal power (burning fossil fuels or running nuclear reactions to boil water and produce steam to spin turbines) to the region. In the 1960s, the Washington Public Power Supply System ([WPPSS](#)) began development of five nuclear power plants. BPA agreed to purchase and market the power output and meld it with low-cost hydropower. Costs to build the plants sky-rocketed and the forecasted demand for the power did not appear (Pope 1991). Of the five nuclear plants proposed, only one was ever completed, two were partially constructed, and two were abandoned in the planning stage. BPA absorbed the cost of the first three plants. Debt payments on the first three plants were rolled into the wholesale electric rate and were responsible for a 600% increase in rates from 1979 to 1984 (CNR 1994). In the 2021 briefing book prepared by NPCC (NPCC 2021), it was noted that “the costs associated with those three plants—more than \$500 million a year—are responsible for about 1/3 of the wholesale power rate Bonneville charges to this day. As of 2020, the total debt for the three plants stands at \$4.834 billion.” In addition to forecasting issues, there were also

concerns that the power planning did not take into consideration environmental concerns, lacked public involvement in the process, and was outside of BPA's direct authority. The Power Act was passed to address these multiple power planning and environmental deficiencies.

The Power Act authorized the Idaho, Montana, Oregon, and Washington to enter into an interstate compact, with the governors of these states each appointing up to two representatives. Collectively, they formed the Pacific Northwest Electric Power and Conservation Planning Council (hereafter Council). The Power Act specifies three responsibilities of the Council: (1) to develop a Program to protect, mitigate and enhance fish and wildlife affected by hydroelectric facilities in the Columbia River Basin, (2) to develop a power plan assuring the Pacific Northwest of an adequate, efficient, economical, and reliable power supply, consistent with the fish and wildlife Program, and (3) to inform and involve the public.

The Power Act does not specifically define the terms "protect and mitigate" but accepts common sense definitions. Examples of definitions for those terms appear in other legislation, including section 4(e) of the Federal Power Act, and a 2022 Council of Environmental Quality (CEQ) [reference document](#) on implementing the National Environmental Policy Act (NEPA) of 1970. In that document, the CEQ defines mitigation as "measures that avoid, minimize, or compensate for effects." Similarly, the Merriam-Webster dictionary defines mitigation as "the process or result of making something less severe, dangerous, painful, harsh, or damaging." The term "enhance" appears in Section 4(h)(8)(A) "... as a means of achieving offsite protection and mitigation with respect to compensation for losses arising from the development and operation of the hydroelectric facilities of the Columbia River and its tributaries as a system."

The Power Act has been summarized [elsewhere](#), so here we focus on seven key points related to fish and wildlife.

- 1) The mitigation responsibility to protect, mitigate, and enhance fish and wildlife encompasses all federal hydroelectric facilities (owned and operated by the U.S. Corps of Engineers and the U.S. Bureau of Reclamation) and non-federal hydroelectric facilities (owned and operated by investors, Public Utility Districts (PUDs), or other local entities and regulated by FERC) within the U.S. portion of the Columbia Basin. Although emphasis is placed on mitigation at large mainstem dams that comprise the Federal Columbia River Power System, mitigation responsibility encompasses all hydroelectric facilities (e.g., Section 4(h)(1)(A); section 4(h)(2)(A)) regardless of location, size, or minimum power generation.
- 2) Mitigation is achieved through a combination of onsite actions (e.g., changes to the operation of the hydrosystem) and offsite mitigation (e.g., restoration of spawning grounds; Section (4(h)(1)(A)). The ability to require operational or structural changes to dams was a significant advancement in mitigation.
- 3) Bonneville Power Administration (BPA) must use both its fund and its authorities "to protect, mitigate, and enhance" in a manner that is consistent with the Council's Fish and Wildlife Program, and this funding cannot be used in lieu of other available funding (Section (4(h)(10)(A)).

- 4) The federal action agencies must take this Program into consideration. Specifically, the U.S. Army Corps of Engineers (Corps), the U.S. Bureau of Reclamation (Bureau), and the Federal Energy Regulatory Commission (FERC) have obligations to make decisions taking into account the Council’s Program “to the fullest extent practicable” while treating fish and wildlife equitably with other authorized purposes of the dams (Section (4)(h)(11)(A)).
- 5) The Program was originally developed and is subsequently amended approximately every five years<sup>1</sup> by soliciting recommendations for measures and objectives from the state and federal fish and wildlife agencies and tribes<sup>2</sup> (hereafter ‘fish and wildlife managers’) and other interested parties in the Columbia Basin (Figure 11; Section 4(h)(2)). Measures included in the Program “will be based on, and supported by, the best available scientific knowledge” (section 4(h)6(B)).
- 6) There is a further requirement that the Program treat the “river and its tributaries as a system” (section 4(h)(1)(A)), which means each submitted (and adopted) measure must be placed within a larger framework connecting the individual recommendations into a cohesive mitigation plan. The Council develops this cohesion by grouping measures on similar topics into overarching strategies and through development of “principles” that describe the intent of each strategy. Other elements of this cohesion (e.g., use of a scientific framework) are described in more detail in the section on “Program Themes Over Time.”
- 7) Although many Program measures benefit endangered species, recovery of ESA-listed species is the legal responsibility of federal agencies. Rather, the Program is focused on protecting, mitigating, and enhancing all focal species affected by the hydrosystem through a combination of onsite and offsite actions. In doing so, the actions taken contribute towards larger recovery efforts.

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<sup>1</sup> “The Power Act requires the Council to review the Power Plan at least every five years, and to call for amendments to the Fish and Wildlife Program prior to reviewing the Power Plan.” -NPCC 2021

<sup>2</sup> Originally, measures were submitted by the federal and state fish and wildlife agencies and the region’s Indian tribes both collaboratively and independently. In 1987, the Columbia Basin Fish and Wildlife Authority (CBFWA) was established to “provide a forum for its members to exchange information on matters affecting anadromous fish, resident fish and wildlife resources and habitat concerns in the Basin and develop unified positions” along with focusing “agency and tribal actions into a single direction, thereby providing the Northwest Power Planning Council and the Bonneville Power Administration with recommendations representing the best available information for the fish and wildlife managers” (CBFWA 2009). In 2013, CBFWA was dissolved.

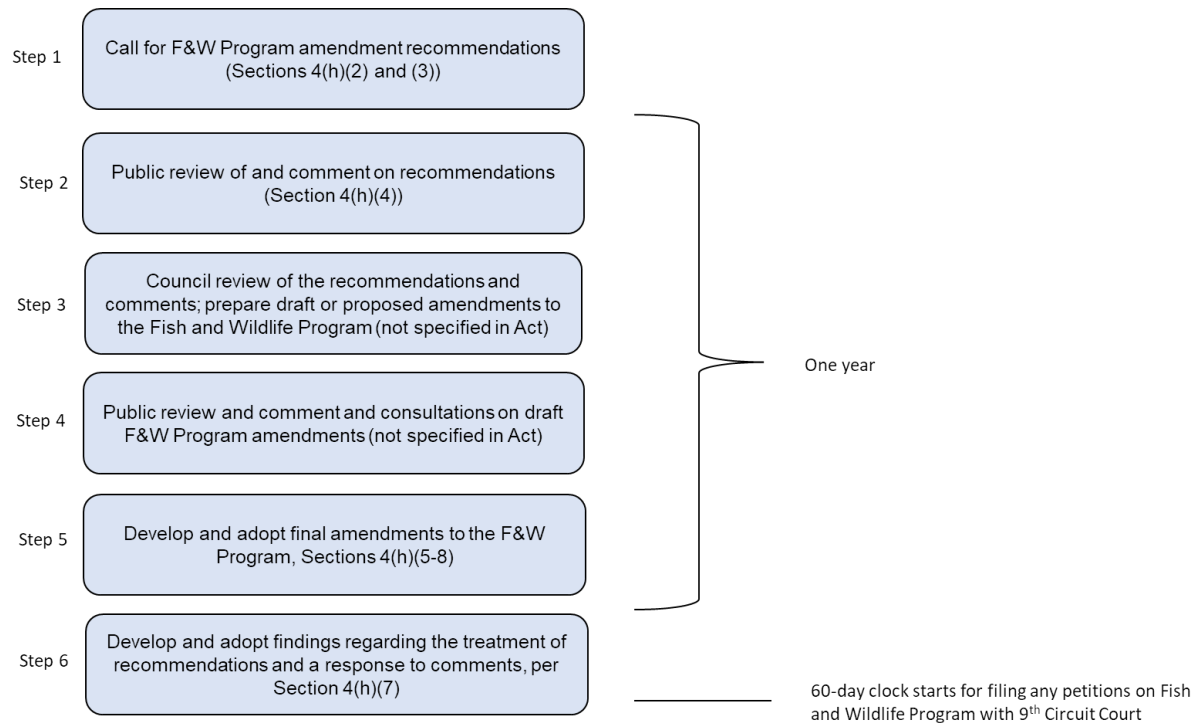


Figure 11. Major steps and associated timelines required for development, amendment, and adoption of the Council's Fish and Wildlife Program.

# The Fish and Wildlife Program

## Overview

Over the last 40 years, there have been seven Fish and Wildlife Programs and ten amendments or addendums to those Programs (Table 1). All these Programs were based on the language in the Act that called for a combination of (1) onsite (in-kind and in-place) actions related to the hydrosystem, and (2) offsite actions to protect, mitigate, and enhance populations of fish and wildlife affected by the hydrosystem. These were designed to function in tandem, with different actions being implemented collectively to achieve goals.

In-kind and in-place actions involve directly improving survival or habitat in the locations where it has been affected (in-place) and in a manner that is consistent with what was lost (in-kind). This is done by changing the structure and operation of the hydrosystem (e.g., flow or passage) to achieve protection and improved survival for fish and wildlife while still leaving the hydrosystem in place. However, hydrosystem impacts can only be partially mitigated in-kind and in-place. Dam operations or passage structures have been changed to decrease negative effects on fish but the dams remain in place along with associated habitat fragmentation and changes to ecosystem function.

To the extent that onsite actions cannot fully mitigate hydrosystem effects, the Act provides for offsite mitigation, including on related spawning grounds. Offsite actions include all efforts not directly located in the mainstem or near a dam. There are two general types of offsite mitigation—replacement of lost

natural production and actions implemented to improve environmental conditions or survival outside of the mainstem. Hatchery programs were established to mitigate the effects of the Columbia River hydrosystem on fish through replacement of lost natural production. These programs complement habitat improvements and are managed to supplement or reintroduce native fish populations and/or support harvest opportunities. Other offsite actions include habitat restoration and protection, addressing predation and invasive species, and Research, Monitoring and Evaluation (RM&E). In the areas blocked to anadromous fish (hereafter blocked areas), in-kind and in-place actions have been implemented to benefit wildlife and some resident species affected by dams, but the remainder of actions have been a combination of hatchery releases of resident species and offsite actions (e.g., restoration).

Fish and Wildlife Programs generally do not prescribe the quantity of effort required to achieve mitigation, aside from production levels established in certain hatchery programs. Rather, Programs emphasize the strategies that will be employed throughout the basin to achieve objectives and goals or highlight particular benchmarks (e.g., flow levels). Across Programs over time, certain common strategies emerge, such as changes to the operation of the hydrosystem, improvements in fish passage, habitat restoration, and fish production. These strategies are supported by a strong emphasis on supporting scientific advances through research, monitoring, and evaluation (RM&E), adaptive management, and promoting regional coordination, data sharing, and public engagement. Other strategies are highly specific to a time period, a region, or even to a specific dam. Collectively, these Programs describe the intention of what mitigation entails, how it will be implemented, and what specific targets must be met.

Table 1. Chronology, description, and organization of the Northwest Power and Conservation Council’s Fish and Wildlife Programs (normal font) and associated amendments or addendums (italicized).

Year	Description	Program organization
1982	1st Program	List of measures primarily organized by salmonid life stages and with emphasis on the hydrosystem
1984	Minor amendment	
1987	2nd Program	List of measures primarily organized by salmonid life stages and with emphasis on the hydrosystem; loss assessments; interim double-the-run goal, simple framework
1988	Protected Area Rules	
1989	Wildlife Rules	
1991-1993	3rd Program	Four-part amendment
	Part 1: Highest priority production and habitat actions	
	Part 2: Mainstem survival and harvest	Strategy for salmon, simple basinwide and salmon framework
	Part 3: System integration	Strategy for salmon
	Part 4: Resident fish and wildlife	
1994	4th Program	Comprehensive Program; long list of specific measures; subbasin plans used to prioritize and implement habitat restoration; simple basinwide

		and salmon framework, goals for basinwide, salmon, resident fish, wildlife
1995	Resident fish and wildlife	
2000	5th Program	Scientific (detailed) framework, basinwide measures, principles, goals, and objectives; intended to be implemented through mainstem and subbasin plans
2003	Mainstem amendments	
2004	Adopt 18 subbasin plans	
2005	Adopt 20 subbasin plans	
2009	6th Program	List of principles, strategies and measures within scientific framework; appendix contains BiOp and subbasin-scale measures, along with goals and objectives
2010	Adopt 1 subbasin plan	
2011	Adopt 1 subbasin plan	
2014	7th Program	List of principles, strategies and measures within scientific framework; appendix contains BiOp and subbasin-scale measures, along with goals and objectives
2020	Part 1 = Goals, objectives, strategy performance indicators	
2020	Part 2 = near term priorities	

## A Shift to Performance

The concept of performance appeared in the Power Act and in different forms in every Fish and Wildlife Program over the last 40 years. For example, Section 4(h)12(A) of the Act calls for an annual report to Congress that includes discussion of "... the effectiveness of the fish and wildlife program." Similar references to effectiveness appear in programs of the 1980s. Because the Program is developed by drawing on regional expertise on how best to mitigate for the hydrosystem, there is an expectation that complete implementation of prescribed actions through investment in mitigation will achieve established objectives and goals. With the 2009 Program, the Council and region began emphasizing the need to understand outcomes from this significant investment. Initial work on this focus involved development of objectives in 2014. This was followed by additional work in developing Part I of the 2020 addendum which included reorganized and sharpened goals and objectives, and newly developed indicators to track performance of the Program's strategies. This effort forms the basis for this current assessment of Program performance.

To characterize the achievements of the Program over time, it is necessary to understand the historical context at the time of each program. This context provides key information on why different elements were included in each Program, what kinds of changes were anticipated from implementing measures or strategies, where changes could occur, and when they could occur. This contextual information provides side boards for the performance assessment.

Context also helps in understanding factors that drive Program content and influence results of implementation. For example, because the Columbia Basin is large and diverse with respect to hydrology, climate, geology, geography, species, and habitat types, development of the hydrosystem has created unique effects in different regions of the basin and for different species. Specific effects vary depending on location, dam type, dam operations, and the duration of time since the dam was constructed. As such, appropriate actions to achieve protection, mitigation, and enhancement vary throughout the basin. Even as substantial effort is applied to mitigate for the impacts of the hydrosystem, other human impacts and natural disturbances in the basin produce environmental degradation that can negatively affect ecosystem function or fish and wildlife populations. Continued development in the basin, changing legal protections, and other significant environmental, social, or political events each have the potential to affect the success of hydropower-related mitigation efforts. Accomplishments of the Program must be understood and interpreted in the context of these changing conditions.

Fish and Wildlife Programs have been developed and amended from recommendations for measures or objectives that were influenced by the changing historical context. Implementation of this Program has also varied, with different regions or topics coming to prominence at different times and different volumes and types of work implemented in different locations. Together, these complexities influence the scope, content, and structure of Programs, expectations for funding and implementation, efficacy of the Program, and the ability to monitor and detect changes.

## Program Categories and Themes Over Time

To show the development of the fish and wildlife Program over time, the section below provides a summary of the Program roughly by decade, reflecting shifts in conceptual advances in Programs, Program structures, and the background context driving those Programs. For each decade, timelines are provided describing major events that influenced the development of the Program or that were influenced by the Program. These events are then related to the major topics appearing in each Program. Because Program topics changed and evolved over time, a common set of terms is used to describe the different kinds of work that had been called for over time, using a set of overarching categories each comprised of several themes (Table 2). The themes in this table are analogous to the strategies used to organize measures in the 2014 Program and 2020 addendum. Although terms are slightly different, themes can be cross walked to strategies such that datasets assembled to describe performance of strategies can also be used to assess performance of work by category and theme across all Programs over time.

Table 2. Examples of types of work within the categories and themes used to group actions called for in the Northwest Power and Conservation Council’s Fish and Wildlife Programs 1982 – 2020.

Category	Theme	Examples
Hydrosystem	Water management	Flow operations, reservoir elevations, spill
	Passage	Transportation, bypass systems, passage structures
	Water quality	Temperature, TDG
Habitat	Restoration	Restoration in tributaries, mainstem, estuary, blocked areas

	Protection	Water conservation, protected areas, strongholds, fish lands
	Wildlife	All measures related to wildlife (including goal setting, loss assessments, habitat evaluation, and O&M, etc.)
	Non-native and invasive species	Suppression or management of species that are not native to the Columbia Basin (e.g., northern pike)
	Native predator management	Suppression or management of species that are native to the Columbia Basin (e.g., pikeminnow, sea lions), but predators to focal species
Artificial production	Artificial production	Increasing the production of anadromous and resident fish through the use of hatcheries or other captive breeding techniques to support conservation, supplementation, harvest, and/or reintroduction objectives
	Facility construction	Hatcheries, fish traps, weirs, acclimation sites, etc.
Program adaptive management	Regional planning	Loss assessments, subbasin planning, establishing goals and objectives
	Harvest recommendations	Policy, management, law enforcement
	Regional coordination	Forums, water budget planning, coordination around decision making
	RM&E and reporting	All RM&E or reporting for each category and for topics not covered in a category (e.g., ocean or climate change)
	Data management	Regional databases and entities that manage them
	Science review	Council, ISAB, ISRP
	Public engagement	Specific calls for public involvement in Council or regional processes

## Pre-Power Act mitigation and events through 1970s

### *Early Mitigation*

Prior to the passage of the Power Act, early mitigation for the hydrosystem included developing fish ladders for adult salmon and steelhead and the beginning of juvenile passage considerations including transportation, screens, bypass, and incidental/involuntary spill (USACE 1998). The Mid-Columbia FERC Settlement of 1980 produced the first application of spill to aid migrating juvenile salmon (Figure 12).

Other efforts included constructing hatcheries (especially in the lower river), and fish production associated with dam-specific authorizations, (Figure 12). Numerous laws were passed during this and prior decades that established hatchery mitigation requirements to address construction and operation of the federal dams, targeting both specific dams as well as the hydrosystem as a whole. These included the Mitchell Act (1938), Grand Coulee Fish Maintenance Project (BOR 1939; Fish and Hanavan 1949), Columbia River Fisheries Development Program (1948; as described in NOAA 1981); [Willamette Valley Mitigation Program](#) (1950); Dworshak Dam Mitigation (FCA 1962), and the Lower Snake River Compensation Plan (LSRCP; WRD 1976).



Although there were significant efforts to improve habitat, modify hydropower operations, and manage harvest and hatcheries, human development on the environment continued to hamper fish restoration and recovery in the basin.

### *Regional Events*

In the 1970s, the U.S. Congress passed significant environmental legislation (Figure 12), emphasizing the importance of environmental protections for both the environment and human health. Protections for fish and wildlife at federal dams occurred through laws including the National Environmental Policy Act (NEPA), which, among other provisions, required federal agencies to assess effects of proposed actions (e.g., development of new facilities or modification of existing facilities or their operation) as part of decision-making. Other protections for fish and wildlife at both federal and non-federal facilities were established through the Clean Water Act of 1972 (CWA 1972) and the Endangered Species Act of 1973 (ESA 1973). The CWA created a structure to regulate discharge of pollutants into the waters of the United States. With reference to the hydrosystem, these pollutants could include excess temperature, excess total dissolved gases or other chemicals that might be used at dams. The ESA protections are further described in the 1990s decade, when the first fish species were listed. Other protections for wildlife were not specifically associated with the hydrosystem, such as the Marine Mammal Protection Act of 1972 (MMPA 1972) and the 1972 amendment to the Migratory Bird Treaty Act of 1918 (MBTA 1972). Eventually these would influence the range of options available for managing predation on ESA-listed salmon and steelhead species.

Despite national emphasis on environmental issues, in the Columbia Basin there was little cooperation or common ground between the major parties associated with operating dams or managing fisheries (NPPC 1982b). Even among organizations with interests that intersected fisheries, there were significant differences of opinion. For example, there were intense fractures between anglers and conservationists, among states (who wanted more equity in the distribution of harvest), and between states and tribes (who sought to enforce treaty rights to fish in their usual and accustomed).

Prior to development of the basin, the majority of salmon and steelhead returned to the interior regions of the basin (NPPC 1986). By the 1970s, less than half of returning fish were destined to areas located above Bonneville Dam. In 1976, the *U.S. v. Oregon* court ruling (a consolidation of two previous lawsuits from 1968), upheld treaty-reserved tribal fishing rights and explicitly noted that the Columbia River treaty tribes were reserved 50% of all the harvestable fish destined for the tribe's usual and accustomed fishing places. To aid in equal sharing of harvest, more fish were produced and released above Bonneville Dam, where tribal fisheries were located. The outcome of this court decision was a series of Columbia Fisheries Management Plans that represent the current framework for managing fisheries and hatchery programs in much of the Columbia River Basin. Other efforts focused on ocean fisheries (Figure 12). The Magnusson-Stevens Fishery Conservation and Management Act of 1976 established eight regional Fishery Management Councils to manage ocean harvest.

## 1980 – 1989

### *Regional Events*

The first decade of the Fish and Wildlife Program began as the era of major dam construction in the Columbia and Snake rivers was drawing to a close (Figure 6). Returns of wild salmon and steelhead were

declining rapidly—to the lowest levels ever seen—and there was great urgency to implement actions that would rebuild stocks throughout the basin. Following the passage of the Power Act in 1980, the formation of the Council in 1981 created a forum for the region to come together and begin developing a framework for the Fish and Wildlife Program (Figure 12). This was the earliest occurrence of Columbia Basin-scale collaboration on fish and wildlife issues. As planning for this framework began, the Council formed a fish and wildlife committee in 1982 to direct planning of the first Fish and Wildlife Program.

Given the perilous condition of salmon returns, the region pursued bold actions. The Salmon and Steelhead Conservation and Enhancement Act of 1982 proposed multiple actions including buying out commercial fishing permits, funding habitat restoration, and funding hatchery operations and maintenance (O&M). In 1985, the U.S. and Canada ratified the Pacific Salmon Treaty to reduce the harvest of Columbia River stocks off the coasts of Canada and Alaska. In 1986, the Federal Water Power Act of 1920 (which regulates non-federal hydroelectric power generation through [currently] the Federal Energy Regulatory Commission; FERC) was amended based on the Northwest Power Act. Of relevance to fish and wildlife mitigation, the new section 4(e) of the Federal Water Power Act stated that when [FERC] issues licenses or relicenses non-federal projects, they must “give equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife ..., the protection of recreational opportunities, and other aspects of environmental quality.” To implement this requirement, mitigation agreements were developed for individual non-federal dams.

Significant agreements related to hydropower operations occurred, as well. The Vernita Bar Agreement in 1988 established criteria for flows in the free-flowing Hanford Reach of the Columbia River to create beneficial mainstem spawning and rearing conditions for Chinook salmon (HRFCPP 2004). A 10-year Memorandum of Agreement (MOA) on fish spill was adopted in 1989, which expanded the seasonal spill program to additional dams that either did not have juvenile passage or had inadequate passage (FPC 2012). Many of these flow, harvest, restoration, artificial production, and settlement actions were originally called for in the 1982 or 1987 Fish and Wildlife Programs or were adopted into Programs and modified over time (see below). Collectively these actions were meant to improve salmon and steelhead survival and contribute to the long-term process of mitigating the effects of the hydrosystem.

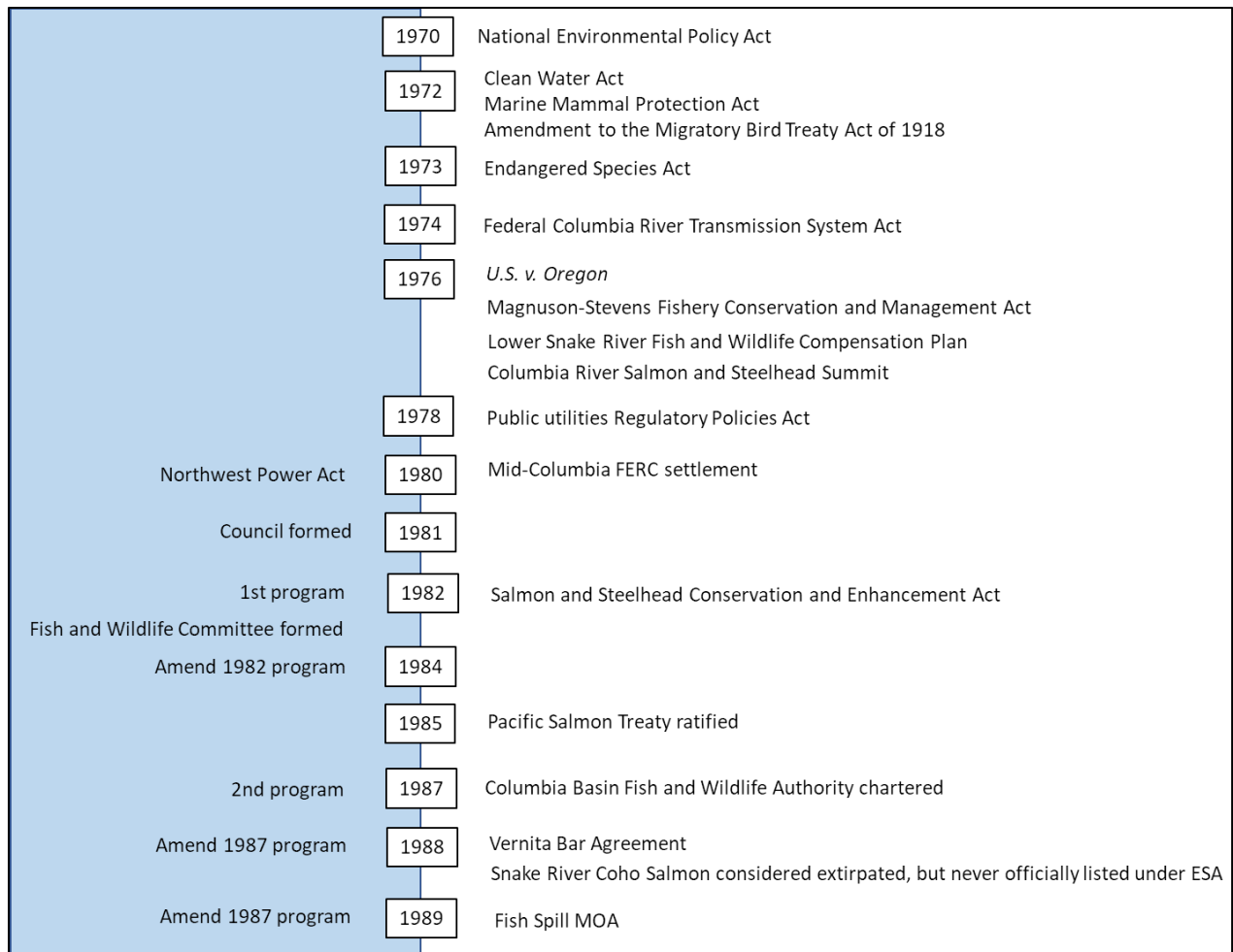


Figure 12. Timeline of Council (left side), regional, and national events (right side) related to fish and wildlife in the Columbia Basin, 1970 – 1989.

## Program Structure

The structure of the Programs in the 1980s was relatively simple (Table 13; end of this section); Programs consisted of sets of measures organized by themes around the broad life stages of salmon and steelhead and their associated needs, resident fish, and wildlife. Other Program topics included enhancement of the Yakima River Basin, future hydroelectric development, coordination of river operations, a multi-year action plan beginning in 1984 (NPPC 1984), losses and goals, and system planning. In 1987, the earliest version of a framework appeared in Programs—it was not equivalent to the scientific framework of the 2000 Program but did characterize the different mitigation strategies in the Program for salmon and steelhead and how they were connected. The content and contributions of these Programs were foundational to all subsequent Fish and Wildlife Programs and most of the topics present in these Programs can be found in some form in every other Program.

Another important aspect of the Program was the significant investment in resources and capacity building to assist in the effort to protect, mitigate and enhance fish and wildlife. This included increased

staffing, purchase of office and field equipment, and support for coordination and training. This capacity building continued as an important component of future Programs.

Types of actions called for in the Programs of the 1980s are listed in Table 3. Further detail is provided below for some actions where context is needed or where actions were a significant component of the recommended work.

## *Hydrosystem*

**Water Management:** The Power Act gave the authority for the Program to require changes to the hydrosystem and its operations for the benefit of fish and wildlife. The first Programs heavily emphasized in-kind and in-place mitigation of the hydrosystem given the high mortality rates of both juveniles and adults during passage. In the 1987 Program, it states: “cumulative juvenile passage mortality for fish migrating ...past nine dams has been estimated to be 77 to 96%, depending on the volume and timing of streamflows. Cumulative adult passage mortality ... [9 dams] ... has been estimated to be 37 to 61%.”

One key element was the water budget—a new concept for ensuring seasonal flows for juvenile fish by carving out a fixed volume of water from storage and releasing it during the juvenile migration season (April 15 – June 15). Released flows were designed to increase water velocity and decrease travel times. One water budget was established for Lower Granite Dam on the Snake River and another for Priest Rapids Dam on the Columbia River. Although managers had preferred specific flow objectives in the Columbia and Snake rivers, the water budget provided a mechanism for water budget managers to achieve flows through shaping the available volume of water.

Hydrosystem modifications were also proposed to benefit natural production and survival of resident fish. For example, the program called for development of flow regimes in the Flathead River and limitations to reservoir fluctuations at Hungry Horse and Libby Dams. Other measures addressed specific resident fish issues associated with particular dams.

**Water Quality:** There was a limited focus on water quality, with measures proposed to maintain water temperature in suitable ranges for fish by releasing water from storage reservoirs (Table 3).

**Fish Passage:** Another category of juvenile migration measures related to fish passage (Table 3). Although most federally owned dams had passage routes for juvenile fish, many of these required improvements. In addition, no juvenile fish passage facilities were present at the five mid-Columbia dams operated by the Public Utility Districts. Programs included requirements to retrofit dams with better fish passage technology and interim spill to aid juvenile migrants until passage facilities were constructed.

The funding and initiation of the Corps of Engineers Columbia River Fish Mitigation Program (CRFM) in 1988 greatly increased funding available to research passage and transportation issues, along with investments in fish passage improvements. The Program also called for evaluations of transportation as part of an overall evaluation of bypass. While bypass was being developed and studied, spill was used on an interim basis to aid migrating juvenile salmon. For upstream migrants, the Program called for improvements in river operations, improvements in fish ladders, and better monitoring facilities and programs. By the end of the decade, some form of passage facilities was either completed or in process

at every federal dam on the Columbia and Snake River, along with many publicly and privately owned dams (NPPC 1990).

## *Habitat*

**Restoration:** During this first decade, habitat restoration was not a significant component of the Program. Measures focused on a select set of local restoration projects in tributaries or the blocked areas (Table 3). The 1987 Program called for subbasin planning with the intention that those plans would guide large-scale habitat restoration work and incorporate local opportunities and constraints. The program specifically called for system and subbasin plans to be developed by fish and wildlife agencies and tribes, in consultation with the Council, hydropower operators, BPA, and land and water managers. There was also a call to reestablish naturally spawning runs in the Yakima River basin, particularly by addressing fish passage needs. This basin was selected as a pilot program for tributary habitat and production mitigation because it was “considered by most fishery experts to be one of the areas in the Columbia River Basin with the greatest potential for the production of anadromous fish” (NPPC 1982a).

**Protection:** Habitat protection efforts took three forms— water conservation, land protection for wildlife (and eventually fish), and river protection from future hydroelectric development. The Yakima Basin was identified as an important area to implement off-site mitigation. One of the key factors in this basin was the over-allocation of water. The Program identified the need for additional water storage or better water management, but deferred advocating for changes until studies could be conducted by the Bureau of Reclamation and the Washington Department of Ecology (NPPC 1983; Table 3).

Another significant component of the Program was the designation of areas in the basin that would be protected from future hydroelectric development). In the 1980s, small hydroelectric development was accelerating rapidly (Figure 4). The passage of the Public Utilities Regulatory Policy Act of 1978 encouraged development of renewable energy, including hydroelectric, by mandating that utilities would be required to buy any developed electricity (PURPA 1978). While it was meant to address potential future electricity shortages in the region, it incentivized a rapid increase in development of small hydroelectric facilities (PURPA 1978; NPPC 1987c). This presented a challenge for utilities because they were required to integrate this new, small generation into the grid (PURPA 1978; NPPC 1987c). Likewise, the region’s fish managers were concerned about the effects on fish and recognized that preventing future degradation of rivers through new hydroelectric development was as significant as mitigating for prior hydroelectric development (NPPC 1987c). Both utilities and fish managers supported an effort to identify areas that would not be open to hydroelectric development. The Council led the Pacific Northwest Rivers Survey to identify a list of river reaches that were appropriate for protection. Approximately 44,000 miles of stream were designated as protected areas (Figure 13; NPPC 1988) within the area serviced by BPA and adopted into the Program. Extending protected areas coverage to that entire BPA service area (extending beyond the basin) was meant to prevent potential hydroelectric projects from simply developing elsewhere. Along with these protected areas, the Council requested that FERC take the Council’s hydroelectric development standards into consideration when developing or licensing hydroelectric facilities (NPPC 1988). To date, no licenses have ever been issued by FERC within these protected areas. StreamNet hosts the [official database](#) on stream reaches designated as

protected areas, along with [full documentation](#) on the history and surveys leading up to protected areas designation.

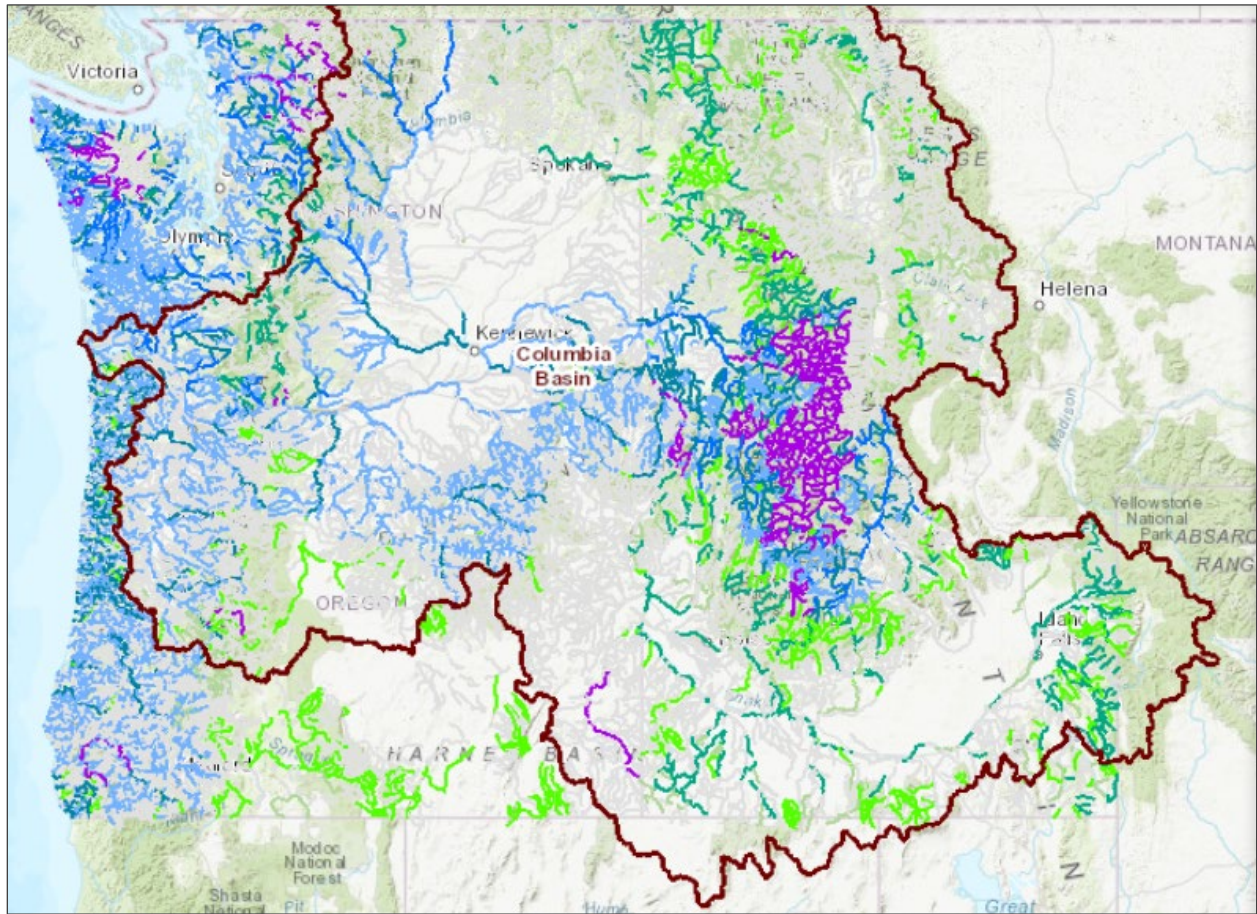


Figure 13. Areas protected from future hydroelectric development within the area serviced by BPA. Blue and green colors correspond to which species occur in the stream: anadromous fish only (light blue), anadromous and resident fish and wildlife (dark blue), anadromous *and* resident fish or wildlife (turquoise), resident fish *only* (neon green), resident fish *and* wildlife (dark green), wildlife *only* (olive). Remaining stream areas are either protected under other federal or state action (magenta) or unprotected (light grey).

**Wildlife:** In the 1980s, the Council’s Programs called for improved understanding of hydrosystem impacts on wildlife (Table 3). This entailed developing data and systemwide mitigation plans for wildlife losses, establishing standards for acquisition of off-site habitat, and addressing problems associated with transmission corridors. Early efforts toward land protection were directed toward wildlife in Montana in association with Libby and Hungry Horse dams. Wildlife mitigation was also called for in the Lower Snake River as part of the Lower Snake River Compensation Plan (LSRCP). The LSRCP was authorized by Congress in the Water Resources Development Act of 1976 to mitigate for losses of salmon, steelhead, and wildlife due to the four lower Snake River dams.

**Native Predator Management:** The first limited efforts to evaluate and control predation on juvenile salmon and steelhead began in the 1980s (Table 3). Changes to the flow regime had been beneficial to

northern pikeminnow and they became increasingly abundant, particularly in habitats downstream of dams. When juvenile salmon and steelhead would pass through turbines on their migration, they would become disoriented and highly susceptible to predation. Predator management measures were exclusively focused on identifying techniques that could be used to remove northern pikeminnow.

### *Artificial Production*

**Artificial Production:** Artificial production was called for in the program in several ways. Measures called on Bonneville to fund operation of certain salmon and steelhead facilities and efforts to better understand how to supplement naturally spawning stocks with hatchery stocks in the Snake and Columbia rivers. Another key emphasis was on production of resident fish. This occurred in two ways: where anadromy was blocked, the Program called for artificial propagation of resident fish as a substitute for anadromous fish (termed resident fish substitution). Programs were called for above Dworshak and above Chief Joseph and Grand Coulee. Other resident fish propagation occurred in areas naturally above anadromy.

**Facility Construction:** Significant investment in hatchery production had occurred prior to the first Program. Numerous hatcheries were constructed to mitigate for the hydrosystem and other impacts throughout the basin, funded or authorized through previous laws. While some of the hatcheries associated with these programs were located near areas impacted by their respective dams, much of the production occurred in the Lower Columbia River below Bonneville Dam despite the majority of fish losses occurring in the upper portions of the basin. Following the *U.S. v. Oregon* lawsuit, there was a need for new hatchery production in the upper portions of the basin. Several large production facilities were called for, along with measures describing the detailed process for master plans, which included information on release sites, brood source, harvest plans, and numerous other details required to take a facility from a design phase to reaching full production over many years. In addition to large production facilities, Programs also called for development of decentralized, low-capital salmon and steelhead production facilities. These were meant to supplement natural salmon and steelhead production in subbasins with low abundance.

### *Program Adaptive Management*

The first Fish and Wildlife Program proposed a mediation and monitoring role for the Council to aid in helping the region deliberate on critical issues and eventually find common ground (NPPC 1982b). This was meant to occur through the newly formed Fish and Wildlife Committee (1982), also tasked with directing planning of the first Fish and Wildlife Program. One example of this mediating role was in developing regional forums (e.g., around passage, survival, and screening issues) to promote coordination among the different federal, state, and tribal fishery managers, and the utilities.

**Regional Planning:** Another example of the Council's mediation role was in regional planning. In 1986, the Council produced a document compiling estimates of pre-development returns to the Columbia Basin, along with estimates of losses from all causes combined and from the hydrosystem specifically (NPPC 1986; Figure 14; Table 3). Pre-development returns were estimated to range from 10 to 16 million salmon and steelhead (NPPC 1986; Figure 14). In total, losses of salmon and steelhead *specifically* attributed to the construction, inundation, and operation of the hydropower system were estimated to

range from 5 to 11 million fish each year. This compared to a total loss from all causes of 7 to 14 million salmon and steelhead per year, demonstrating that although multiple causes affected salmon populations, the largest losses were attributed to the hydrosystem. These hydrosystem losses also included the complete loss of salmon and steelhead runs in the blocked areas above Chief Joseph Dam (Columbia River), Hells Canyon Dam (Snake River), Dworshak Dam (North Fork Clearwater River), and in the upper reaches of the Deschutes, tributaries to the Willamette, upper Cowlitz, and upper Yakima (NPPC 1986). Other ranges of historical estimates exist based on the specific assumptions made and datasets used by researchers. These other estimates range from around 6 million (ISAB 2015), to 35 million—as estimated by BPA in an early report based on fish wheel catch rates (BPA 1984 as described in NPPC 1986). The compilation of losses (NPPC 1986) was included as an appendix to the 1987 Program (NPPC 1987a).



Figure 14. Comparison of estimated historical returns of salmon and steelhead (green), losses from all mortality sources (orange), and losses only due to hydrosystem impacts (blue bars). Lighter bar = low end of range, darker bar = high end of range; NPPC 1986) in the Columbia River Basin.

The assessment of hydropower-related losses of salmon and steelhead was meant to partially define BPA’s mitigation responsibility. Based on established losses and the estimated average run size of 2.5 million adult fish from 1976 to 1981, the Council established an interim goal to double the current returns of salmon and steelhead to achieve 5 million adult returns annually (NPPC 1987a). This total was calculated by including adults returning to the mouth of the Columbia River and those harvested in the ocean. Although these 5 million fish were not apportioned geographically or by population, it was intended that a significant portion of these fish would return above Bonneville Dam and that genetic diversity would be preserved (NPPC 1987a).

By the late 1980s, the Council had initiated a new and comprehensive planning effort. The Council had estimated that full implementation of all Program measures might only add another million salmon and



steelhead to the basin (NPPC 1987b). To achieve further mitigation, additional measures would need to be identified in each subbasin. Each of these individual subbasin plans was meant to be integrated into a system plan that would coordinate local subbasin needs with measures improving survival in the mainstem and ocean, along with balancing the needs of natural production and artificial propagation (NPPC 1987b).

It is important to note that the collective loss and fragmentation of habitat, resident and anadromous fish populations, and wildlife populations is not a one-time loss, but rather an annual loss since these various impacts occurred (Figure 15). As these losses persisted over time, the function of the ecosystem was altered and is now capable of supporting fewer fish and wildlife than previously in a reduced range of habitat types (McClure et al. 2008). It is instructional to view losses cumulatively because of the long-term consequence of diminished returns and habitat capacity— that is, decreased population abundance and diversity negatively affect ecosystem resilience and result in a lower capacity for adaptation to future impacts (Bottom et al. 2009; Oliver et al. 2015; Schindler et al. 2015). Cumulative losses also capture the impact to humans who have had a long relationship with salmon. Although cumulative losses of fish and wildlife cannot be precisely calculated, a conceptual approach can illustrate their magnitude). In Figure 15, cumulative losses of salmon and steelhead were calculated by summing the upper and lower ranges of hydropower losses over time, contrasted with salmon and steelhead counts at Bonneville Dam. In this figure, cumulative values were only calculated from 1980 – 2021, corresponding with the adoption of the Northwest Power Act. Actual losses began much earlier and accrued incrementally as the hydrosystem was developed.

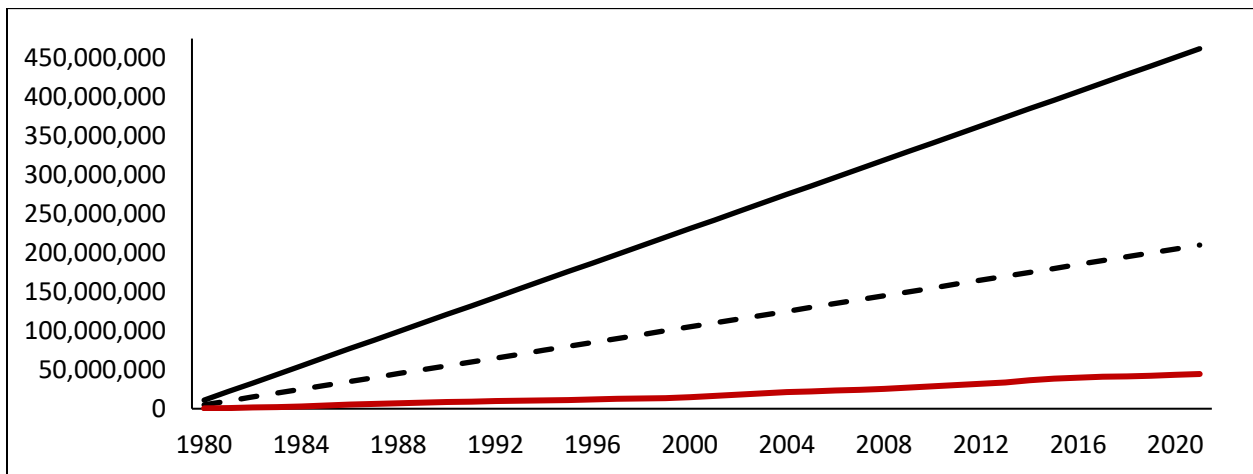


Figure 15. Comparison of estimated cumulative losses of salmon and steelhead due to hydrosystem impacts (upper range [11,000,000 per year] = solid black line, lower range [5,000,000 per year] = dashed black line; NPPC 1986) relative to cumulative returns of salmon and steelhead counted at Bonneville Dam (red line; data from Fish Passage Center). Cumulative values were summed for 1980 – 2021, corresponding with the adoption of the Northwest Power Act. Actual losses began as dams were constructed. Note: the low end of the hydrosystem loss (dashed line) also represents the mitigation goal adopted in the Fish and Wildlife Program (NPPC 1987a).

**Harvest Recommendations:** The 1980s Programs emphasized the need to coordinate efforts to improve natural production, artificial propagation, and harvest policies, referred to as system integration. At the time, upriver fish were particularly vulnerable to harvest in mixed stock fisheries that were dominated

by more abundant lower-river hatchery fish. System integration was meant to prevent each of these efforts from being implemented at cross purposes with the other efforts. The 1982 and 1987 Programs contained measures describing the relationship of the Program to harvest management and policy. The Program itself did not specify any harvest regulations because harvest is managed in forums not associated with the Act. However, the Program did recommend restricting funding to only those stocks for which harvest was well-controlled. The Program also called for regular consultation and coordination with agencies that oversee harvest, both in the Columbia River and the ocean. The Program included measures calling for known-stock fishery demonstration programs. These selective harvest programs were meant to allow for the non-treaty harvest of marked hatchery fish, while not causing further declines in co-occurring and depleted wild populations.

**RM&E and Reporting:** RM&E has been a fundamental component of the Program from its inception. From the 1987 Program, “The Council has been particularly mindful of its responsibility to base this Program on the best available scientific knowledge, particularly in those areas requiring immediate action.” The Program further emphasized monitoring and evaluation of implementation to understand the effectiveness of measures and to address critical uncertainties regarding salmon and steelhead (NPPC 1987b).

Programs of the 1980s identified needed RM&E on a diversity of topics, each meant to feed into adaptive management of the Program. Indeed, because of the scientific uncertainty related to rebuilding strategies, population status, and suitable goals, adaptive management was meant to allow for early implementation along with active learning and subsequent improvement in implementation (Lee and Lawrence 1985). Early Programs proposed numerous studies related to the hydrosystem, including improving bypass, transportation, spill criteria, adult passage, reservoir survival, smolt monitoring, adult counting, diseases at fishways, and impacts on sturgeon. There was also a call for research associated with natural production and artificial propagation, including research on fish disease, hatchery effectiveness, and supplementation efforts. This decade was also the first time there was a call for evaluating the role of oceanographic factors in the plume on juvenile salmonids. The research resulting from these first Programs was instrumental in advancing future implementation efforts.

**Data Management:** RM&E and reporting efforts in the 1980s highlighted the need for large-scale data management. During this period, the Program called for development of the Coordinated Information System (CIS), the Fish Passage Center (FPC), and other databases in support of Program efforts.

**Science Review:** The earliest stages of science review in the Program were called for in the 1980s through the Fish Propagation Panel<sup>3</sup> and the Scientific Review Group (Table 3). Other technical science groups were also described and meant to be convened as needed (e.g., related to establishing protected areas or loss statements and goals).

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<sup>3</sup> “The 1982 program included designation of a Fish Propagation Panel, which was intended to formalize the process for obtaining scientific advice from the fishery agencies and tribes, particularly on the topic of hatcheries and fish production. The Fish Propagation Panel was made up of representatives of the fishery agencies, tribes, and electric power producers. It lasted only about a year but introduced the role of a scientific advisory group into the program. Perhaps one of its more significant recommendations was that the Council’s planning for restoration of fish and wildlife be organized on a subbasin basis.” ISRP [2005-14](#)

## *Other Key Topics and Accomplishments*

In addition to the work covered in the four categories, there were two other key topics in Programs in the 1980s. First, the flow, reservoir, and passage measures in the Program were to be considered a “hard constraint” in hydrosystem operations and on power planning. This represented a major change from how efforts to modify the hydrosystem for fish had proceeded in the past. Second, supporting weak stocks was emphasized as a way to prevent ESA-listings (Table 3). Contemporary Programs now include this emphasis on protecting weak stocks through principles describing the importance of diversity in addition to abundance, but they also contain an emphasis on building from strength.

In thinking about what was accomplished in developing these Programs, it is important to recall that there were no salmon recovery plans, large-scale mitigation efforts, or collaborative frameworks at the time to guide the development of the early Programs. There was no prescription for what elements were needed in this Program or for a singular approach to organizing content or proposing ideas. The first Program was developed by initiating a massive collaborative effort resulting in over 2,200 pages of recommendations and supporting documents and another 5,000 pages of written comments on the draft Program (NPPC 1983). Soon after the first Program was adopted it was reopened for amendments in 1984 and then again in 1987.

The first Programs were also ambitious and pioneered new approaches and technology. In developing Programs, new processes were put into place to translate legislation and funding requirements into actions throughout the basin. The early years of the Program contributed tremendously to the knowledge base in the region. Much of this was done without easy access to computers and before widespread access to the internet. Early investment in the Program contributed to building capacity in the region by investing in personnel that would be available to implement the Program, providing infrastructure (e.g., providing computers to managers throughout the region) and developing the first regional databases.

The regional investment of time and expertise into the Programs and associated analyses at the time was also tremendous. For example, significant effort went into identifying the 44,000 miles of stream to be protected from hydroelectric development, and developing estimates of historical salmon returns and losses. All these efforts involved developing processes to assess the available science and translate that science into policy, management, and funding recommendations.

Table 3. Major components of Fish and Wildlife Programs and amendments, organized by category and theme, 1982 – 1989.

Category	Theme	Major components
Hydrosystem	Water management	Water budget; flows for resident and anadromous fish; drawdown limitations at Libby and Hungry Horse; fish spill MOA adopted in 1989
	Passage	Interim transportation; work on bypass; interim spill until bypass complete
	Water quality	Storage use to maintain water temperatures for fish
Habitat	Restoration	Targeted restoration in tributaries and (in 1987) blocked areas
	Protection	Water conservation in Yakima Basin; Screens; Protected areas designated, and rules adopted in 1988

	Wildlife	Establish criteria for mitigation; review status of past and current mitigation; 1989—Wildlife Rules; interim goal for wildlife mitigation (35% of lost HUs in next 10 years)
	Native predator management	Study methods to control pikeminnow
Artificial production	Artificial production	Supplement naturally spawning stocks with hatchery stocks in mainstem Snake and Columbia Rivers; production of resident species; resident fish substitution
	Facility construction	Design and construction of new facilities for anadromous and resident species; O&M for some facilities; identify suitable hatchery sites
Program adaptive management	Regional planning	Salmon and steelhead loss assessments; interim double-the-run goal established in 1987; calls for system and subbasin planning and 5-year action plan
	Harvest recommendations	Harvest must be adequately controlled and consistent with Program objectives; known-stock fishery demonstration programs
	RM&E and reporting	Studies on improving bypass, transportation, spill criteria, adult passage, reservoir survival, smolt monitoring, adult counting, diseases at fishways, and impacts on sturgeon  Studies regarding improving natural production through flows and restoration, including in Hanford reach  Studies on artificial propagation of white sturgeon, salmon, and steelhead, increasing production at existing facilities; supplementation techniques, disease issues Habitat  Study on effects of oceanographic factors in plume on juvenile salmon
	Data management	Establish Coordinated Information System; establish Fish Passage Center; hatchery production database; natural production database
	Science review	1982—Fish Propagation Group, 1989—Creation of Scientific Review Group
	Public engagement	Public participation in water conservation and other topics
Other critical concepts		Program is a hard constraint in power planning; support weak stocks

## 1990-1999

### *Regional Events*

If the 1980s were a time of hope that rapid implementation of Program measures could dramatically improve fish runs, the 1990s were a time of stark recognition of the magnitude of the problem. Actions taken to rebuild salmon and steelhead populations in the 1980s were insufficient and populations continued to decline. During the 1990s, six evolutionarily significant units of salmon and eight distinct population segments of steelhead, Kootenai River white sturgeon, bull trout, and Oregon chub were listed under the ESA (Figure 16). These listings required the agencies operating and utilizing the dams

(action agencies) to consult with either the NMFS or the USFWS to determine whether operation of the hydrosystem would cause harm to listed species. These consultations resulted in biological opinions (BiOps) along with reasonable and prudent alternatives (RPAs) to be taken to reduce impacts on listed species. As NMFS and the USFWS developed biological opinions, these were often the subject of litigation. That litigation resulted in changes to the BiOps, and these changes were reflected *in* the Programs or incorporated measures *from* the Programs.<sup>4</sup>

In 1991, the four Northwest governors, federal and state agencies, tribes, and industries participated in the Salmon Summit, convened by U.S. Senator Mark Hatfield (OR), to begin planning efforts to develop a new, long term management plan for salmon (NPPC 1991c; Figure 16). From these discussions, the chief outcome was that the Corps agreed to lower the elevation in Snake River reservoirs (NPPC 1991c). Other discussions occurred on how much storage water should be released in the Snake River, management of Northern Pikeminnow, and annual meetings to plan spring flow releases (NPPC 1991c). A version of these provisions was incorporated into the Council's Program (NPPC 1991a; NPPC 1991b; NPPC 1992a).

During the second decade of the Program, two Programs and one amendment were adopted, though the first Program was developed in four parts from 1991-1993 (Figure 16). Several lawsuits were filed on the 1991- 1993 Program arguing both that the Council's Program had gone too far and also not far enough (see [more background](#)). The Ninth U.S. Circuit Court of Appeals ruled that the Council failed to explain its reasons for rejecting recommendations to amend the program (*NRIC v. NPPC* 1994). Furthermore, the court's opinion included an interpretation of the role of the Council in Program development. In particular, the court emphasized that the Council must show a "high degree of deference" to the expertise of the region's fish and wildlife managers (*NRIC v. NPPC* 1994). Immediately following this opinion, the Council initiated a new and comprehensive Program amendment in 1994 (salmon and steelhead; NPPC 1994) and 1995 (resident fish and wildlife; NPPC 1995a).

In 1996, Congress amended the Power Act to create a process for scientific review of Program implementation (Section 4(h)10(D); Figure 16), including the creation of the eleven-member Independent Scientific Review Panel (ISRP) to review projects and their results. This amendment was in part spurred by recommendations from the Program's scientific review groups<sup>5</sup> and a report by the National Academy of Science on salmon in the Northwest which noted the need for projects to undergo scientific review (NAS 1996). The Council and NMFS created the Independent Scientific Advisory Board in 1996 to review the science supporting their respective programs. While the ISRP evaluates projects and their results, the ISAB reviews broader scientific issues and analytical methods such as large-scale

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<sup>4</sup> The 1995 BiOp was the first to determine that the proposed operation of the FCRPS would cause jeopardy to listed species. It incorporated all the hydrosystem provisions from previous Council Programs, although specific values associated with provisions were modified in some cases. The 1995 BiOp jeopardy analysis incorporated two world views on mitigation – one view promoted actions in the hydrosystem as part of a larger set of actions across the whole life cycle to get out of jeopardy and the other promoted more improvements in the hydrosystem to get out jeopardy. Differences in these world views were expected to be resolved in a "1999 decision." Ultimately, the two views were rectified in the 2000 BiOp by calling for substantial hydrosystem actions and substantial tributary and estuary habitat and other offsite mitigation actions.

<sup>5</sup> From [ISRP 2005](#): "The SRG, ISG and ISAB all stressed the need for peer review and provided recommendations on specific policies and procedures to assist Bonneville and the Council in developing a peer review process responsive to federal initiatives (Coutant and Cada 1985; SRG 1990)."

modeling efforts. The work of the ISAB is coordinated through the ISAB administrative oversight panel, which includes representatives from the Council, NOAA, and Columbia Basin Tribes (coordinated through the Columbia River Inter-tribal Fish Commission; CRITFC).

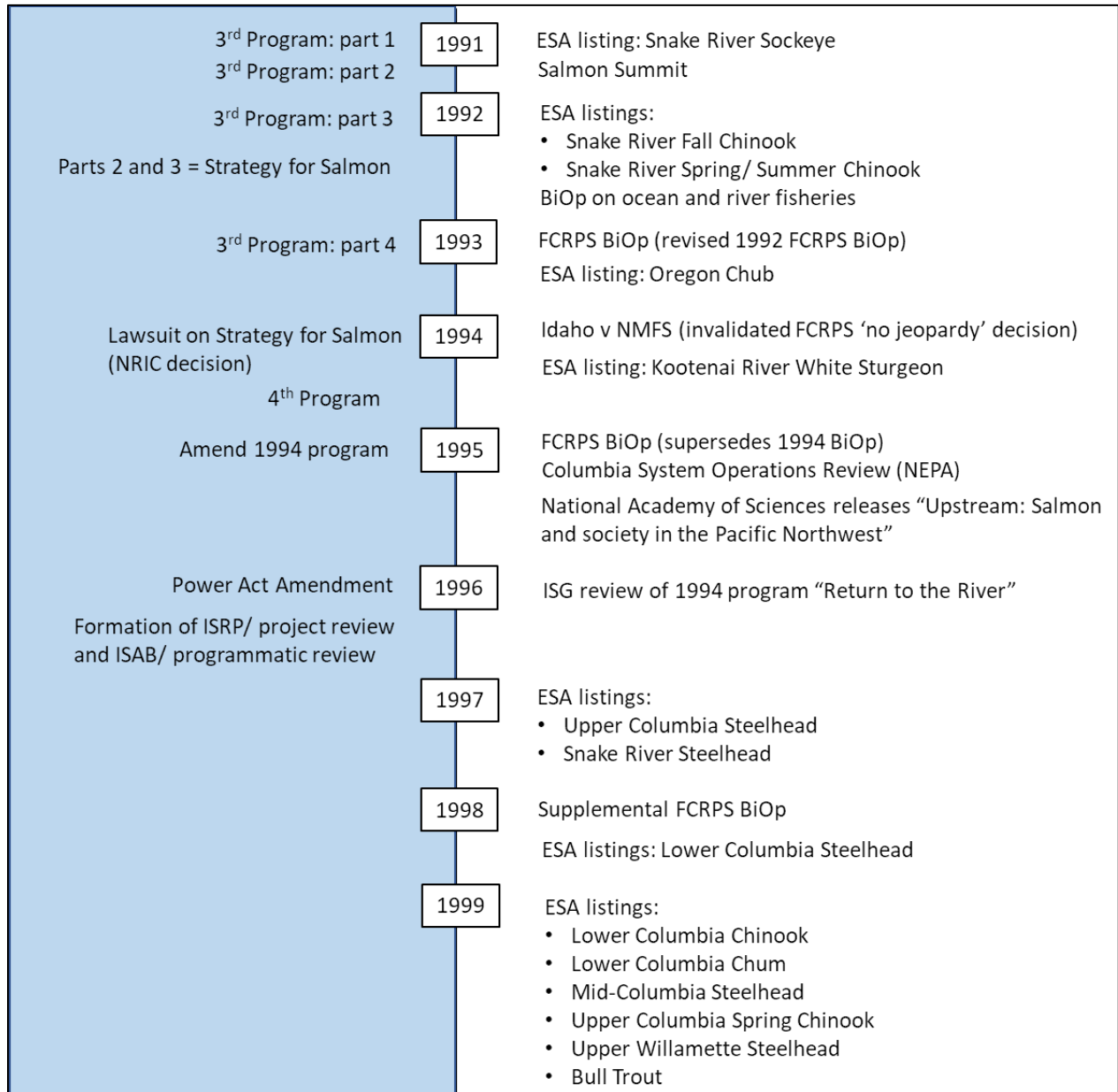


Figure 16. Timeline of Council (left side), regional, and national events (right side) related to fish and wildlife in the Columbia Basin, 1990 – 1999.

### *Program Structure*

In the 1990s, Programs became far more detailed and complex and represented a huge expansion from the Programs of the 1980s (Table 4; end of this section). In the 1991-1993 Program, the first three parts

dealt with salmon and steelhead. The first part was released concurrently with the first ESA listings and the Salmon Summit (Figure 16). This part encompassed the highest priority production and habitat actions for salmon and steelhead meant to be implemented immediately while further development of the Program was underway (NPPC 1991a). In developing this part, the Council requested that fish and wildlife agencies and tribes develop an integrated systems plan to incorporate elements from a set of existing agency and tribal plans to increase production of salmon and steelhead in 31 subbasins (NPPC 1991a). Many of these elements focused on screening and passage and increasing production in the basin. From this integrated plan, 130 projects were proposed for priority implementation and 30 were accepted. The remainder were retained for future consideration.

The second and third parts, the strategy for salmon, focused on mainstem survival and harvest and system integration (NPPC 1991b; NPPC 1992a). The fourth part of the Program amendment addressed resident fish and wildlife. Measures included establishing a percentage of funding to be allocated to resident fish (15%) and wildlife (15%) projects, a prioritized list of resident fish projects to be completed within a decade, implementation of Libby and Hungry Horse mitigation actions, adoption of wildlife loss statements (including operational losses), and a call for further wildlife mitigation planning (NPPC 1993).

In response to the 1994 NRIC v NPPC court ruling (Figure 16), the 1994 Program was redeveloped, greatly expanded, and largely dedicated to measures associated with salmon and steelhead. The 1995 amendment was used to develop measures for resident fish and wildlife. The additional detail in these Programs built off the structure of previous Programs while also acknowledging that more aggressive action was needed to address continued declines of salmon and steelhead. Programs in the 1990s included the simple framework for salmon and steelhead and also added a simple basinwide framework. This framework characterized general goals for resident fish and wildlife, and policies describing how each type of measure (e.g., all measures related to resident fish substitution) should be implemented.

Both the strategy for salmon and the revised 1994-1995 Program promoted ecosystem thinking (treating the Columbia Basin as a system, from the headwaters to the ocean, and inclusive of all habitats and species), to address impacts on listed and non-listed salmon and steelhead. During this decade, ecosystem-based approaches began to appear in multiple restoration and planning documents, including the Council's Programs and first round of subbasin plans (in the early 1990s), biological opinions, the Oregon Plan for Salmon and Watersheds (Oregon 1997), and the Spirit of the Salmon plan (CRITFC 1995).

Types of actions called for in the Programs of the 1990s are listed in Table 4. Further detail is provided below for some actions where context is needed or where actions were a significant component of the work that was called for.

## *Hydrosystem*

**Water Management:** Changes to the operation of the hydrosystem remained a major part of the Program in the 1990s. The concept of the water budget developed in the Council's Program was incorporated into biological opinions and continued to evolve from specific target volumes to a combination of volume and flow targets.

One of the largest changes was the addition of 1 million acre-feet of water to the water budget, a suggestion springing from discussions during the Salmon Summit. To further improve migration

conditions for juvenile salmon and steelhead, the Program called for a drawdown at lower Snake River dams to near-spillway crest elevations (NPPC 1994). Drawdown was also called for at John Day Dam to the minimum irrigation pool. These drawdowns were meant to increase water velocity and decrease travel time of juvenile migrants.

As flow and reservoir operations were pursued through the 1994 Program for the benefit of anadromous fish, there was increasing concern about the effects of those operations on resident fish. The Council committed to addressing resident fish hydro operations in the 1995 amendment, and major flow measures were proposed. In Montana, the operation of Libby and Hungry Horse dams resulted in reservoir fluctuations that were detrimental to species like kokanee, bull trout, and Westslope cutthroat trout. At Lake Pend Oreille, in Idaho, decreases in lake elevations after kokanee spawned were thought to be a factor in their population decline. To address these, the Program included requirements for managing reservoir levels at Libby and Hungry Horse dams and new operations at these dams to allow resident fish to complete their life cycle (e.g., necessary flows for spawning or for egg development). These recommendations conflicted with actions in the BiOps oriented towards securing more flow from the upper Columbia for salmon and steelhead. Because the Council was concerned about negative effects on resident fish, NMFS modified its position in 1995 to allow for better coordination of reservoir management and protection of resident fish species (NPPC 1995b). Flow measures at Libby Dam were also proposed to improve spawning conditions for endangered Kootenai River white sturgeon.

**Fish Passage:** The Program called for continued focus on building bypass systems and screening turbines at mainstem dams throughout the basin. Congress appropriated money to implement this work, and the plan was for all screening to be completed by 1998 (NPPC 1992b). Specific screening measures were also called for in tributary dams. At the same time, during drought years of the 1990s, the Programs called for transporting the maximum number of fish possible and improving the conditions fish experienced in barges. The Program also called for the complete implementation of actions in the 1989 Fish Spill MOA.

**Water Quality:** The Council requested that the EPA review and report on water quality in the basin (Table 4). Water quality concerns included insufficient flows, excess temperature, and pollutants. Although the issues were clear, the specific methods to address them were still in development. As such, the Program called for water demonstration projects to improve instream flows and water quality in each of the four basin states. Other measures focused on enforcing existing rules and pursuing options to purchase water rights to increase flows.

Additional measures focused on water temperature and total dissolved gas (TDG). In the Willamette Basin, cold water below dams inhibited spawning, and studies were called for on structural and non-structural improvements that could restore natural spawning temperatures. In the Snake River, high water temperatures negatively impacted migrating adults, and measures were proposed to release cold water from Dworshak Dam to lower water temperatures throughout the lower Snake River. For TDG, there was an early call to better understand effects on fish, particularly in relation to possible reservoir drawdowns. The study was meant to characterize symptoms of gas bubble trauma and identify relationships between spill levels and TDG (NPPC 1994).



## *Habitat*

**Restoration:** There was a growing emphasis on habitat restoration in Programs of the 1990s. The 1994 Program included numerous measures and principles guiding the kinds of actions, collaboration, and priorities that should be completed in tributaries to aid anadromous and resident fish. For example, the first subbasin plans were completed in 1990, and the Council called for these to be updated by the end of 1996. These plans were meant to coordinate habitat and production actions although they were never actually adopted in the Program.

The Council's approach to habitat restoration was to first maintain existing habitat through developing better land management (e.g., grazing, logging, etc.) and promoting a variety of restoration approaches. To do this at the watershed scale, it was necessary to coordinate among multiple entities. A model watershed approach was proposed to coordinate land and water uses and to address limiting factors cooperatively with government and private landowners (Table 4). Each of the four states was called to designate a model watershed.

**Protection:** Protection measures included calls for land conservation in riparian zones and water conservation. Riparian conservation occurred through conservation easements, land exchanges, or purchases. Water protection included a call for reviewing water quality standards, improving enforcement of existing water rights, installing flow monitoring equipment in new diversions to ensure appropriate water quantities are withdrawn, and incentivizing water conservation. Other measures included restricting new water rights if there was insufficient flow for salmon and steelhead or purchasing water rights when possible. These were meant to provide additional instream flow or improve water quality to protect weak stocks.

The Program also called for near-term screening at water withdrawal facilities (diversions). Screening was funded through both BPA and Mitchell Act funding and the Program called for additional screen building shops to accelerate the pace of screen installation.

**Wildlife:** In the 1990s, there was a continued call for assessing and adopting wildlife losses related to construction, inundation, and operation (NPPC 1995a; Table 4). Long-term wildlife agreements were in place for Libby and Hungry Horse dams with the State of Montana, and Dworshak Dam with the State of Idaho and Nez Perce Tribe, and a short-term agreement was in place in Washington. Other mitigation work occurred on a per-project basis (NPPC 1995b). The Programs called for additional settlement agreements, specifically recommending that interim wildlife agreements with the states of Oregon and Idaho be signed within 90 days of amendment adoption and long-term agreements be signed within 3 years. These agreements were meant to include credit for work already done, to define mitigation in terms of observed productivity of habitat and not hypothetical future productivity, and to correspond with monitoring and evaluation activities.

**Native Predator Management:** Predator management efforts increased and expanded in the 1990s. For Northern pikeminnow, prior removals had decreased population abundance by about 10%. The new direction in the 1990s was to increase that level to approximately 20% which was expected to result in at least a 50% reduction in predation on juvenile salmonids (NPPC 1994). Additional predator management measures focused on marine mammals and avian predators. Marine mammals had increased in abundance following passage of the Marine Mammal Protection Act (MMPA) of 1972.

Marine mammals could not be removed because of the MMPA, but the Program called for numerous studies to document specific effects on salmon and steelhead and to investigate opportunities to modify the MMPA to allow some control activities. Likewise, the 1972 amendment to the Migratory Bird Treaty Act of 1918 resulted in new protections for some avian predators, like the double-crested cormorant (Wires et al. 2001). At the same time, the U.S. banned DDT, a chemical that bio-accumulated in birds and negatively affected their reproduction (Carson 1962). As a result of these actions and other changes to food availability and habitat, population abundance began to increase and avian predators colonized new habitats in the Columbia River including human-made dredge-spoil islands (Wires et al. 2001). They were able to exploit high smolt concentrations from hatchery releases and high concentrations of disoriented smolts below dams (NPPC 1994). The 1994 Program called for the immediate study of avian predation in the estuary associated with bird colonies on dredge-spoil islands.

**Non-native and Invasive Species:** Programs called for investigating the effect of non-native or invasive species on resident and anadromous fish, particularly if they were ESA-listed. The first calls for investigating shad occurred in the 1990s. [American shad](#) are an anadromous species and were introduced to the Sacramento River in 1871 ([ISAB 2021](#)); from there they invaded the Columbia River and rapidly increased in abundance. Other measures focused on removal of brook trout, encouraging unrestricted harvest of non-native species, selecting trout release sites to avoid interactions with native species, and conducting habitat restoration in a way that would not benefit non-native or invasive species.

### *Artificial Production*

**Artificial Production:** In the 1990s, most production in the basin was authorized outside of the Fish and Wildlife Program. One exception was a set of hatcheries in the mid-Columbia River, lower Snake River, and upper Columbia River that were operated by the tribes to supplement the natural origin runs that remained, or to reintroduce fish to areas where wild runs were extirpated. Another exception was the continued production of resident species as a substitute for anadromous species where they had been extirpated in the blocked areas.

Starting in Fiscal Year 1998, the annual prioritization process for projects funded under the Fish and Wildlife Program included a review by the Independent Scientific Review Panel (ISRP). During this review, the Independent Scientific Review Panel recommended a comprehensive basinwide review of artificial production. The ISRP recommended that until completion of the review, the Council “not approve funding for the construction and operation of new artificial propagation programs,” with this exception:

“To prevent a complete moratorium on new production, the ISRP recommends that the Council permit funding for an individual project only if the project proponents can demonstrate they have taken [Council’s 1994 Fish and Wildlife Program] measures 7.0D, 7.1A, 7.1C, and 7.1F into account in the program design and the Council concurs. To ensure that standard is met, the individual projects should be funded only after a positive recommendation from an independent peer review panel.”

The Council responded with an interim approach to this issue called the [Three-Step Review Process](#).

Along with a focus on supplementation, harvest augmentation, or captive broodstocks, Programs of the 1990s emphasized reprogramming production at existing hatcheries as a cost-saving alternative to facility construction, improving existing propagation, and identifying opportunities for future production, as warranted. Programs also called for the use of captive broodstocks to support critically endangered stocks (e.g., endangered Snake River sockeye and threatened Snake River spring/summer Chinook) and there was a limited call for the use of hatchery fish for reintroduction in blocked areas (i.e., upper Cowlitz). In support of these different propagation needs, Programs contained long lists of policies, a description of needed research to improve supplementation (see RM&E, below), and other topics to implement propagation in a way that would minimize potential negative impacts to the environment and natural-origin fish.

**Facility Construction:** Programs called for increased production of anadromous fish at existing facilities, expanded infrastructure for propagating new species at existing facilities, development of new facilities for anadromous and resident fish, and construction of other facilities including collection or acclimation sites. These changes were meant to provide the tools to allow hatchery programs to meet best management practices for the benefit and protection of anadromous and resident fish.

### *Program Adaptive Management*

**Regional Planning:** Resident fish losses due to the hydrosystem have occurred throughout the basin, but specific assessments of these losses are limited. As of 2022, losses of resident fish have only been assessed due to the operation of Libby and Hungry Horse dams (Table 4). During the 1990s resident fish losses at Libby and Hungry Horse dams were described in mitigation plans, which were approved by the Council and adopted into the Program (NPPC 1995a). Fish losses upstream of Libby Dam from construction and inundation included rainbow trout, Westslope cutthroat trout and mountain whitefish (FWP, CSKT, and KTOI 1998). Downstream losses included Westslope cutthroat trout, about 90% of burbot, and effectively all Kootenai River white sturgeon (FWP, CSKT, and KTOI 1998). Fish losses at Hungry Horse Dam were assessed both due to habitat inundation and loss of connectivity to the Flathead Lake ecosystem and included juvenile and adult cutthroat trout, adult bull trout, and adult kokanee salmon (Fraley et al. 1990 and references contained within).

Goals were established for specific populations of resident and anadromous fish. Resident fish goals were established to mitigate losses through restoring habitat, rather than by rebuilding populations to an established level. These improved habitats were meant to benefit a diversity of resident species. Goals were also described for weak stocks of Snake River salmon. There were also calls for rebuilding populations of burbot and sturgeon. The Strategy for Salmon set rebuilding targets for spring Chinook, summer Chinook, and fall Chinook.

**Harvest recommendations:** The Council and the Fish and Wildlife Program do not have a role in setting harvest limits. Programs in the 1990s highlighted the importance of harvest agreements including the Pacific Salmon Treaty, the Columbia River Fish Management Plans (products of the U.S. v Oregon lawsuit), and the Columbia River Compact (shared management of Columbia River fisheries between Oregon, Washington, and U.S. v. Oregon treaty tribes). In addition, Programs included recommendations meant to improve adult returns of salmon and steelhead to the basin. In particular, there was a call for more conservative harvest limits in the river and ocean and for better management of mixed-stock fisheries such that weak stocks would not be over-harvested when mixed in with more abundant

hatchery stocks. Other recommendations included establishing terminal fisheries (off-channel release and harvest sites for hatchery fish to reduce encounters with wild fish in the mainstem) and identifying possible gear for live-catch or select harvest fisheries. Finally, the Program included measures calling for an end to high-seas drift net fisheries.

**Regional Coordination:** In the 1990s, several groups were assembled to work on key issues related to the Program. The Council created a Fish Operations Executive Committee to coordinate mainstem flow and river operations. This was also a forum to resolve flow-related disputes (NPPC 1992b). The Council also called on a newly formed Integrated Hatchery Operations Team to develop regional guidelines for hatchery practices, management, and future production. There was also a call for a regional assessment of supplementation to be carried out by managers that was meant to create a framework for supplementation and associated post-release objectives. The Basin Oversight Group was called for to “address progress, problems and issues regarding Program implementation” (NPPC 1994). This entailed reviewing annual implementation work plans and monitoring reports and making recommendations to the Council. Finally, the Fish Screening Oversight Committee was convened to provide technical information supporting screening efforts and to function as a forum where information on screening could be exchanged among regional practitioners.

**RM&E:** Hydrosystem RM&E needs identified in the 1990s focused on identifying the effects of specific operations on resident and anadromous fish and their habitats (Table 4). For example, studies were proposed to evaluate the effects of operations at Dworshak and Big Fork dams (among others) on resident fish. Other research included identifying the effect of development and operation of the hydrosystem on sturgeon and better understanding the relationship between water elevations at Lake Pend Oreille and survival of kokanee. For anadromous fish, there was a call to study increased summer flows in the Columbia River to aid juvenile salmon migrations. In anticipation of the potential for future drawdown at John Day, studies were proposed to evaluate relocating facilities and identifying necessary modifications that would allow the reservoir to be operated at lower levels. Similar studies were proposed on the Snake River. Studies also focused on juvenile passage. This included evaluating new bypass facilities (e.g., at McNary Dam), and testing designs for surface collectors.

The focus on RM&E related to habitat and production expanded substantially in the 1990s. In recognition of continued sturgeon declines above Bonneville, the Program called for analysis of all sturgeon populations above Bonneville—particularly in the Kootenai River. Other biological assessments were called for on Snake River fall Chinook, lamprey, bull trout, kokanee, and chum salmon. Hatchery-focused research included studies related to the effect of artificial production practices on native resident and anadromous fish, survival and stray rates of hatchery fish, evaluating the feasibility of marking all hatchery salmon, evaluating certain propagation and disease-control techniques, and evaluating alternative hatchery facilities (e.g., spawning channels).

**Data Management:** Expanding on calls for data management in the 1980s, Programs in the 1990s supported development of the Coordinated Information System (Table 4). This system included previously called for databases (natural and hatchery production) along with new summaries of scientific information gleaned from project implementation, habitat data (with carrying capacity), and accounting of project expenditures.

**Science Review:** In 1993, the Scientific Review Group (SRG) assembled a list of critical uncertainties during their review of the 1992 Annual Implementation Work Plan (SRG 1993). A major

recommendation from this review was that the Fish and Wildlife Program needed a conceptual framework linking the salmonid life cycle to the full complement of habitats used in freshwater and the marine environment to complete that life cycle. In 1994 the Independent Science Group (ISG—precursor to ISAB) was created, replacing the SRG. One of their first tasks was to review the 1994-1995 Program. That review, entitled “Return to the River,” was pivotal in shaping a more ecosystem focused direction for the Program based on a scientific foundation. In 1996, the ISAB supplanted the ISG and provided scientific advice and recommendations on the fish and wildlife programs of the Council, NOAA, and the Columbia River Inter-Tribal Fish Commission. The ISRP was created in response to the 1996 amendment to the Power Act. This was the beginning of project-scale review in the Program.

A major effort in the 1990s was the Council-led review of artificial production. initiated in response to Congress, who called on the Council and ISAB to review all federally funded artificial production programs in the Columbia Basin. The ISAB review was released in 1998 (ISAB 1998) and the Council recommendation followed in 1999 (NPPC 1999). The objective was to develop a “formal recommendation for a coordinated policy for the future operation of federally-funded hatcheries” (NPPC 1999). Although not a component of Programs in the 1990s, the review was influential in the development of the 2000 Program and established the basis for artificial production provisions at a basin wide scale.

### *Other key topics and accomplishments*

Part 4 of the 1991-1993 Program called for BPA to apportion 15% of the budget to resident fish and wildlife, each (NPPC 1993). This funding allocation was a marked increase from funding levels for resident fish and wildlife in the 1980s (NPPC 2001) and is still found in contemporary programs (NPPC 2014).

Table 4. Major components of each Fish and Wildlife Program and amendment, organized by category and theme, 1991 – 1999.

Category	Theme	Major components
Hydrosystem	Water management	Additional 1 million acre-feet in the water budget; drawdown at lower Snake River dams and at John Day Dam; seasonal and species-specific flow and reservoir objectives; rule curves for Hungry Horse and Libby
	Passage	Improve bypass systems and passage; conduct and evaluate smolt transportation; operate spillways and turbines to enhance fish passage; evaluate research needs for lamprey passage; explore new bypass technologies (e.g., surface bypass systems, spill, and behavioral guidance devices); implement fish spill MOA
	Water quality	Use storage or selective withdrawal to maintain temperatures for fish; study and reduce TDG during spill; monitor water quality; study methods to decrease water temperature in ladders
Habitat	Restoration	Prioritized restoration list in action plan to be implemented over next 10 years; list includes projects in tributaries, upland habitats, and blocked areas; projects benefit resident (e.g., bull trout) and anadromous species; evaluate methods to restore estuarine habitats; plan and implement model watershed projects;

	Protection	Land exchanges, purchases, or easements to benefit fish; four demonstration water conservation projects and other measures to protect instream flow; emphasis on screening diversions
	Wildlife	Adopt final loss assessments for construction and inundation (C&I) and determine operational losses; complete land acquisitions under LSRCP; develop long-term agreements for all wildlife mitigation; develop systemwide method for crediting new and existing mitigation actions, including from restoration and from fish lands
	Native predator management	Reduce number of predators, especially northern pikeminnow and avian predators at outfalls; pursue options for lethal take of marine mammals; evaluate predator abundance in Lake Pend Oreille
	Non-native and invasive species	Evaluate effect of increasing shad populations; remove brook trout; reduce non-native fish populations where they occur with listed species
Artificial production	Artificial production	Conservation of certain species (e.g., Snake River sockeye); propagation of salmon, steelhead, sturgeon, other resident fish and resident fish substitution projects; M&E on hatchery practices to address uncertainties; reprogram lower river hatcheries with upriver release sites; reintroduce anadromous fish into blocked areas, where feasible
	Facility construction	Adult trapping and portable collection/ acclimation/ release facilities; water supply for hatchery; construct additional facilities to improve production; design and construct certain resident fish hatcheries; O&M on certain hatcheries
Program adaptive management	Regional planning	Adopt rebuilding goals for naturally reproducing salmon and steelhead weak stocks; complete assessments of resident fish losses and develop biological objectives; resident fish losses at Hungry Horse adopted in Program and mitigation plan approved; develop annual implementation work plans
	Harvest recommendations	Harvest management consistent with rebuilding schedules and escapement targets; develop/ fund commercial fishing permit buy-back/leasing program for non-treaty Columbia River fisheries; many other stock-specific monitoring, coordination, reporting, and harvest recommendations; more conservative harvest limits including certain fishery closures and ending high-seas drift-net fisheries
	Regional coordination	Integrated Hatchery Operations Team; Council Genetics Team; coordination among parties on hatchery, wildlife, and system operation efforts; Regional Assessment of Supplementation Projects; transboundary coordination; Fish Screening Oversight Committee; and others
	RM&E and reporting	Study options to increase flows for fish; impact of flow operations and reservoir elevations on anadromous fish (e.g., effects of zero nighttime flows in lower Snake River on adult passage; spill effects on adult passage), resident fish, and wildlife; effectiveness of flow improvements at Vernita Bar; install PIT tag detection at select dams; monitor flow, fish passage, smolt condition; relationship between flow, velocity, and travel time; improve water temp and supply forecasting

		<p>Study water availability, water quality, and temperature; test vegetation plantings at reservoirs; monitor and evaluate habitat improvement; study predation on juvenile and adult salmon</p> <p>Study cumulative/ systemwide impacts of hydrosystem, harvest management, artificial production practices on native resident and anadromous fish; biological assessments (e.g., Snake River Fall Chinook, lamprey, sturgeon, bull trout, kokanee); survival and stray rates of hatchery fish; propagation techniques; fish marking; develop fish health research plan; alternative hatchery facilities (e.g., spawning channels); potential for shad fishery; evaluate survival through all life stages; interactions between shad and anadromous salmonids</p> <p>Study effects of the construction and operation of the hydrosystem on the ocean plume</p> <p>Prepare annual report evaluating Program progress using annual monitoring information in CIS</p>
	Data management	Continue funding CIS; genetic stock ID database; develop project accounting database (precursor to Pisces/ CBfish); support FPC; develop database for blocked area fish surveys
	Science review	Development of Independent Scientific Group (ISG); ISAB supplants ISG in 1996; ISRP created from amendment to NW Power Act; IEAB established in 1996; Artificial Production Review
	Public engagement	Public participation in water conservation, fish conservation planning, and other topics; public review process for wildlife mitigation and resident fish crediting
Other critical concepts		Support weak stocks. 1994 Program develops conceptual foundation

## 2000-2011

### *Regional Events*

ESA-listings continued in the 2000s with the listing of Lower Columbia River coho salmon and upper Willamette Chinook salmon in 2005 (Figure 17). Development and subsequent litigation of BiOps also continued in this decade<sup>6</sup>. The 2000 FCRPS BiOp called for aggressive offsite mitigation activities to

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<sup>6</sup> After a federal administration change in the early 2000s, federal fisheries management agencies were encouraged to consider dams as part of the environmental baseline, as opposed to considering the unregulated system as a baseline. Adopting this new perspective, in the revised FCRPS 2004 BiOp, NMFS no longer found that operation of the FCRPS caused jeopardy to ESA-listed salmon or steelhead, because the comparison was to the status quo of a regulated system. This BiOp was immediately challenged (*National Wildlife Federation (NWF) v. NMFS*), and the Court invalidated the BiOp on major structural and analytical grounds. Simultaneously, the court granted NWF a preliminary injunction allowing for spill during the summer of 2005, followed by an opinion and court-ordered spill in 2006. A new FCRPS BiOp was released in 2008. This BiOp called for expansive offsite tributary and estuary habit actions and included a supplement on risk/adaptive management. The BiOp was again the subject of litigation, with specific arguments that there was no certainty the required habitat work would occur after 2014. The U.S.

improve salmon survival in their habitat and at hatcheries. This call for offsite mitigation mirrored the approach already taken in the Council's 2000 Program. A second BiOp in 2000 was developed by the USFWS on Libby Dam related to endangered Kootenai River white sturgeon (Figure 17). BiOps were also produced for the Willamette Basin, harvest, and the Snake River (Figure 17).

In 2006 the Court ordered spill for fish based on data and recommendations from the Fish Passage Center (FPC)<sup>7</sup>, which had been part of the Fish and Wildlife Program since 1983. In response, pressure was placed on BPA to defund the FPC. The decision to defund the FPC resulted in litigation (*Northwest Environmental Defense Center v. Bonneville Power Administration*) arguing this action was not consistent with the Council's Fish and Wildlife Program (Figure 17). The U.S. 9<sup>th</sup> Circuit Court of Appeals agreed with the plaintiff, and funding was restored. This became the first major test of the requirement that BPA's funding be "consistent" with the Council's Fish and Wildlife Program.

In the 2000s, new, long-term funding agreements were developed in the basin. The first major agreement occurred in 2002 when the PUDs signed 50-year mitigation agreements (Figure 17). These included plans for bypass, spill, hatchery production, habitat restoration, predator management and included a goal of no-net impact on salmon and steelhead. In the mid-2000s, BPA developed long-term funding agreements with multiple states and tribes in the basin, termed the "Accords" (Figure 17). The accords were meant to stabilize funding over time for accord parties and increase funding associated with a set of projects named in the accord agreements. The guaranteed funding of identified projects served as an assurance to the judge in the FCRPS litigation that the RPAs described in the BiOp would be reasonably sure to be implemented. As part of the accord agreements, BPA required that parties would not participate in litigation over the FCRPS BiOp. While the accords created opportunities for parties to plan long-term, they also created a set of challenges. Funding rules differed between accord and non-accord parties (e.g., cost of living increases, the ability to shift funding among projects implemented by an entity, and overall funding volume). In addition, projects were meant to be reviewed by the ISRP, recommended by the Council to BPA, and then BPA would make a funding decision. With long-term agreements guaranteeing a set amount of funding to each entity, it became less clear how that project review process influenced ultimate funding decisions on a project-by-project basis.

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District Court of Oregon's 2011 ruling allowed implementation of the 2008 BiOp to continue through 2014, remanded the BiOp, and asked for a list of specific habitat restoration projects that would be completed between 2014 and 2018.

<sup>7</sup> The 2006 court-ordered spill cited data and recommendations from the Fish Passage Center (FPC) that indicated increasing spill would result in faster juvenile salmon and steelhead travel time and improved juvenile survival. When that spill order was implemented in 2006, Senator Larry Craig of Idaho inserted language in a Senate energy appropriations bill that would defund the FPC, arguing that they were reaching beyond the science and that additional spill would cost the region in foregone power generation. Pressure was placed on BPA to transfer the majority of funding from the FPC to a smolt monitoring project that would be implemented by CBFWA and the Pacific Northwest National Lab. Remaining (and significant) data and analytical functions of the FPC would no longer be funded at all. The FPC had been part of the Fish and Wildlife Program (previously as the Water Budget Center) since 1983.



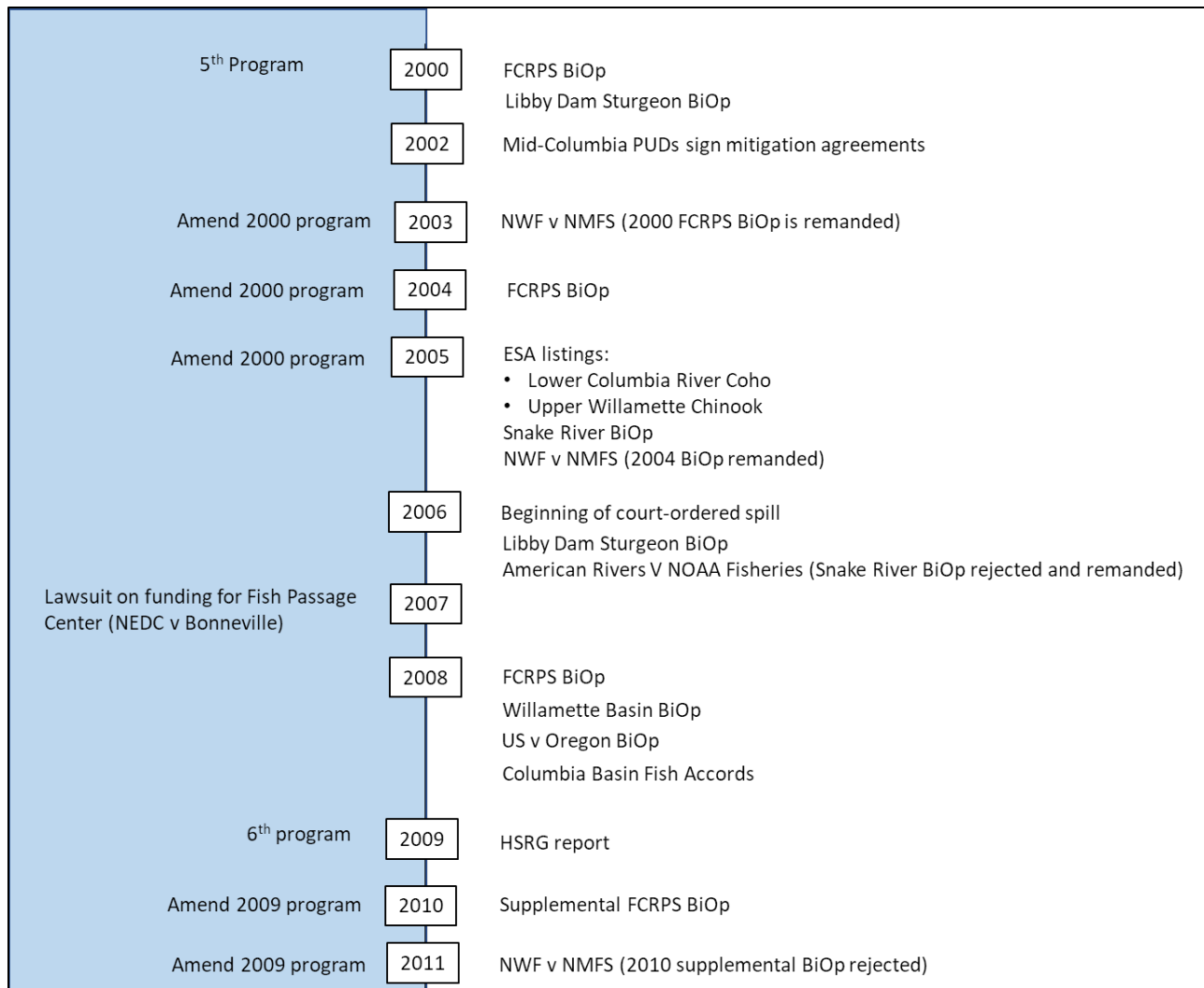


Figure 17. Timeline of Council (left side), regional, and national events (right side) related to fish and wildlife in the Columbia Basin, 2000 – 2011.

## *Program Structure*

In 2000, the Fish and Wildlife Program was fundamentally restructured while retaining the major provisions implemented from the previous 20 years. This restructuring was developed from the recommendations in the ISG's review of the 1994/1995 Program entitled 'Return to the River.' A newly proposed scientific framework connected an overarching vision, to goals, objectives, strategies, principles, and measures. There was a new emphasis on ecosystem function and better approximation of natural conditions, along with an emphasis that the natural environment was meant to serve as a baseline. The scientific framework contained elements of the frameworks of the late 1980s and 1990s, but it was much more detailed and integrated. The Framework was developed by the Council and other regional partners through the Multi-species Framework Project (Marcot et al. 2002). This was a major Council-coordinated effort bringing state, federal, and tribal governments together with stakeholders

“to help foster a regional perspective of the ecology and management of fish, wildlife, and ecosystems of the Columbia River Basin” (McConnaha 1999).

The new 2000 Program heavily emphasized habitat actions, as did the subsequent 2000 BiOp. The intention was for the Program to be implemented through mainstem and subbasin plans so that regional limiting factors or conditions could govern the kinds of actions implemented throughout the basin. This included actions like resident fish substitution projects. The mainstem plan contained some hydrosystem measures, but the majority of these appeared as actions in the BiOp, which were adopted as measures in the Program. As mainstem and subbasin plans were being developed, all of the measures from 1994 and 1995 Programs remained in effect. This 2000 Program also recognized three geographic scales for planning and implementation—the basinwide scale, ecological provinces, and subbasins.

The 2003 Program focused on mainstem amendments, including specific hydrosystem operations, inclusion of BiOp measures, Montana amendments for storage reservoir protections for listed and non-listed species, measures for upriver and unlisted species, and mainstem habitat. In 2004 and 2005, subbasin plans were adopted and all off-site mitigation measures were listed in these plans. They included a technical assessment of limiting factors and a management plan linked to those limiting factors. ESA watershed recovery plans were largely built off these subbasin plans.

In 2009, the Council adopted a new Program. This Program incorporated the framework from 2000, the mainstem plan from 2003, and the subbasin plans from 2004 and 2005. It also recognized the 2008 accords. The organization of this Program reflected the new framework with basinwide strategies, province-scale strategies (e.g., ocean and mainstem), and a discussion of elements required in subbasin plans and the procedure for implementing those plans. There was also a discussion of implementation, including project review, scientific review, and other coordination and reporting needs.

Types of actions called for in the Programs of the 2000s are listed in Table 5 at the end of this section. Further detail is provided below for some actions where context is needed or where actions were a significant component of the work that was called for.

## *Hydrosystem*

**Water Management:** Hydrosystem measures in the Program became more conceptual in the 2000s because the specific details on water management and fish passage were incorporated in the BiOps, and BiOp actions were adopted in the Program (Table 5). The hydrosystem strategy emphasized that the baseline for passage or survival studies was the natural river environment (Table 5), in contrast to federal guidance in the early to mid-2000s. In the mainstem amendments, the hydrosystem strategy described the need to “manage water through the hydrosystem so that patterns of flow more closely approximate the natural hydrographic patterns and are directed at re-establishing natural river processes where feasible and produce the highest possible survival rates for a broad range of affected fish within the physical limitations of the multiple purposes of the region’s storage reservoirs and hydrosystem” (NPCC 2003; Table 5).

As part of this overall water management strategy, there were specific operations described for certain species and certain locations (e.g., dams or reservoirs) in the basin (Table 5). For example, at Libby and Hungry Horse dams, Programs called for implementation of variable discharge (VARQ) flood control operations. In this operation, less water would be released from reservoirs in the winter as part of

typical flood storage management so that there was a greater chance of meeting reservoir refill targets in the summer. Other operations at Libby Dam were designed to simulate a spring freshet to assist Kootenai River white sturgeon spawning. In the Hanford Reach, the Program called for continued implementation of the flow management described in the Vernita Bar Agreement and subsequent agreements to stabilize flows and prevent stranding, particularly for fall Chinook salmon. Seasonal refill or release targets were also described as part of a strategy to provide sufficient flows for migrating juvenile salmon and steelhead. Other flow measures were described for bull trout and other native species.

## *Habitat*

**Restoration:** Restoration was called for throughout the basin, from the blocked areas to the estuary, including in the mainstem and tributaries (Table 5). There was also a major emphasis on restoring ecosystem function to benefit multiple species (anadromous, resident, and wildlife). The specific details guiding restoration were described in the subbasin plans, and from this point forward, those plans were meant to guide habitat restoration for the Program.

**Protection:** In the 2000 Program, the Council recommended that Bonneville “establish a funding agreement for land and water acquisitions” (NPPC 2000; Table 5). This was an expansion of previous water conservation efforts that had occurred in the 1990s. Bonneville established the Columbia Basin Water Transactions Program in response to the 2000 Columbia River Basin Fish and Wildlife Program and the 2000 FCRPS BiOp.

**Wildlife:** Another big change occurred in wildlife mitigation. To encourage more rapid progress on wildlife settlement agreements, the 1994/95 Program had called for interim agreements to be completed within 90 days of adoption of the Program and long-term agreements to be completed within 3 years (Table 5). Many of those agreements were still incomplete at the time of the 2000 Program, so the Program set a deadline for developing those agreements as April 1, 2001 (NPCC 2011). After that date, any losses not yet part of a settlement agreement and not yet mitigated would be doubled (2:1 crediting), thus requiring twice as much mitigation (NPPC 2000). That crediting ratio was retained in the 2009 Program (Table 5). The 2009 Program also called for a Wildlife Mitigation Advisory Committee to establish a ledger of habitat units acquired, address accounting issues around habitat units, and create a database to track acquisition and assign to projects. This became the [Wildlife Crediting Forum](#), which was formed in 2010.

**Non-native and Invasive Species:** In the 2000s, there was increased concern about negative effects of non-native species in the Columbia Basin. Policies were called for on invasive species that posed a threat to habitat, infrastructure, or focal species, including American shad, zebra and quagga mussels, silver carp, and Eurasian milfoil.

## *Artificial Production*

In the 2000s, two large review processes were underway that produced recommendations related to artificial propagation. Congress created the Columbia River Hatchery Reform project in 2006 and the Hatchery Scientific Review Group came from that process. This group was tasked with developing standards for integrated and segregated hatchery Programs and standards for proportion of natural

origin spawners necessary to maintain genetic diversity (NPCC 2009). The 2009 Program identified that the upcoming recommendations from that report would be integrated into the Program. Likewise, in 2004, the Council completed a review of artificial production in the basin (NPCC 2004). This review was an outcome of the 1999 review the Council conducted at the request of Congress (NPCC 1999). One product of this review was a set of standards for how hatchery Programs should be operated (e.g., artificial production actions must have an adaptive management design). These recommendations were incorporated into the 2009 Program to guide future artificial production (NPCC 2009).

Other concepts during this decade related to where and when it was preferable to restore native species or to manage runs of non-native species. In principle, the recommendation was to restore habitat to support native resident fish in their native range when feasible. When not feasible, the recommendation was to manage non-native fish to use available existing and improved habitats. The Program also called for restoration of anadromous fish into areas blocked by dams to be actively pursued where feasible (Table 5).

### *Program Adaptive Management*

**Regional Planning:** With a new focus on offsite mitigation, subbasin plans became foundational to the Program (Table 5). These plans represented the second round of subbasin planning, with the first occurring in the 1990s. The 2000 Program described criteria for the content in subbasin plans and between 2004 and 2011, plans were adopted for 59 subbasins. These plans included a technical assessment of limiting factors and a management plan linked to those limiting factors.

Other efforts included developing interim goals (Table 5). Goals included (1) halting declining trends (no target year), (2) improving smolt-to-adult returns (SARs) to achieve survival in the range of 2-6%; (3) continuing to restore lamprey; (4) restoring the widest possible set of healthy populations in each province (no target year); (5) increasing total adult salmon and steelhead runs above Bonneville to an average of 5 million by 2025 and within 100 years achieving full mitigation for losses of anadromous fish; (6) achieving within 100 years full mitigation for losses of resident fish; (7) restoring native resident fish species to near historical abundance wherever possible; and (8) reintroducing anadromous fish into blocked areas, where feasible. Additional goals were identified for resident fish and wildlife. While some of these goals were quantitative, many were not. In the 2009 Program, there was a call to develop quantitative biological objectives to support these goals.

**Harvest Recommendations:** Harvest measures in the 2000s shifted away from the specific policy recommendations and management strategies that had appeared in prior Programs. Instead, the measures included supporting opportunities to create terminal fisheries, monitoring and evaluating commercial harvest, and reviewing management plans to ensure their consistency with recovery plans (Table 5).

**RM&E and Reporting:** Several research themes were explored in the 2000s (Table 5). On the topic of the ocean, the Program called for research to separate marine mortality from freshwater mortality in the salmon life cycle. General principles for ocean research were also described, including a need to (1) consider ocean conditions and effects of climate change when recommending strategies and implementing measures, (2) manage to help species survive a variety of ocean conditions, and (3)

identify, protect, and restore ecosystem function in the Columbia River plume as affected by hydrosystem. Other research focused on climate change, toxic pollutants, and invasive species.

Large-scale hydrosystem RM&E continued in the 2000s. For salmon and steelhead in general, the Program called for a comprehensive evaluation of survival, flow targets, flow augmentation, and life cycle survival. For juveniles, research was identified to study juvenile transportation and delayed mortality, along with comparing survival of in-river and transported migrants. In support of this research, additional PIT tag detectors were called for to be installed at dams. Other studies were related to the effects of spill and TDG on survival. For adults, there was a focus on improving fish counts, studying temperature effects on migration, and better understanding fish behavior. Research was also proposed on survival impacts to sturgeon following downstream passage at dams with and without removable spillway weirs.

The estuary was a new focus of research in the 2000s. The Program recognized a need to better understand processes affecting the estuary and opportunities for restoration. There was a call to evaluate the effects of flow regulation, dredging to maintain the navigational channel, and water quality on habitats in the estuary. There was also a call to better understand salmon and steelhead survival rates through the estuary. This was a companion to survival research in the lower river and ocean.

The Program also called for establishing a basinwide research plan that would be coordinated with the mainstem and subbasin plans. This was meant to aid in identifying and resolving key uncertainties for the Program and implementation. As an early part of performance, the Program called for, and the Council adopted, High Level Indicators for the purpose of reporting success and accomplishments. Similarly, the Program identified a need for a systemwide annual report that would describe whether projects in the subbasins were achieving Program objectives. This decade also marked the beginning of the Governor's Cost Report on BPA's fish and wildlife expenditures and hydropower operating costs. This report differs from the Report to Congress, called for under Section 4(h)(12)(A) of the Power Act, which requires annual reporting on "actions taken and to be taken by the Council..., the effectiveness of the fish and wildlife program, and potential revisions or modifications to the program to be included in the plan when adopted."

**Data Management:** Significant changes in data management occurred in the 2000s. Previously, Program research was tracked through separate databases (e.g., coordinated information system (CIS) or the habitat survey database that supported the protected areas rules) or existed only in the grey literature within individual agencies, not available to the public. In a [1993 status update](#) on developing the CIS, Ann Roseburry, the librarian with the Columbia Basin Fish and Wildlife Library, wrote, "... A great deal of the research, reports and records which might be assumed to be available from the producing agencies are not. Further, over the years, many of these reports have not been forwarded to the agency libraries... or to the state libraries. As agency researchers, manager[s] and policy staff have retired, Basin history and memory have been lost and, in some cases, documents have been destroyed or discarded." In the 2000 Program, measures called for all research funded by Bonneville to be available through the internet and a library open to the public (Table 5). In response, BPA developed an online database (now called [CBfish](#)) to track project implementation and associated outputs.

**Science Review:** The 2000 Program was the first to follow the 1996 amendment creating the ISRP. In this Program, the project review roles were described for the regional managers, the ISRP, and the Council

(Table 5). The ISRP’s role was to conduct a review of the projects’ scientific merits and results and make recommendations of whether proposed projects were “based on sound science principles, benefit fish and wildlife, have clearly defined objectives and outcomes, have provisions for monitoring and evaluation of results, and are consistent with the Program” (NPPC 2000). Following the ISRP review, the Council’s role was to “decide which projects to recommend to Bonneville for funding to implement the Program” (NPPC 2000). This project review role was further expanded to include review of subbasin plans, through assessing the strength of the underlying technical assessments and how well the subbasin plans linked the recommended management actions to the technical assessments.

There was also an obligation, as written in the Act, that the Council must “take into consideration the effects of ocean conditions on fish and wildlife populations and must determine that projects employ cost-effective means to meet Program objectives” (NPPC 2000). In 2000, there was a call to develop a research plan that could be used to identify and prioritize research (NPPC 2000); by 2006, the research plan was finalized (NPCC 2006).

### *Other Key Topics and Accomplishments*

Whereas previous Programs had emphasized supporting weak stocks, Programs in the 2000s suggested a new approach of building from strength. From the 2003 mainstem amendment, *“Identify and protect habitat areas and ecological functions that are relatively productive for spawning, resting, rearing, and migrating salmon and steelhead in the mainstem. ...where feasible, restore and enhance habitats and ecological functions that connect to the protected productive areas to support the expansion of productive populations and to connect weaker and stronger populations, so as to restore more natural population structures.”*

Table 5. Major components of each Fish and Wildlife Program and amendment, organized by category and theme, 2000 – 2011.

Category	Theme	Major components
Hydrosystem	Water management	Re-establish natural river processes to extent feasible to benefit resident and anadromous fish; protect and expand mainstem spawning and rearing habitat through flow operations; all water management measures in BiOps are part of this Program; minimize impacts of spill on adults; implement Var-Q; flows for particular species noted (e.g., Vernita Bar agreement, sturgeon, bull trout, and other native fish and wildlife)
	Passage	Conduct fish transportation until benefits of in-river migration vs transportation assessed; support multiple passage options and structures for diverse species; test and develop surface bypass and passage structures; maximize spillway survival; relocate outfalls when there are issues with survival, injury, or predation; improve effectiveness of adult fish passage; install PIT tag detectors; BiOp actions are incorporated in Council's mainstem plan; improve juvenile and adult Pacific lamprey passage and survival and reduce migration delays through hydrosystem; install fish friendly turbines; improve fish counting

	Water quality	Release water from reservoirs to cool river for adult salmon and steelhead; continue developing monitoring and models to support temperature and TDG management; continue developing passage structures that reduce TDG
Habitat	Restoration	Restore habitat to support native resident fish in their native range when feasible; when not feasible, manage non-native fish to use available existing and improved habitats; Restore ecosystem function in different habitat zones, including estuary, mainstem and transboundary habitats; survey all mainstem reaches and identify needed improvements; restoration in other areas (e.g., Lake Roosevelt); specific habitat measures are found in Subbasin Plans and BiOp; long term effectiveness monitoring
	Protection	Protected areas standards to be taken into consideration by FERC; recommendation that BPA establish a Land and Water Acquisition fund; acquire riparian lands; mitigate for resident fish habitat via long term agreements; work with regional entities to establish criteria for recognizing strongholds; investigate and reduce sources of toxic contamination; continue efforts to screen diversions
	Wildlife	Complete mitigation agreements for remaining habitat units at a 2:1 ratio; propose O&M plans for wildlife agreements that do not already have them; assess operational losses and mitigate for direct and secondary losses using subbasin plans; complete mitigation to address the assessed C&I losses; O&M funded through mitigation settlement agreements for fish and wildlife in an amount to cover the actions in the management plan;
	Native predator management	Evaluate impact of predation on listed fish and on SARs; specific predator management policies targeting native piscivorous fish, birds, and pinnipeds
	Non-native and invasive species	Increased concern about effects of non-native species; suppress non-native populations that adversely affect salmonids (e.g., Shad); policies for other invasive species noted (e.g., Zebra and Quagga Mussels, Silver Carp, Eurasian Milfoil)
Artificial production	Artificial production	Implement recommendations from 1999 and 2004 artificial production reviews; consider adopting Hatchery Science Review Group (HSRG) recommendations when available; restoration of anadromous fish into areas blocked by dams should be actively pursued where feasible.
Program adaptive management	Regional planning	Implement Program through subbasin plans; between 2004 and 2011, adopted 40 subbasin plans representing 59 subbasins; complete assessments of resident fish losses and consider adopting them into the Program; goals and objectives at basinwide and province scales; Council's mainstem plan is built on recognizing other plans and biological opinions (e.g., BiOps, fish accords, FERC) regarding the hydrosystem and its operation
	Harvest recommendations	Increase harvest opportunities for resident and anadromous fish consistent with sound biological management practices; ensure harvest rates do not threaten recovery of naturally spawning

		populations; monitor in-river and ocean fisheries; peer review of harvest management plans; document impact of harvest on SARs
	Regional coordination	Joint sponsorship by Council and federal agencies of a regional implementation structure for coordinating on hydro operations (should include TMT, SCT, Hydro coordination team, water quality team, Regional Implementation Oversight Group, Willamette action team for ecosystem restoration); continue coordination on key activities including data management, M&E framework, tracking objectives, coordinating funding sources within subbasins, etc.
	RM&E and reporting	<p>Study survival of in-river and transported migrants, including delayed mortality and stray rates; adult passage (e.g., improved fish counts, temperature effects, fish behavior); juvenile transportation at McNary, of Snake River Fall Chinook; comprehensive evaluation of survival, flow targets, flow augmentation, ramping schedules, spill, TDG; surface passage technologies or turbine operations; downstream passage of sturgeon (e.g., mortality, effects of removable spillway weirs on sturgeon); improve runoff forecasting techniques as part of planning for climate change and evaluate other operations (e.g., changes in flood control operations) that could minimize climate change impacts on hydrology; annual report on hydro operations;</p> <p>Monitor and evaluate habitat and wildlife response to mitigation; evaluate importance of mainstem habitat protection for bull trout; evaluate salmon and steelhead survival rates in estuary (and LCR and marine environment); evaluate effects of flow regulation/ dredging/ water quality on estuary habitat)</p> <p>Research on natural production of lamprey, white sturgeon, burbot; annual reporting on AP programs and five-year review on whether programs successfully implementing reforms</p> <p>Separate marine mortality from freshwater mortality in life cycle; identify, protect, restore ecosystem function in plume as affected by hydrosystem</p> <p>Establish basinwide research plan and coordinate it with the mainstem and subbasin plans; High Level Indicators for the purpose of reporting success and accomplishments; annual report to governors and congress on BPA's fish and wildlife expenditures and hydropower operating costs</p>
	Data management	Continue operation of FPC; all research funded by Bonneville will be available through the internet and a library open to the public; Council will identify data needs in basin
	Science review	Role of the Council in project review described; role of ISRP described in Program including requirement for annual report on results from prior year's Program expenditures
	Public engagement	Harvest discussions occur in open and public process; science and policy exchanges



Other critical concepts		2000 Scientific framework; considered a habitat-based Program now; build from strength; current allocation of funding among Anadromous (70%), Resident (15%), and Wildlife (15%) will be maintained until new budget allocation is adopted
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## 2012 – Present

### *Regional Events*

In the current decade, significant climatic events have impacted Columbia Basin fish and wildlife. From late 2013 – 2016, a marine heat wave, termed ‘the blob’, formed over the North Pacific. The affected region was characterized by exceptionally warm surface water temperatures and low productivity. As the blob eventually moved onto shore, productivity in the nearshore environment also plummeted and numerous marine species were negatively affected. This widespread low productivity resulted in extremely poor ocean survival rates of Columbia Basin salmon and steelhead. Additional marine heatwaves occurred in 2019, 2020, and 2021. During 2015, at the height of the blob, water temperatures in the Columbia River exceeded 70° F at the time that sockeye salmon were migrating upstream. Over 250,000 sockeye salmon died during migration before they could reach their spawning grounds,

Other climatic impacts included widespread fires throughout the basin, prolonged drought, and extreme temperature events. In 2020, the West experienced one of the worst fire years on record and fires impacted fish and wildlife habitat and infrastructure (e.g., hatcheries), along with causing disastrous impacts to humans. In 2021, a heat dome formed over the Pacific Northwest, extending up into British Columbia. This was described by NOAA as a [once-in-a-millennium event](#) and broke all-time temperature records in Oregon, Washington, and Canada. Each of these events demonstrates the vulnerability of the region to climate change events, particularly when multiple events in the region and beyond occur simultaneously.

In this current decade, litigation on the FCRPS BiOp has continued (Figure 18) and resulted in completion of an Environmental Impact Statement for the Columbia River Hydrosystem, as well as a new Biological Opinion<sup>8</sup>. During this time, a new [2018 spill agreement](#) was developed and incorporated into the regulatory documents.

There have been some notable events in the current decade. In 2015, the Oregon chub was delisted from the ESA (Figure 18). This was the first fish species ever delisted because of recovery, and it benefited from the wildlife mitigation and habitat restoration work done through the Program in the Willamette Basin. There has also been progress on addressing pinniped predation with the Marine Mammal Protection Act amendment in 2018 (Figure 18), a process in which the Council contributed significantly.

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<sup>8</sup> In 2016, the U.S. District Court of Oregon remanded the 2014 BiOp. The Court disagreed with assertions that the FCRPS operations complied with the ESA and said that the federal agencies had not fully considered all options to improve survival of salmon and steelhead, including breaching the four dams on the Lower Snake River. NOAA was required to prepare a new BiOp by 2018 and the action agencies were required to prepare an Environmental Impact Statement (EIS) as required under NEPA (USACE 2020) to be followed or accompanied by a new BiOp. This EIS had to include an analysis of breaching. One outcome from this process was a new spill agreement in 2018 to be implemented 2019-2021.

There has been continued collaboration on salmon recovery planning through regional efforts. In 2017, NOAA convened the Marine Fisheries Advisory Committee Columbia Basin Partnership Task Force. The group was comprised of federal agencies, state agencies, tribes, environmental advocates, and other interested parties, and sought to develop a framework for rebuilding stocks of non-listed species and recovering listed species in the basin that are affected by all sources of impacts in the basin, not just the hydrosystem. An early outcome of this group was the compilation of current abundance data on salmon and steelhead and establishing abundance goals for these stocks to achieve healthy and harvestable levels. Collectively, the partnership agreed to a high-end goal of 3.6 million *natural-origin* salmon and steelhead adults returning to the Columbia Basin, as measured at the mouth.

The Columbia River Treaty—signed by the U.S. and Canada in 1961 and first implemented in 1964 to provide downriver flood control—reaches a decision point in 2024. At this time, either party can exit the treaty by giving 10 years notice (Columbia River Treaty 1961). In addition, in 2024, the management of flood control using storage dams in Canada reverts from ‘assured annual flood control’ to ‘called-upon flood control’ unless another agreement is completed (Columbia River Treaty 1961). Currently, the parties to the treaty are in the negotiation process to [modernize the treaty](#) (Figure 18). Negotiations include discussions on out-of-date power provisions, environmental and fish considerations, and flood management.

Poor returns of steelhead in the Snake River have prompted continued discussion around the future of lower Snake River dams (Murray – Inslee 2022, CEQ 2022; NOAA/NMFS 2022). Numerous analyses have been produced on power replacement options, biological needs, and options (and associated cost) to replace the other uses of the lower Snake River or to compensate river users. Regionally, this remains an extremely controversial topic.

Against a backdrop of climate change and regional planning efforts, the global Covid pandemic (SARS-CoV-2) killed millions of people and caused devastating social and economic disruption. At the Fish and Wildlife Program level, the pandemic disrupted the supply chain, work protocols, and the economy in ways that affected implementation of Program actions (to varying degrees), with ongoing impacts still unfolding.

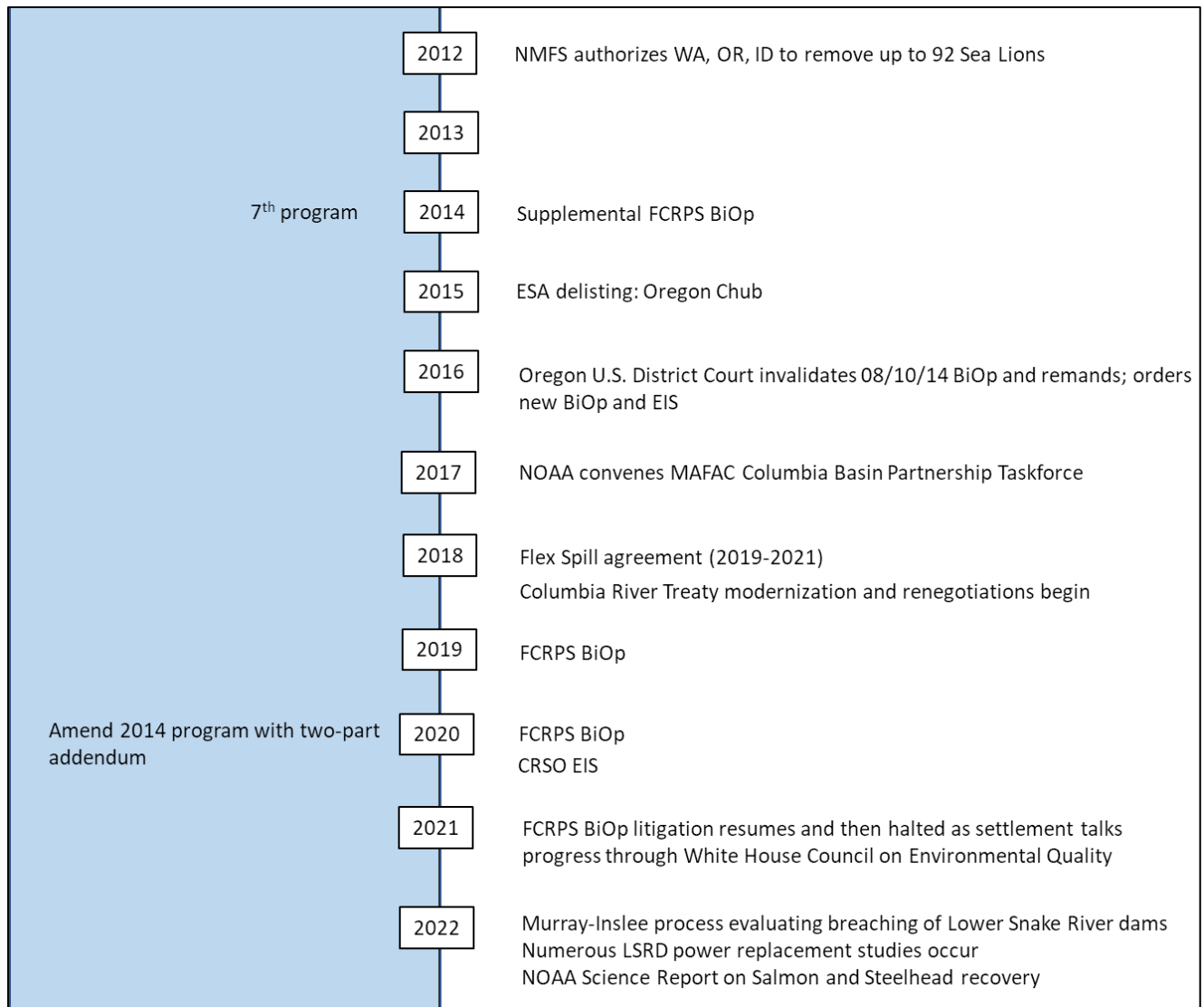


Figure 18. Timeline of Council (left side), regional, and national events (right side) related to fish and wildlife in the Columbia Basin, 2012 – 2022.

### *Program Structure*

The 2014 Program was structured as a list of principles, strategies, and measures organized within a scientific framework (NPCC 2014). The Program appendix contains BiOp and subbasin-scale measures, along with a detailed list of goals and objectives (Table 6, end of this section). The 2014 Program also includes a set of emerging priorities (NPCC 2014). The 2020 Addendum was developed in two parts—one focusing on reorganized goals and objectives along with new strategy performance indicators, and one focusing on near-term priorities (NPCC 2020). The previously adopted subbasin plans continue to be part of the Program.

The 2014/2020 Program is a compilation of the types of work implemented since 1982 and the innovations and research that have contributed to new topics or scientific advances. For example, the

growing frequency of natural disasters and observations of temperature increases, changing precipitation patterns, and sea level rise have highlighted the need to consider the effects of the climate on the many efforts of the Fish and Wildlife Program. There has also been growing recognition of the effects of the hydrosystem on sturgeon, lamprey, eulachon and burbot. Additionally, the 2014/2020 Program recognizes that the volume of work implemented in the blocked areas has been insufficient, leading to further recommendations for increased mitigation effort and funding.

In recognition of the long-term investment of time and money in mitigation work, the 2014 Program and the 2020 Addendum emphasized assessing the performance of the Program (NPCC 2014; NPCC 2020). While this performance concept has existed in some form in every Program, the 2020 addendum included a set of indicators and an approach to track and evaluate performance (NPCC 2020).

Types of actions called for in the Programs post-2012 are listed in Table 6. Because this current Program includes much of the work that has been previously described, only new or complex elements are expanded on below where context is needed.

## *Hydrosystem*

**Water Management:** The majority of hydrosystem actions are described in detail in the BiOps and are incorporated in the 2014 program by reference. Description of water management within the program is largely conceptual. In 2020, the Council highlighted as a near-term priority that the Corps and Bureau implement additional operational changes at Libby and Hungry Horse Dams (Table 6). Operational changes included slower ramp rates, altered draft and refill targets, integrating VarQ flood management with sturgeon flows, and altered operations during drought years. The Program continued to call for an adaptive management approach to all flow and passage measures.

## *Habitat*

**Restoration:** Beginning in the 2000s, there was a shift from isolated restoration actions to more integrated actions. This continued in the current decade, along with enhanced focus on removing fish passage barriers, restoring floodplain habitat in the tributaries, and restoring mainstem habitat. In the mainstem, new work was proposed to identify and restore thermal refugia as part of a strategy on climate adaptation. Other restoration actions were proposed for specific species (e.g., sturgeon, lamprey). In 2020, there was further emphasis on increasing investment in blocked areas mitigation.

**Protection:-** New concepts in protection were proposed in the 2014 Program relating to identifying strongholds (Table 6). The concept of strongholds was meant to protect high quality, intact habitat and associated populations so that they could serve as a source for recolonizing or rebuilding weak stocks.

Existing protections were expanded for water quantity and quality. For example, the Program called for improving water quantity and restoring a more natural hydrograph through acquiring water rights. There was also a call to implement the 2010 Columbia River Basin Toxics Reduction Action Plan. The toxics workgroup was started in 2014 as part of this effort, and there was also a science – policy forum on the topic. There was also a general emphasis on meeting water quality standards and restoring water quality where needed.

**Wildlife:** The work of the [Wildlife Crediting Forum](#) continued through the [Wildlife Advisory Committee](#), which was formed in 2013 to make recommendations on operational losses and future Habitat Evaluation Procedure (HEP) needs. In the 2014 Program, the wildlife strategy called for a recommendation on how to determine operational losses and set a deadline of 2015 to complete this effort. Managers convened a crediting forum to determine the mitigation value of existing land parcels, and to which dams those credits would be assigned. Numerous crediting discussions occurred. Following the forum, a series of HEP reports were produced for different regions of the basin to establish the status of crediting for past and present mitigation for federal dams, and to outline remaining areas of difference between BPA and managers. The 2014 Program called for mitigation agreements for construction and inundation to be completed by 2016.

Losses of wildlife habitat from construction and inundation were assessed as inundated acres, as lost habitat units (characterized by species-specific habitat types lost), or as a combination of both when losses and associated mitigation were allocated among multiple agencies or tribes during settlement agreements (Figure 19). Operational losses were assessed and settled at a subset of projects. By the late 2010s, construction and inundation losses were either settled or partially settled in acres (NPCC 2011; Figure 19) and remaining losses were mitigated through individual projects.

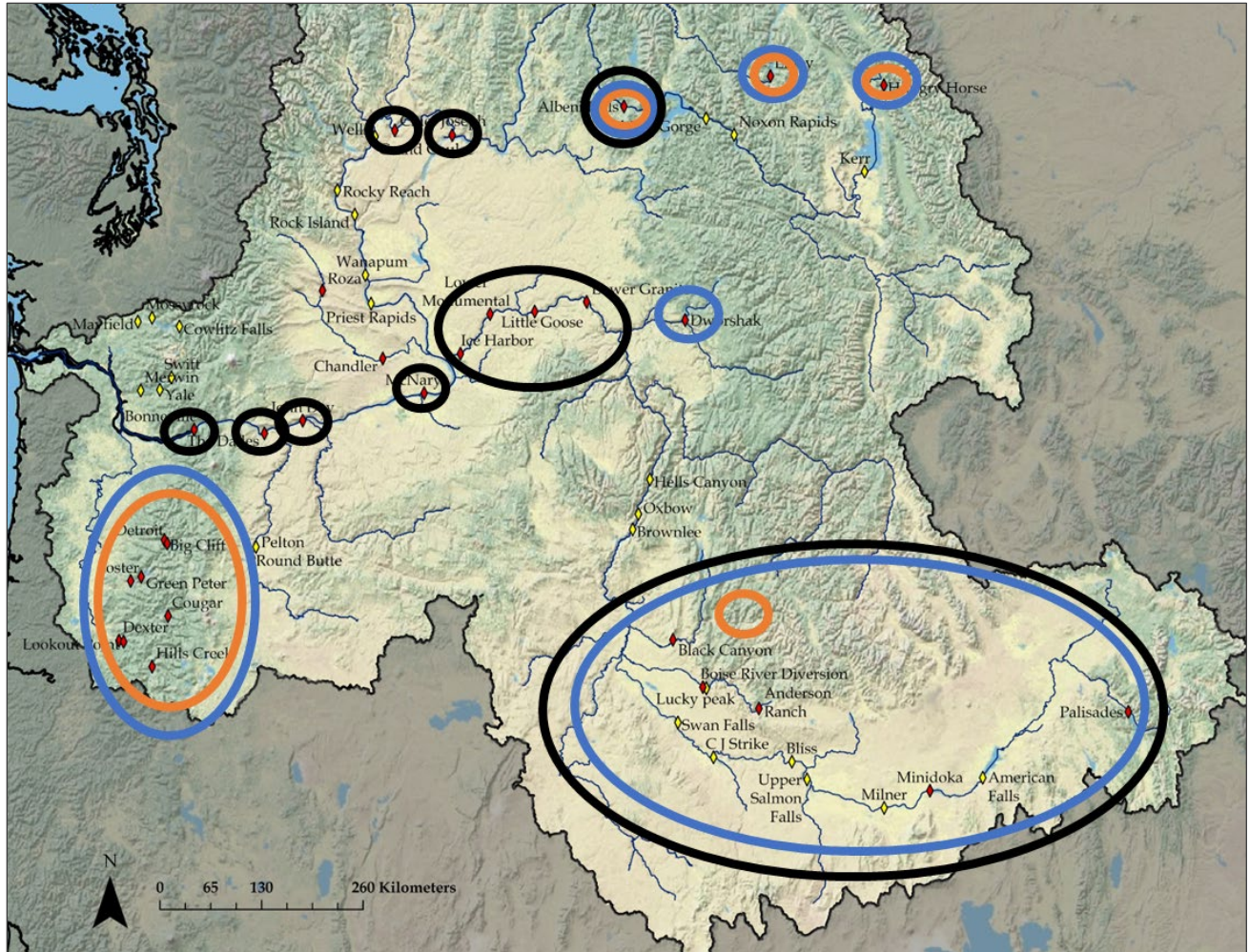


Figure 19. Location of federal dams where wildlife losses have been assessed resulting from construction and inundation (black = losses assessed in habitat units, blue = losses assessed in acres) and operation (orange = acres; partially assessed) of the hydrosystem. Map created in ArcGIS Pro (C) 2020 ESRI. All rights reserved.

**Native Predator Management:** In the current decade, there was an expanded emphasis on predation. A science and policy exchange on predation was held in 2012. In the 2014 Program, numerous measures on predator management were included—both of native species (sea lions, seals, northern pikeminnow, double-crested cormorants, Caspian terns, white pelicans) and non-native species (northern pike, brook trout, other game fish). This was re-emphasized in 2020 with a near-term priority of sustaining and supporting ongoing efforts to reduce predation by northern pike.

**Non-native and Invasive Species:** A major issue in the current decade has been invasive zebra and quagga mussels. The Columbia Basin is the only major river basin in the U.S. that has not been impacted by zebra and quagga mussels. Where they have been introduced elsewhere, they can clog up hydrosystem infrastructure and disrupt the ecosystem. In the Columbia Basin, such impacts could negatively impact substantial restoration work. The Council highlighted this as an emerging priority in 2014, urging the Corps of Engineers to help fund detection and response actions.

## *Artificial Production*

**Artificial Production:** The 2014 program outlined a set of principles related to integrating guidance from the Hatchery Science Review Group (HSRG 2009) and best management practices, along with calling for comprehensive RM&E on hatchery effectiveness. With several programs funding or managing artificial propagation in the basin, there was a need to develop a comprehensive source for hatchery-related information. To assist in this effort, the Council convened an Informal Hatchery Workgroup in 2019. This group collaboratively developed a tracking tool for the region's hatchery programs, both within and outside the Fish and Wildlife Program which also included background information on basin hatchery programs.

**Facilities:** In the 2014 Program, the Council included an [asset management strategy](#) with the objectives of inventorying assets, identifying O&M needs, determining the condition of assets, and prioritizing repairs/investment. The corresponding Asset Management Strategic Plan was adopted by the Council in 2018.

## *Program Adaptive Management*

**Regional Planning:** One key element from the 2014 Program was a set of emerging priorities (Table 6; NPCC 2014). These included a set of actions that either needed to be expanded or added for priority topics (see page 116 of the 2014 Program). In 2020, some of these were re-emphasized as priorities and additional topics were highlighted as priorities for the near-term (See part II of the 2020 addendum; NPCC 2020).

A major effort was undertaken in the 2014 Program to develop quantitative objectives for the existing Program goals. These were re-organized, reformulated, and supplemented where necessary in the 2020 addendum to allow for improved tracking and evaluation of Program performance. Goals focused on (1) salmon and steelhead, (2) other native aquatic focal species (3) wildlife, (4) the ecosystem, and (5) communication and evaluating Program performance. For each goal, a set of quantitative or qualitative objectives was identified to serve as short-term benchmarks when evaluating progress and performance.

Regional planning efforts also focused on loss assessments, objectives for wild fish, and recovery planning for eulachon. The 2014 Program has continued to call for the completion of loss assessments for resident fish. The current focus expands previous calls to include completing loss assessments for lamprey. Along with loss assessments, there was a focus on identifying quantitative objectives for wild fish. The Program only contains two measures related to wild fish, but did identify a need to collect, organize, and review objectives. Lastly, as planning progresses to rebuild eulachon populations, the Program committed to incorporating eventual plans.

**Regional Coordination:** Numerous regional coordination efforts are ongoing (Table 6). For example, the Regional Coordination Forum was created in the early part of this decade following the end of CBFWA to continue providing an opportunity for the region to discuss issues. The 2014 Program calls for this forum to be held each year and requires participation from those receiving Program coordination funding.

The 2014 Program included language about using cost savings to fund new projects or invest in emerging priorities. This led to the formation of a Cost Savings Workgroup, which held a series of

meetings to discuss the approach to finding funds and prioritizing how they would be spent. The 2020 addendum included a near term priority to develop an improved public process to find cost savings.

In support of assessing Program goals, objectives, and strategies, the 2020 Addendum called for the development of a workgroup to support the Council in reviewing and discussing datasets to be used for tracking progress in implementing program strategies.

**RM&E and Reporting:** RM&E continues to be a major focus of Programs, with measures calling for research on topics related to the hydrosystem, habitat, and reintroduction into blocked areas. There was also an ongoing effort to develop guidance for Monitoring, Evaluating, Research, and Reporting (MERR) efforts in the Program. A substantial amount of work has focused on understanding the effects of the hydrosystem on salmon and steelhead. Recently, there has been a much greater emphasis on exploring opportunities to reintroduce salmon to the upper Columbia blocked area. In the 2014 Program and 2020 addendum, specific measures called for a phased approach to evaluating reintroduction of anadromous fish above Chief Joseph and Grand Coulee dams.

In the current decade, hydrosystem research has expanded to other species, including sturgeon, lamprey, and eulachon. Measures focused on both evaluating the effects of dam operation or dredging on various species, along with better understanding species-specific passage issues. For example, the Program called for monitoring and evaluating the response of white sturgeon to restoration actions and determining species status and viability (e.g., abundance and productivity) throughout the basin. There were also measures related to monitoring sturgeon passage and collecting biological data related to survival and the effects of isolation on subpopulation dynamics. For lamprey, there was a need to better understand basic information on abundance and distribution. The Program called for these to be reported on every five years and for research into possible tagging methods for lamprey that would facilitate improved tracking. Measures called for monitoring and reporting on lamprey passage at dams, along with documenting predation on lamprey during passage. Other measures called for research on the abundance of eulachon on dams.

The 2020 addendum introduced the concept of Strategy Performance Indicators (SPIs). For each of the Program's 18 major strategies, quantitative metrics were identified with the constraint that the associated data had to be readily available and relevant at the basin scale (i.e., not tracking the work of an individual project in a single location). The SPIs were not officially adopted in the Program to facilitate future edits that might be required as datasets were assembled and reviewed for each SPI. The 2020 addendum called for annual reporting on the SPIs. That reporting occurs through the [Program Tracker](#).

Two other key research topics were the ocean and climate change. Research in the ocean included a new focus on understanding carryover effects—conditions experienced in freshwater that can influence marine survival (e.g., growth, migration date, or stream temperatures). Monitoring work fed into developing an annual index of ocean survival and an overall objective of identifying, protecting, and restoring ecosystem function in the plume, as affected by the hydrosystem. As part of this enhanced focus on the ocean, a new forum was created to discuss issues in the plume and ocean—the Ocean and Plume Science and Management Forum. As funding shifted throughout the decade, the ocean projects operated on decreased budgets, impacting the array of monitoring and analytical products that could be offered to the region. As such, the 2020 addendum identified a near term priority of restoring and sustaining funding for ocean monitoring and research.



Climate research and monitoring actions were varied. The Program called for the development of better runoff forecasting models. There was also a need for better weather and water monitoring in high-altitude areas, particularly those areas where glacial melt was the source of late summer stream flows. Other analytical needs included evaluating the relationship of climate change to mitigation, evaluating options for climate adaptation (including hydro operations to mitigate climate change effects in the estuary and plume), and evaluating the effects of climate change on certain species. A science – policy forum was called for on climate change and the Program called for publicly sharing research results. Lastly, the 2020 addendum included as a near term priority that climate change implications be considered on all aspects of the Program.

**Science Review:** As part of the effort to update the Council’s 2006 research plan, in 2016, the Council [asked](#) the ISAB and ISRP to develop a report (ISAB/ISRP 2016) that includes: “a revised set of critical uncertainties; a detailed list of research themes or categories that fully encompasses past, current, and possible future research; scientific input on identifying priorities among the critical uncertainties; and a determination of whether ongoing research is making progress in answering critical uncertainties listed in the current research plan.”

### *Other Key Topics and Accomplishments*

The 2014 Program included an investment strategy for asset management (see artificial production facilities). One component of this related to operations and maintenance for fish screens and lands. In order to develop a list of screens in need of maintenance, it was first necessary to have a full inventory of screens in the basin. The Fish Screens Oversight Committee (FSOC) was convened to produce that inventory. <https://www.nwcouncil.org/fish-and-wildlife/forums-and-workgroups/om-strategic-plan/>

Table 6. Major components of each Fish and Wildlife Program and amendment, organized by category and theme, 2014 – 2020.

Category	Theme	Major components
Hydrosystem	Water management	Flow measures to improve ecosystem function in mainstem and to support more naturally timed flow for the benefit of all fish affected by hydrosystem; measures in BiOps are included in Program; implement operational changes at Libby and Hungry Horse
	Passage	Implement and evaluate transportation efforts; support and improve multiple passage options for diverse species (including lamprey); improve adult passage structures for multiple species; improve fish counting, minimize spill impacts on adults
	Water quality	Release water from storage reservoirs to maintain temps in best ranges for fish; continue developing monitoring and models to support temperature and TDG management; continue developing passage structures that reduce TDG
Habitat	Restoration	Implement habitat restoration; restore mainstem habitat; restore ecosystem function in estuary as affected by hydrosystem; establish objectives and indicators; invest in mitigation in blocked areas
	Protection	Protected areas standards to be taken into consideration by FERC; resident fish losses should be settled through land acquisitions;

		consider recognizing stronghold areas based on state and tribal recommendations; improve water quantity and restore more natural hydrograph through acquiring water rights; implement 2010 Columbia River Basin Toxics Reduction Action Plan; screen water diversions to protect diversity of species
	Wildlife	Acquire and restore uplands for wildlife habitat; complete wildlife operational loss assessments; develop/ implement acquisition and enhancement projects to fully mitigate; complete mitigation agreements for remaining C&I; invest in mitigation in blocked areas
	Native predator management	Technical workgroup; evaluate predation on certain species; remove predators; sustain and support ongoing efforts to reduce predation by pinnipeds and birds
	Non-native and invasive species	Eradicate from strongholds; monitor and evaluate nuisance species; control non-native/invasive species where they pose a threat; prevent establishment of zebra and quagga mussels; assess potential impacts of using non-native fish species for mitigation: evaluate effects on resident fish; Sustain and support ongoing efforts to reduce predation by northern pike
Artificial production	Artificial production	Continue to reintroduce salmon and steelhead to where they were extirpated; support Kootenai white sturgeon production; rebuild native fish numbers; invest in mitigation in blocked areas
Program adaptive management	Regional planning	Complete and adopt resident fish loss assessments; complete loss assessment for lamprey; emerging priorities; clarified goals and objectives from 2014 Program; Near term priorities
	Harvest recommendations	Monitor/manage sturgeon fishery; harvest opportunities in blocked areas; develop interim fisheries where native fisheries are lost or are imperiled
	Regional coordination	Coordinate control of invasive species
	RM&E and reporting	<p>Study predation on lamprey during passage at dams; abundance of eulachon at Bonneville; lamprey passage counts at dams; effects of operations on certain species (e.g., sturgeon, lamprey), effects of dredging (including on lamprey, sturgeon); evaluate sturgeon passage and associated data</p> <p>Study habitat restoration effectiveness; spawning and habitat model for sturgeon; estuary/ plume habitat for eulachon; juvenile outmigrants in estuary; effects of contaminants on different species and the ecosystem</p> <p>Monitor and evaluate white sturgeon response to restoration actions and status; monitor status of hatchery sturgeon and assess tagging options; report on lamprey status and distribution every 5 years; evaluate potential for lamprey propagation and translocations; consider implications of climate change in all aspects of Program</p>
	Data management	Continue supporting FPC; BPA supports continued use of monitoring resources.org (PNAMP resource) and requires projects to report data

		publicly using regional databases; Manage data associated with SPIs and Program Tracker
	Science review	Council reviews HLIs periodically; participate in adaptive management strategy regarding monitoring methods; initiate performance evaluation; developed Strategy Performance Indicators
	Public engagement	Public involvement in all processes; recognition of partners; Council monitors success of outreach; develop improved public process to find cost savings
Other critical concepts		Balance power needs and fish survival needs, especially under emergency situations

## Using the Retrospective to Define and Focus Program Performance Assessments

### 40 Years of Implementation

Over the last 40 years, an estimated 1850+ projects have been funded by BPA to implement measures in the Council’s Fish and Wildlife Program. Major hydrosystem operational and structural changes and other required actions have occurred in addition to this estimated number of projects. Direct program actions include habitat restoration, hatcheries, research, and predator management. Major hydrosystem operational and structural changes include actions like reservoir elevations, protected flows, and fish passage. Other required actions include licensing and relicensing considerations from FERC in the protected areas (Figure 13). In some cases, actions taken to implement the Fish and Wildlife Program are entirely funded by BPA or implemented through an action agency. In other cases, funding from BPA is used to leverage additional contributions from other entities.

### Other Efforts in the Basin

Although the efforts occurring through the Fish and Wildlife Program are substantial, they are also a part of a tapestry of mitigation efforts in the basin. This tapestry represents a large, collaborative effort among many federal and state agencies, tribes, non-profits, and other governmental or non-governmental entities. Each of these entities operates with unique purposes and over different or overlapping geographic extents. The efforts themselves range from specific or single-entity actions to mitigate for individual dams to collaborative efforts to address fish production or ecosystem function where multiple partners and multiple programs each contribute to observed outcomes. It is important to consider the Program in relation to these other efforts when assessing performance as mitigation outcomes are influenced by this full tapestry of efforts.

## Next Steps: Categorical Assessments and Status and Trends Assessment

There is limited precedent for assessing performance of a program the size of the Fish and Wildlife Program—40 years, multi-disciplinary, and at the scale of the Columbia Basin. Given this scale, we developed an overall approach to manage the volume and complexity of information and to integrate data from SPIs and Program Tracker, along with other data sources. We identified the following key elements:

- (1) clear definitions of expectations and performance
- (2) an understanding of the program history and key events
- (3) a structured approach to organizing information
- (4) clear benchmarks and indicators

The performance assessment includes three connected efforts- this retrospective, categorical assessments of implementation, and a status and trends evaluation of Program goals and objectives.

The retrospective provided an understanding of Program history and key events. In particular, the historical context provided key information on why different elements have been included in the Program over time, what kind of changes were expected to occur, where those changes could occur, and when they could occur. This functioned as sideboards for the performance assessment. In preparing this retrospective, we went through a detailed process to assemble the full set of measures across 40 years of Programs. These were organized by category and theme so that we could determine how Programs have developed and changed over time and when different topics came to prominence. Because the Program is so large, the retrospective was also critical for defining and focusing the upcoming assessments on major topics in each Program.

The categorical assessments will provide further information on implementation of the key measures identified from the retrospective, organized according to the main categories in the Program (Hydrosystem, Habitat, Artificial production, and Program Adaptive Management). These categories are implemented collectively to achieve mitigation. Through a series of Categorical Assessments, we will address a common set of questions: (1) what was called for in the Program (inputs); (2) what was implemented (outputs); and (3) how implementation compares to existing benchmarks, when available. In summarizing inputs and outputs, we will incorporate content from existing summaries (e.g., the Program Tracker with Strategy Performance Indicators or dashboards on particular topics) and also develop new summaries from a variety of information sources. Given the variety of sources used and variable recording keeping over the last 40 years, each topic is described in the level of detail available.

Concurrent with the categorical assessments, we are tracking progress toward the goals and objectives described in the 2020 addendum. This status and trends assessment will incorporate some datasets on Program Tracker and other sources of information.

Collectively, the retrospective, the categorical assessments, and the status and trends assessment will provide a long-term, large-scale understanding of program performance over time, including key

information for tracking progress on goals and objectives. They will also aid in characterizing what conditions might currently exist had the Program not been implemented and what the trajectory of change looks like in the basin, given the background environmental and human development changes that have co-occurred with implementation. These three assessments will serve as an educational tool to assist the region with identifying future mitigation needs and to support future Program amendments.

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